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Innovative Educational Technologies, Tools and Methods for E-learning

Scientific Editor

Eugenia Smyrnova-Trybulska

Katowice–Cieszyn 2020

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University of Silesia in Katowice
Faculty of Arts and Sciences
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Monograph

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TABLE OF CONTENTS

CHAPTER III.
E-learning in STEM and STEAM Education

CHAPTER IV.
E-environment and Cyberspace.
E-learning and Internationalisation in Higher Education

Innovative Educational Technologies, Tools and Methods for E-learning
Scientific Editor Eugenia Smyrnova-Trybulska
"E-learning", 12, Katowice–Cieszyn 2020, pp. 11–13
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INTRODUCTION

The theme of the conference is: *"Innovative Educational Technologies, Tools and Methods for E-learning"*.
The monograph ***"Innovative Educational Technologies, Tools and Methods for E-learning"*** includes articles based on the best papers prepared and presented by authors from nine European countries and from more than twenty universities during the scientific conference entitled "Theoretical and Practical Aspects of Distance Learning", subtitled: ***"Innovative Educational Technologies, Tools and Methods for E-learning"***, which was held on 12–13 October 2020, organized by the Faculty of Arts and Sciences of Education in Cieszyn, the Faculty of Social Sciences, the Institute of Pedagogy, Faculty of Science and Technology, the Institute of Computer Science, University of Silesia in Katowice, Poland. Co-organizers and Partners: University of Ostrava (UO), Czech Republic, Silesian University in Opava (SU), Czech Republic, Constantine the Philosopher University in Nitra (UKF) Slovakia, University of Extremadura (UEx), Spain, University of Twente (UT), The Netherlands, Lisbon Lucíada University (LU), Portugal, Curtin University in Perth (CU), Australia, Borys Grinchenko Kyiv University (BGKU), Ukraine, Herzen State Pedagogical University of Russia, St.Petersburg (HSPU), Russian Federation, Dniprovsk State Technical University (DSTU), Ukraine, IADIS – International Association for Development, of the Information Society, a non-profit association, Polish Pedagogical Society, Branch in Cieszyn, Polish Scientific Society for Internet Education, Association of Academic E-learning, Poland.
Experts on STEM and robotics in education from 10 countries, in particular Australia, Bulgaria, Czechia, the Netherlands, Poland, Portugal, Slovakia, Ukraine, Russia, Turkey, reflect about Innovative Educational Technologies, Tools and Methods for E-learning, presented research results, contemporary trends and scientific an educational project devoted MOOCs, Artificial intelligence (AI), augmented reality (AR), virtual reality (VR), Selected Web 2.0 and Web 3.0 technology, LMS, CMS, STEM, mobile learning other topics.
The speakers from the Universidade Lusiada de Lisboa (Portugal), the Comenius University in Bratislava (Slovakia), Plovdiv University "Paisii Hilendarski" (Bulgaria), Borys Grinchenko Kyiv University (Ukraine), Gdańsk Technical University (Poland), Herzen State Pedagogical University of Russia, St. Petersburg (Russia), Jagiellonian University (Poland), Warsaw University (Poland), Silesian University in Opava (Czech Republic), University of Silesia in Katowice (Poland), Lisbone Lusiada University, Lisbone (Portugal), K.D. Ushynskyi South Ukrainian National Pedagogic-

al University (Ukraine), Mykhailo Drahomanov National Pedagogical University, Kyiv, (Ukraine), Dniprovsk State Technical University (Ukraine), University of Ostrava (Czech Republic), Pedagogical University of Krakow (Poland), University of Social Sciences and Humanities in Warsaw (Poland), Instituto Superior de Tecnologias Avançads (Portugal), Makarenko Sumy State Pedagogical University (Ukraine), Ternopil University (Ukraine), Kherson State University (Ukraine), Izmail State University of Humanities (Ukraine), and other educational institutions delivered lectures providing insights into interesting studies, presented their recent research results and discussed their further scientific work.

The authors include experts, well-known scholars, young researchers, highly trained academic lecturers with long experience in the field of e-learning, PhD students, distance course developers, authors of multimedia teaching materials, designers of websites and educational sites.

I am convinced that this monograph will be an interesting and valuable publication, describing the theoretical, methodological and practical issues in the field of E-learning in STEM education offering proposals of solutions to certain important problems and showing the road to further work in this field, allowing exchange of experiences of scholars from various universities from many European countries and other countries of the world.

This book includes a sequence of responses to numerous questions that have not been answered yet. The papers of the authors included in the monograph are an attempt at providing such answers. The aspects and problems discussed in the materials include the following:

The conference topics include the following thematic sections:

1. Innovative Educational Technologies, Tools and Methods for E-learning

- Educational technologies for e-learning
- Modern ICT tools for e-learning – review, implementation, opportunities for effectiveness learning and teaching
- Innovative methods for e-learning – theoretical and practical aspects of using
- MOOCs – methodology of design, conducting, implementation and evaluation
- Artificial intelligence (AI), augmented reality (AR), virtual reality (VR)
- Selected Web 2.0 and Web 3.0 technology
- LMS, CMS, VSCR, SSA, CSA
- Cloud computing environment, social media, multimedia resources, (video) tutorial design
- Simulations, models in e-learning and distance learning
- Networking, distance learning systems
- M-learning

2. E-learning and Internationalisation in Higher Education. E-environment and Cyberspace

- Contemporary trends in world education – globalization,
- internationalization, mobility

- Legal, social, human, scientific, technical aspects of distance learning and e-learning in different countries
- European and national standards of e-learning quality evaluation
- Psychological and ethical aspects of distance learning and e-learning in different
- Collaborative learning in e-learning
- E-environment of the university
- SMART universities. SMART technology in education
- E-learning in a sustainable society
- Comparative approach

3. E-learning and STEM Education

- Robots and Coding in education
- Immersive learning environments. Blockchain. Bots
- Internet of things. 3D printing
- STEM education contemporary trends and challenges
- Successful examples of e-learning
- Distance learning in humanities and science
- Quality of teaching, training
- Evaluation of synchronous and asynchronous teaching and learning, methodology and good examples

4. Development of Key and Soft Competences and E-learning

- Effective development of teachers' digital skills
- Key competences and soft skills in the digital society
- Use of e-learning in improving the level of students' digital competences
- E-learning for humanities
- E-learning for science and technologies
- E-Learning and Lifelong Learning
- Self-learning based on Internet technology

Publishing this monograph is a good example of expanding and strengthening international cooperation. I am very grateful for valuable remarks and suggestions which contributed to the quality of the publication. Here I especially want to thank Dr Mariusz Marczak for his assistance in proofreading and editing this publication. Also, I would like to say 'thank you' to the authors for the preparation and permission to publish their articles. I wish all readers a pleasant read. Thank you.

Eugenia Smyrnova-Trybulska

CHAPTER I.
Innovative Educational Technologies, Tools and Methods for E-learning

Innovative Educational Technologies, Tools and Methods for E-learning
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THE MOODLE COMMUNITY PLATFORM VERSUS THE MICROSOFT TEAMS CORPORATE APPLICATION

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Abstract: *The aim of study was to identify trends on the LMS's and e-learning industry's market in the context of students' and academics' needs in regard to distance education. Features and capabilities of the Moodle and Microsoft Teams platforms for distance education and networking purposes were analyzed and also the 5119 questionnaires conducted among the Cracow Pedagogical University students participating in distance education. 3167 questionnaires were conducted between 18th and 21st March 2020, another 1927 between 26th May and 7th June 2020, and a group of 25 students enrolled in Culture and Media Studies course completed questionnaires between 1st and 18th June 2020. The results of the research indicated that Moodle platform is better protected from unauthorized access. MT is more attractive regarding to video meetings system, but working with MT is absorbing, stressful and exhausting especially for the tutor, because MT is inscribed into corporate practices, and is dominated by visual and synchronous communication. When it comes to testing knowledge, 37% students preferred Moodle, 22% – MT, while 41% – other. Moodle refers to university traditions, while MT – to culture of corporate co-operation and uniformity. Regulations should not aim at pleasing students' by attractive tools, but should safeguard the good quality of distance education.*

Keywords: e-learning industry market; corporation; attractiveness; video meetings; regulations.

INTRODUCTION

Currently, the digital learning environment in Poland is based mainly on the Moodle (Modular Object-Oriented Dynamic Learning Environment) or on Microsoft Teams (MT) platforms. Despite their educational orientation, those platforms use different communication channels and tools. That is why, they influence teaching processes, students' soft competences and social contacts differently.

The Moodle platform and Microsoft Teams application are frequently utilized during the COVID-19 pandemic for distance education purposes. The Moodle is an open source platform installed on university or school servers, licensed by the GNU, free to use and designed for use in education. In 2015, it was the most popular LMS, endorsed by Moodle Users Association. In contrast, MT is an application created, managed and retailed by the Microsoft, designed for corporation use, and based on the Microsoft 365 platform. It used to be a component the Office 365 package. However, because of the current pandemic, from 11th March 2020 till 2021 companies, schools and private individuals can access it free of charge. Both teaching platforms have inbuilt videoconferencing, chats, archiving, file exchange, and tests options. Each of these applications differently shapes user's soft competencies, and otherwise forms: collective awareness, attitude to cultural environment, time management, generation of information, attitude to corporate ideology, and evaluation of cognitive capitalism. They also differently approach issues regarding user's privacy. The expansiveness of Microsoft Teams positively correlates with students' and tutors' fatigue. The impact of prolonged use of those applications on students was studied by analyzing questionnaires obtained from 5119 students.

1. AIM, HYPOTHESIS AND METHODS

The aim of this study was to identify trends on the LMS's and e-learning industry's market in the context of students' and academics' needs in regard to distance education. To this end, the features and capabilities of the Moodle and MT platforms used in schools, at universities, and by other institutions and workplaces for distance education and networking purposes were analyzed. The following hypothesis was formulated: *the Moodle platform is more useful in distance education, because the MT application, despite having attractive visual communication features, has many features of a corporate tool and thus is less adequate for tertiary level education*.

2. RESEARCH MATERIAL

The functionality of both platforms, up to date research and information on those were analyzed. The 5119 questionnaires conducted among the Cracow Pedagogical University students participating in distance education during the COVID-19 pandemic were also analyzed. 3167 questionnaires were conducted between 18th and 21st March 2020 in the purpose to describe and try to capture the impact of the coronavirus pandemic on the life and functioning of Krakow youth (Długosz, 2020a), another 1927 between 26th May and 7th June 2020 in the purpose to describe the impact of the coronavirus pandemic on the life and functioning of students (Długosz, 2020b), and a group of 25 students enrolled in *Culture and Media Studies* course completed questionnaires between 1st and 18th June 2020 in the purpose to examine the quality of distance learning (Stoch, Kosek, 2020). The results showed that 89% of Pedagogical University students were enrolled in classes delivered via the Moodle platform, while 80% in those delivered via MT platform (Długosz, 2020b: 35).

Thus, the obtained results, assessments and conclusions are based on surveys carried out by other people for other purposes, but also on internet sources and the author's own experiences.

3. LIMITATIONS

The questionnaires were conducted among students from one university; therefore, conclusions cannot be generalized. However, the results show trends in the evolution of educational tools, of the LMS market and e-learning industry, as well as the needs of students', and lecturers' working patterns.

4. RESULTS

4.1. Similarities

Both platforms allow the tutor and participants to upload educational materials such as films, audio recordings, video meetings, multimedia presentations, graphics and animations. Both platforms allow for test preparation, chatting, transferring files, messaging, and archiving. Both platforms are available in mobile versions and can operate in the Cloud. Both platforms can be accessed anytime, anywhere.

4.2. Differences

4.2.1. Creators

The Moodle platform is co-created by its users. It is endorsed by Moodle Users Association and financed by crowdsourcing. By contrast, MT is a commercial product of the American technology company – Microsoft, the designer and owner of Microsoft Windows, the Microsoft Office suite and the Internet Explorer browser. In terms of accumulated capital, Microsoft ranks third on the list of the U.S. public companies, after Apple and Amazon.

4.2.2. Popularity

The Moodle platform has been used e.g. by Open University (UK) since 2005, i.e. it is a platform with a long teaching tradition at a tertiary level. In 2015, Moodle with an estimated 73.8 million users was probably the most popular LMS system, followed by Edmondo and Blackboard (Pappas, 2015). In 2020, the LMS was used by educational providers delivering over 26 million registered courses and accessed by 212 million users from 242 countries (Moodle.org). USA, Spain, India, Mexico, Germany, Brazil, France, Russian Federation, Indonesia and Colombia have the highest number of registered Moodle users.

In the ranking of the most popular course management systems called *Top learning tools* (2019) prepared by Jane Hart, the Moodle platform occupied the 50th position;

dropped 8 places during the year. The application was in the 16th position as a higher education educational tool, and in the 44th position as a workplace training tool.
On the other hand, Microsoft launched MT in March 14th, 2017 as a fee-charging corporation networking tool. In *Hart's* ranking of the most popular team collaboration platforms (2019), MT was placed in the 11th position – it moved up 16 positions during that year. It ranked 5th as a workplace learning tool, preceded by PowerPoint, Google Search, YouTube and MS Word. But as a personal and professional learning tool it came 20th, and as a higher education tool – it was 34th.
However, after the tool was adapted for distance education and made available free of charge during the COVID-19 pandemic (Tur, 2020), 31 million new users (increase of 70%) accessed it within first 6 weeks. It has been accessed by up to 75 million users per day, and up to 200 million people accessed the MT platform per day to participate in meetings. MT was utilised by over 183 000 educational institutions (Protalinski 2020). From 2021 onwards, however, free access to MT will cease. Employees, primary and secondary school students, university students, teachers, lecturers and tutors who in the meantime have familiarized themselves with its functions and have saved some data on the OneDrive Cloud would be the ones likely to continue its use.

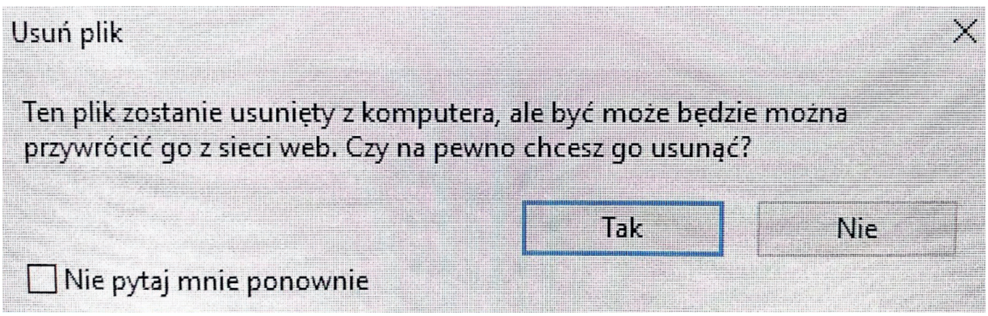
4.2.3. Costs of use

Downloading and using the Moodle platform will continue to be free of charge. Free access is possible as the platform is operated as an open source software under the GNU General Public License and copyright. Therefore, it can be accessed, distributed and improved by the users.
On the other hand, the fee for using MT is calculated depending on chosen functions and ranges from US$5 to US$20 per user (Microsoft). Educational version of Office 365 A1 which comprises of Outlook, Word, Excel, Power Point, One Note, Teams, Stream and other is free for download (Microsoft, 2020b).

4.2.4. User's privacy

Data posted on the Moodle platform are mainly saved on servers owned by the school, university or other educational entity. Therefore, it is protected from unauthorized external access and the collected data is not processed or sold by corporations. Open source software guarantees transparency of the operational system, allows introducing additional security features hence does not allow sharing information about users. Permanently deleting data is possible in the case of this platform.
In contrast, documents posted on the MT platform are saved along with user's telemetric data on OneDrive Cloud, i.e. on servers owned by Microsoft. The corporation keeps copies of all deleted documents (except videos) in so called bin even after the user had deleted them; it is worth saying that deleted documents say a lot about a user. Figure 1 shows a pop-up window containing information that documents deleted on computer are still saved in the OneDrive.
Saving data on students' progress on OneDrive is inconsistent with the intention of the ministerial ordinance: "Feedback on distance education students' progress should be stored at university's distance education platform or other tool designated for this purpose" (Ministry of Science and Higher Education, 2020, p. 4). Meanwhile, intro-

ducing MT to over 183 million educational institutions and facilitating over 34 million teleconferences, teleconsultations and healthcare meetings, Microsoft collected and saved on OneDrive lots of highly sensitive information. It is worth noting that the Microsoft has been following users of paid Office 365 suite and downloading titles of their private emails. That is why in 2018, due to unauthorized disclosure of telemetric data and private information about students and tutors, German province Hessen banned the use of the Microsoft's software in schools (Interia, 2019) "because the Microsoft suite's cloud storage and telemetry collection are not in line with the EU's General Data Protection Regulations" (Oates, 2019). Chinese authorities ordered that all foreign PCs, hardware and operating systems used by state offices and institutions are to be replaced till 2022 (Cuthbertson, 2019). Nonetheless, corporate MT software does not allow to establish source code. It has in-built automatic update system which sends reports on the software owned by the user of the Microsoft product. The user of Microsoft sites is also prompted to share their location, which is not the case with the Moodle platform.



F i g u r e 1. MT – information: „Delete file / This file will be deleted from your computer, but you will be able to restore it from the web. Are you sure you want to delete it? / Yes / No / Don't ask me again"

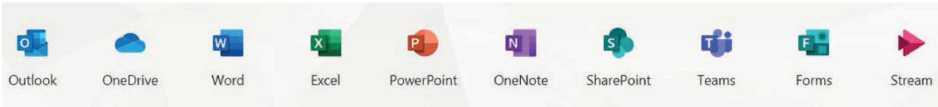
S o u r c e: scan by A. Ślósarz.

When it comes to conducting tutorials and examinations by the use of MT, students should be asked to provide consent to process their personal data and should be presented with the list of entities which would have access to this data.

4.2.5. Inter-connected applications and services

Both applications are inter-connected with e-mail box. In the case of the Moodle platform, this is the e-mail address provided by the user. MT service, on the other hand, uses e-mail address which was provided to the user as a part of the Office 365 suite alongside other programs, as shown in Figure 2.

With each consecutive click, Microsoft opens: Class Notebook, Dynamics 365, Calendar, Staff Notebook, Delve, Kaizala, People, Power Apps, Whiteboard. In addition to those, 571 apps, bots, and assistants are available in the *Applications* tab. In this way, MT became a tool for promoting several hundred Microsoft products.



F i g u r e 2. A set of applications inter-connected with MT
S o u r c e: scan by A. Ślósarz.

4.2.6. Attractiveness

In 2015, surveyed students reported that LMS's functionality was deficient because the platform lacked: *live and video conferencing options* (38%), *mobile learning options* (27%), *gamification* (22%) and *social learning options* (20%) (Pappas, 2019). Therefore, BigBlueButton i.e. Web conferencing system designed for online learning, has been made available on the Moodle platform. On the other hand, Microsoft edited the MT service to meet educational market's needs. During pandemic, teachers who were not prepared to conduct online education sessions opted for MT and often limited their teaching sessions to video meetings and marking written assignments.
It is important to note that 50% of students find "showing themselves and their surroundings to the camera stressful" (Długosz, 2020b, p. 42). In addition, real-time video communication has not proved to be synonymous with social presence which gives one a sense of physical and emotional intimacy, builds trust and increases satisfaction in chosen course of studies (Cobb, 2009, p. 251). In case of on-line education, social presence is based mainly on sending social signals such as showing interpersonal involvement, maintaining eye contact, using body language and on other non-verbal communication. Thus, it depends on tutor's and students' didactic and technical competences as well as on their engagement in communication; it does not depend just on technology. Showing oneself on the screen in real time is not synonymous with being socially present. Unfortunately, numerous regulations of many universities' which require taking classes in a synchronous mode by the use of the MT service seem to regard those two to be equivalent (Gmiterek-Zabłocka, 2020). Many institutions perceive MT as a way of ensuring contact between students and tutors and therefore MT has become "the favorite didactic tool of academic teachers during pandemic, especially those who have never before encountered distance education platforms" (Urbaniec, 2020).
Students were asked about assessment of distance education. It is worth emphasizing that 19% of them stated that found distance education more effective as compared with attending tutorials in person, and 16% – that it did not affect their study either way (Długosz, 2020b: 41). This means that some tutors and students effectively used their competences and digital teaching tools. They were aware that "interactivity of communication tools can drive social presence and students' satisfaction in online learning" (Park et al., 2020, p. 1).
In contrast, many students asked about minuses of distance learning mentioned excessive amount of study material to work through (68%), lack of direct contact with peers therefore lack of opportunity for group studying (58%), lack of direct contact with lecturers and tutors (57%), and lack of possibility to ask them questions (49%)

as disadvantages of distance education (Długosz 2020b: 40). Therefore, it can be said that some lecturers and tutors treated distance education tools as a one-way communication tools and file transfer utensils. Instead of an environment conducive to learning and collaboration, the lecturers and tutors created a file repository, where they uploaded study materials and student assignments; which is inconsistent with the ordinance of the Minister obliging academic lecturers and tutors to provide students not only with teaching materials but also with activities in the form of exercises, assessment criteria, regular feedback on their learning progress and regular monitoring of their progress (Ministry of Science and Higher Education, 2020: 1–2). Poorly organized distance education may make students to form negative attitude towards it for the future.

Students were asked about preferred methods of learning. The fact that the most of them (48%) preferred classes via MT conducted in real-time, rather than sharing materials prepared by the lecturers and tutors (20%) (Długosz, 2020b: 36) testifies that MT provides them with a illusion of having direct contact with academic team. However, when it comes to feelings related to remote education, the level of weariness caused by distance education turned out to be enormous: 64% of students reported fatigue, 62% – mental exhaustion, 60% – mood swings, and 59% – reduction in motivation to learn (Długosz, 2020b: 42). Therefore, it can be said that all participants, and especially tutor, found video conferencing absorbing, stressful and tiring. Visual communication in synchronous mode develops interpersonal relationships, facilitates oral communication, co-management and integration, but on the other hand it can promote undesirable practices and perpetuate errors. It requires the tutor and participants to be available at a specific time, have access to good quality equipment and Internet connection necessary for video transmission, as well as be in an environment adapted for distance education – quiet, peaceful and aesthetic. It may violate user's privacy due to default recording option. The latter inconvenience can be addressed by turning off the camera or blurring / substituting the background. Therefore, working with MT is absorbing, stressful and exhausting for all participants, and especially for the tutor.

4.2.7. Organisation of education

By default, the Moodle platform automatically sets the hierarchy of the tutor who prepares educational resources and students' who can, however, be active on forums and participate in chats, share documents, edit content of the Wiktionary / the board / journal and jointly develop wiki. It is possible to delegate tutor's privilages to selected students who can e.g. moderate the forum. The democratisation of the educational process satisfies the need for social learning. However, at the same time it poses a threat to the quality and value of knowledge being shared. Therefore, any changes to the default hierarchy are to be made by the tutor, who takes into account their educational impact. The Moodle platform promotes written and asynchronous communication processes, which requires the tutor to invest additional time, but allows students to work at a time convenient for them and protects their privacy.

For comparision, MT is inscribed into corporate practices, and is dominated by visual and synchronous communication. Therefore, the hierarchical management model has been transformed into Rensis Likert's democratised, participatory and multidirectional IV model back from 1967 (Dobek-Ostrowska, 2007). Everyone – under discretion of a person chairing the meeting which is the default MT's setting – can speak, show themselves on screen, make their computer's screen visible to all participants, send and receive documents because such a model of organisational communication turned out to be the most desirable, flexible, and tolerant of changes and chaos. The European Union obliges enterprises to involve employees in decision-making processes (European Parliament, 2002). However, MT service is not a system suitable for a large number of users, for sessions including power relations and for educational communication in which the role of tutor is clearly defined.

The Regulation of the Ministry of Science and Higher Education obliges lecturers and tutors to use teaching methods which incorporate synchronous or asynchronous interactions (Ministry of Science and Higher Education, 2020: 1), the choice is up to the lecturer/tutor and the students. In the Institute of Polish Philology, 38% of students preferred asynchronous classes characteristic of the Moodle platform, only 8% – synchronous – characteristic of MT, 21% – had no preference (Stoch, Kosek, 2020: 4). Students asked about choosing preferred way of distance learning (synchronous or asynchronous) explained their preferences for asynchronous classes e.g. by:

- *Asynchronous are better for me because I find it easier to concentrate and to organize my time; I think that zoom learning is a worse option for visual learners like me.*
- *The synchronous form is more mobilizing, although there might be some problems; for example some students had to go to work at the session time, and there were also some technical problems.* (Stoch, Kosek, 2020: 5).

When it comes to testing knowledge, 37% students asked about the most effective tool preferred Moodle, 22% –MT, while 41% – other. The preference for Moodle was explained, among others, as follows:

- *The most effective for me are tests available through the Moodle platform; being time-limited, they verify our true knowledge under time pressure; it is much harder to search for answers in the materials on hand.*
- *Moodle is the best because it sets time limits, let you know the correct answers, and is easy to follow.* (Stoch, Kosek, 2020: 15–16)

These statements show that for 37% of students the Moodle platform is better suited for teaching and examination purposes than MT. It can also be used for conducting final examinations – the ministerial recommendation allows such to be held as part of synchronous online contact via "video conferencing, internet conferencing, remote teaching platform and other tools designed for synchronous group work." (Ministry of Science and Higher Education, 2020: 4). Therefore, university chancellors' regulations which order to save final examinations' video recordings on MT, especially when the university owns a platform are controversial. Live streaming usually puts participants under additional stress, may be associated with some technical problems and violates user's privacy. Therefore, there is an urgent need for universities to review their final examination procedures, allow remote option of such, and to ensure safe storage of student's personal data, their pictures, their ID numbers and the pictures of their ID which they show to the camera on university servers and not on Microsoft's (Świder, 2020).

4.2.8. Graphic design

The Moodle logo refers to university traditions (see Figure 3), while MT – to culture of corporate co-operation which is symbolised by its logo placed in front of uniformed employees icons. Their silhouettes have been reduced to the letters of the alphabet: j, i. This means that corporate employees are deprived of individual features and turned into company elements (see Figure 4).

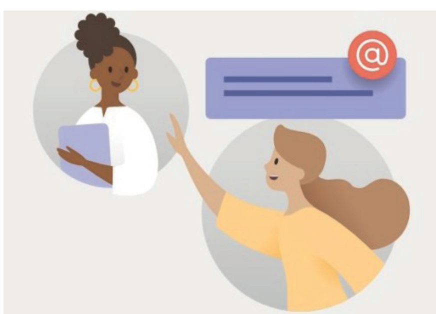
F i g u r e 3. Moodle logo

S o u r c e: Moodle, https://moodle.org/pluginfile.php/2840042/mod_page/content/23/Moodle-Logo-RGB.png (accessed 10.07.2020)

F i g u r e 4. Microsoft Teams (MT) logo

S o u r c e: Wikipedia, https://pl.wikipedia.org/wiki/Microsoft_Teams (accessed 10.07.2020)

The graphic design of the Moodle platform enhances communication by visually organising available materials and exercises. On the other hand, MT, by the use of graphics, promotes corporate technological solutions, own products, multiculturalism and implements user-specific affective control which are frequently used by corporations. Figure 5 shows MT's chat icon found on the main site, while Figure 6 shows its user's assignments icon.



F i g u r e 5. MT chat graphics

S o u r c e: Scan by A. Ślósarz.

F i g u r e 6. MT assignment graphics
S o u r c e: Scan by A. Ślósarz.

Smiling chat participants serve as a workplace emotions influence tool. Oppressive non-verbal expression and body language induces desired emotional response in clients and employees. It also triggers positive attitude to the tasks to be performed. Hence, in Figure 6 there is a smiling emoticon on the box filled with tasks. However, an intense emotional work often causes psychological exhaustion e.g. stress, depression, and burnout (Szarecki, 2012: 96).

Figures 4, 5, and 6 which are specific to a corporate culture failed as educational tools during COVID-19 pandemic. Large proportion of students already tired of remaining in isolation and overloaded with assignments developed psychosomatic symptoms which intensified as the pandemic continued (Długosz, 2020b: 23–28).

4.2.9. Active and passive functions of application

Moodle allows the lecturer and the users to: format and post documents and entries, send files, determine ways of communication e.g. via chats or forums. The application opens after the user types the URL address in the browser and logs in (or activates the smartphone version of the application by tapping the icon); logging out closes the application. Therefore, it is the user who decides about the time and duration of their work.

On the other hand, MT in additon to the above also performs some actions automatically: it is the first to open on the screen, it appears in the taskbar, it has a built-in chat option, does not require logging out and remains active 24 hours a day. Messages can be sent with sound reminders sounding every 2 minutes for 20 minutes. Therefore, MT is mainly an audio-visual application, it dominates other programs and user's other activities. In this way, *bodily colonisation of a person working in a corporate culture* occurs (Szarecki 2012: 94). It is no wonder then that the majority of questionnaireed students were *fatigued by distance education* (Długosz, 2020b: 41–43).

4.2.10. Shaping soft competences and collective awareness

Both presented applications differently shape person's soft competencies. After Niall Sclater we can say that the Moodle and a number of other LMSs are *relatively pedagogy-neutral and are merely shells in which to put content and ativities* (Sclater, 2015). The Moodle develops in a user a systematic and critical approach to their own work and to educational materials. If the tutor competently organises classes, it also triggers cooperation and joint knowledge creation on a forum, in a dictionary or in wiki. Elements of gamification are available: displaying names of best performing students, providing badges, giving praise, etc.

For comparision, MT requires strict observance of session times, collaboration and formalisation of information preparation sessions and students‘ management, uniformity expressed e.g. in addressing participants by their first name and surname preceeded by „@“, which guarantees that the message will be sent as e-mail to the chosen person. Thus, corporate ideology and cognitive capitalism values are being consolidated in collective consciousness e.g. cult of the digital technological revolution / intellectual work / international economic flow as a expression of global capitalism / rebellion against the state-economic order (Ratajczak, 2015: 58–59).

According to Peter L. Berger and Thomas Luckmann (1966), knowledge is derived from social interactions. Therefore, educatio institutions and corporations are equally important for generation of students using MT as part of their education.

CONCLUSION AND RECOMMENDATIONS

The hypothesis stating that *the Moodle platform is more valuable for distance education, because the MT application, despite having attractive visual communication features, has many features of a corporate tool and thus is less adequate for tertiary level education* has been confirmed. To this confirmation leads a comparison of their creators and owners, interconnected applications, costs of use, user's privacy treatment, organization of education, graphic design and the shaping of soft competences. The functions of both the Moodle and MT platforms are useful in e-learning. It is, therefore, advisable to base distance education on an educational platform which enables video communication in real time. The best solution is Moodle platform with options such as interactive visual contact in real time, and possibility of saving recordings on university's server. This enable secure storage of registered resources, and allow users to easily collect, search, share, upload and access those.

On the other hand, MT service failed to enable direct, real-time communication. Academics still have to develop suitable forms of their social presence in distance communications. To facilitate that, it is necessary to study the quality of distance lectures and tutorials. should not aim at pleasing students' or lecturers'/tutors' by recommending use of attractive tools, but rather should safeguard good quality distance education. Therefore, directives to prepare high-quality distance education sessions gained increased importance during current pandemic (Kędzierska et al., 2015; Association for Academic E-learning 2008).

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CLOUD COMPUTING AND E-LEARNING (COMPUTER NETWORK LABORATORIES FOR CURRICULUM DEVELOPMENT IN CLOUD COMPUTING)

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Abstract: *This work demonstrates that the use of laboratories for the development of curricular work in the area of information technology exclusively supported by cloud computing technology does not decrease the level of learning and assessment objectives on the part of students. This scenario arose due to the need to interrupt face-to-face classes in physical laboratories due to the COVID-19 Pandemic.*

Keywords: Cloud Computing; Azure; Distance learning; WEB App, Virtual Labs.

INTRODUCTION

In common language Cloud Computing (CC) is a set of computational resources made available to a set of users, remotely, taking the form of services. And like any service today, electricity, water, gas, etc., are always available for both individual and business use. This is possible because throughout the second half of the 20th century, the technological industry adopted a set of standard models from different sources and technological platforms. CN works as a universal, paid service, but always available to users/customers who need it, in the same way that they have the electricity service. The main principle that supports this technology and this model is the provision of computing, storage and software as a service. Cloud is a distributed and parallel computing system, consisting of a collection of virtualized and interconnected computers that are presented as a set of dynamic and unified resources, based on the Service Level Agreement (SLA) established between the service provider and the end customer. Due to the crisis caused by the pandemic of COVID-19, almost all universities had to change the model of classroom classes to a model of distance classes. The paradigm is radically different. In certain scientific and technical areas, the transition was easier, however in the case of laboratory classes the process became more complex or even impossible. In the specific case of computer network laboratories in which they were based on computers and servers installed on universities on-premise infrastructures, the process was almost impossible and these laboratory classes had to be postponed, or complex processes had to be created so that students could go to the labs. What we intend with this work is to develop a demonstration of a model that can allow to simulate the teaching of the development and operation of computer networks through a laboratory created by the teacher in a Cloud Computing system, in this case at Azure.

The main objective of this work is to verify whether the use of cloud computing laboratories (in this case in Azure) for curriculum development as a substitution for physical laboratories on university campuses, due to the mandatory interruption of classroom classes in the context of COVID-19, had an impact in learning on school success, as manifested in assessments. This study is contextualised in the area of informatics and involved MA-level students in Computer Science.

1. FUNDAMENTALS OF CLOUD COMPUTING

1.1. Definitions

The term cloud computing (CC) has become somewhat of a sensational term, almost everyone in the industry has its own definition of CN, in this paper we adopted the definition of CC adopted by *National Institute of Technology and Standard*s (NIST) (NIST, 2020): "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics (On-demand self-service, Broad network access, Resource pooling, Rapid elasticity, Measured Service); three service models (Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS)); and, four deployment models (Private cloud, Community cloud, Public cloud, Hybrid cloud). Key enabling technologies include fast wide-area networks, powerful, inexpensive server computers, and high-performance virtualization for commodity hardware. The Cloud Computing model offers the promise of massive cost savings combined with increased IT agility. It is considered critical that government and industry begin adoption of this technology in response to difficult economic constraints. However, cloud computing technology challenges many traditional approaches to datacenter and enterprise application design and management. Cloud computing is currently being used; however, security, interoperability, and portability are cited as major barriers to broader adoption. The long-term goal is to provide thought leadership and guidance around the cloud computing paradigm to catalyze its use within industry and government. NIST aims to shorten the adoption cycle, which will enable near-term cost savings and increased ability to quickly create and deploy enterprise applications. NIST aims to foster cloud computing systems and practices that support interoperability, portability, and security requirements that are appropriate and achievable for important usage scenarios" (MELL T, 2011).

In common language, Cloud Computing (CC) is a set of computational resources made available to a set of users, remotely, taking the form of services. And like any service today, electricity, water, gas, etc., are always available for both individual and business use. This is possible since throughout the second half of the 20th century, the technological industry adopted a set of standard models from different sources and technological platforms. CC works as a universal, paid service, but always available to users/customers who need it, in the same way that they have access to power supply. However, CC is a term that has many meanings, but an effort has been made in the last ten years to establish common denominators in these meanings, in order to create a more objective definition. This effort has mainly been made through the publications of the Information Technology Infrastructure Library (ITIL), which is a library of good practices to be applied in infrastructures, operations and maintenance of information technology services, having been developed by the Central Computer and Telecommunications Agency (CCTA), today under the Office for Government Commerce (OGC) in England. In the most generic form, and following the ITIL concept, a service is a relationship between a consumer and a provider, in which the provider makes available and delivers to the consumer a value (service) and the consumer avoids the risks and investments in providing it this value (service) itself, currently the CC is also inserted in this context. For example, the simple storage and database management services of a commercial store on the Web, if they are using the CC, are always available to the store owner, as well as to his customers, without the said owner having to worry about maintaining those services, and don't have to bear the investment risks of purchasing a complex platform. If the business does not go well, it simply cancels the services, having had no losses associated with the investment of technological fixed assets (CSIAC, 2020).

The term CC is recent, but the concept and idea go back to the 60s and 70s of the 20th century, when computing was very localised and exceptionally expensive. The concept of CC appears as a result of another concept that was called time-sharing, and which implied a sharing by several entities, at different times, the same computing equipment. However, today, there are substantial differences between the concept of computational time-sharing and CC. At the time of computational time-sharing, the services or machines that held them could only be used by one operator at a time, that is, they were divided into portions of time and not portions of accommodation space; today the question of time sharing does not exist, it pays according to the service that is obtained or the space that the information occupies, but not according to the time that this resource is being used. But the basic idea is very similar, it is to provide a computing service remotely and not locally. Using simple and daily concepts by analogy, we can say that both the computational time-sharing system and the CC system can be seen as a service that is made available in the same way as electricity or water, that is, they are available when we need them , we pay for that availability and for its use, e.g. if we use Office 365 we pay for its use, as when we consume electricity, but we can also pay for the accommodation of the documents produced by it, as we pay if we want to have a storage system for backup power (CSIAC, 2020).

1.2. Main characteristics of cloud computing technology

In on-demand self-service services, a consumer can unilaterally provision computing resources, such as server time and storage network, as needed automatically, without requiring human interaction with each service provider.

Wide network access, resources are available on the network and accessible through standard mechanisms that promote use by thin or thick heterogeneous client platforms (e.g. cell phones, tablets, laptops, and workstations).

Pooled resources, the provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to the consumer's requirements. There is a sense of location independence, as the customer generally has no control or knowledge about the exact location of the resources provided, but may be able to specify the location at a higher level of abstraction (for example, country, state or data centre). Examples of resources include storage, processing, memory and network bandwidth (SOUNDARJAN, 2015).

Fast elasticity, resources can be provisioned elastically and made available, in some cases automatically, to quickly scale out and in, according to needs. To the consumer, the resources available for provisioning generally appear to be unlimited and can be appropriated in any quantity and at any time.

Services with metrics, cloud systems automatically control and optimize the use of resources, leveraging a metering resource at levels of abstraction appropriate to the types of services (for example, storage, processing, bandwidth and active user accounts). The use of resources can be monitored, controlled and reported, providing transparency to the provider and the consumer of the services used (BRANDAO, 2019).

1.3. Service Model

Currently, cloud computing technology has three service models (cf. Figure 1):

Infrastructure as a Service (IaaS), the user can implement and execute software arbitrarily, which can include operating systems and applications. The user does not administer or control the underlying cloud infrastructure, but has control over operating systems, storage, deployed applications and limited control over some network components, for example, host firewalls. The services offered by this delivery model include: hosting servers, Web servers, storage, computing hardware, operating systems, virtual instances, load balancing, Internet access and bandwidth provisioning.

Platform as a Service (PaaS), allows a cloud user to implement a product created or purchased by the consumer as applications using programming languages and tools supported by the service provider. The user: has control over the implemented applications and, possibly, the settings of the hosting environment of the same. It does not administer or control the underlying cloud infrastructure, including network, servers, operating systems or storage. It is not particularly useful when: the application must be portable; proprietary programming languages are used; hardware and software must be customized to improve application performance (CARLYLE, 2016).

Software as a Service, applications are provided by the service provider. The user does not administer or control the underlying cloud infrastructure or the resources of individual applications. Services offered include business services, such as workflow management, groupware and collaboration, supply chain, communications, digital signature, customer relationship management (CRM), desktop software, financial, geospatial and research management. Web 2.0 applications, such as: metadata management, social networks, blogs, wiki services and portal services. It is not suitable for real-time applications or for those where data cannot be hosted externally. Examples: Office 365, Salesforce.com, Gmail (VOORSLUYS, 2011).

1.4. Implementation Models

There are four models for implementing cloud computing technology:
Private Cloud, the cloud infrastructure is provisioned for exclusive use by a single organisation, composed of several consumers (for example, business units). It can be owned, managed and operated by the organization, third parties or a combination of them, and it can exist on or off the premises (ARMBRUST, 2009).
Community Cloud, the cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that share concerns (for example, mission, security requirements, policy and compliance considerations). It can be owned, managed and operated by one or more community organizations, by third parties or a combination of them, and it can exist on or off the premises (PAGE, 2012).
Public cloud, the cloud infrastructure is provisioned for open use by the general public. It may be owned, administered and operated by a company, academic or governmental organization, or some combination thereof. It exists on the premises of the cloud provider.
Hybrid Cloud, the cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community or public) that remain unique entities, but are united by standardized or proprietary technology that allows the portability of data and applications (for example, cloud augmentation for load balancing between clouds).

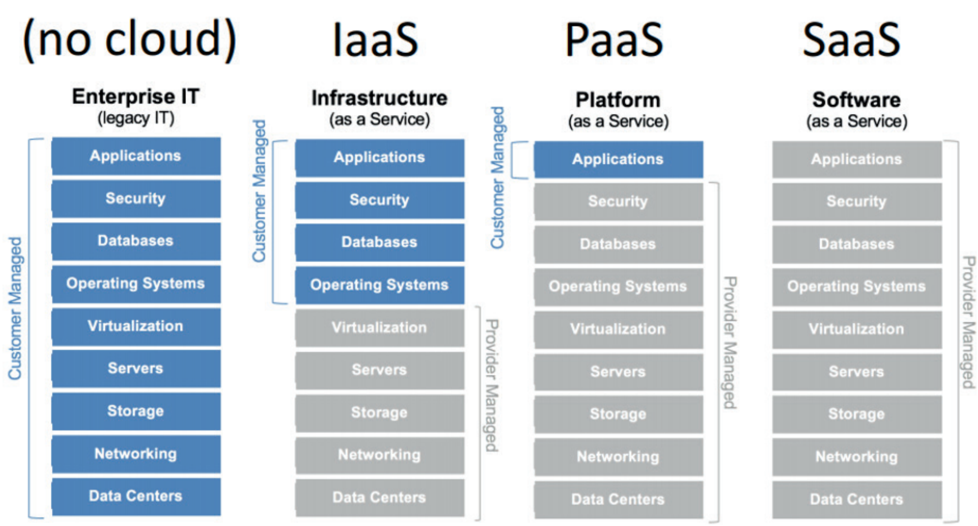


Figure 1. Models of Cloud Computing Services

Source: Own work.

2. LABORATORY TO TEACH HOW TO CREATE A WEB APP

The plan for creating a WEB App follows the exact indications advised by Microsoft in its teaching plan for the development of these solutions in azure (https://docs.microsoft.com/en-us/learn/modules/host-a-web-app-with-azure-app-service/3-exercise-create-a-web-app-in-the-azure-portal?pivots=csharp).

If you want building a website for a new business, or you're running an existing web app on an aging on-premises server. Setting up a new server can be challenging. You need appropriate hardware, likely a server-level operating system, and a web hosting stack. Hosting your web application using Azure App Service makes deploying and managing a web app much easier when compared to managing a physical server. In this module, we'll implement and deploy a web app to App Service.

Learning objectives: Use the Azure portal to create an Azure App Service web app; use developer tools to create the code for a starter web application; deploy your code to App Service.

Using the Azure portal, you can easily add deployment slots to an App Service web app. For instance, you can create a staging deployment slot where you can push your code to test on Azure. Once you are happy with your code, you can easily swap the staging deployment slot with the production slot. You do all this with a few simple mouse clicks in the Azure portal.

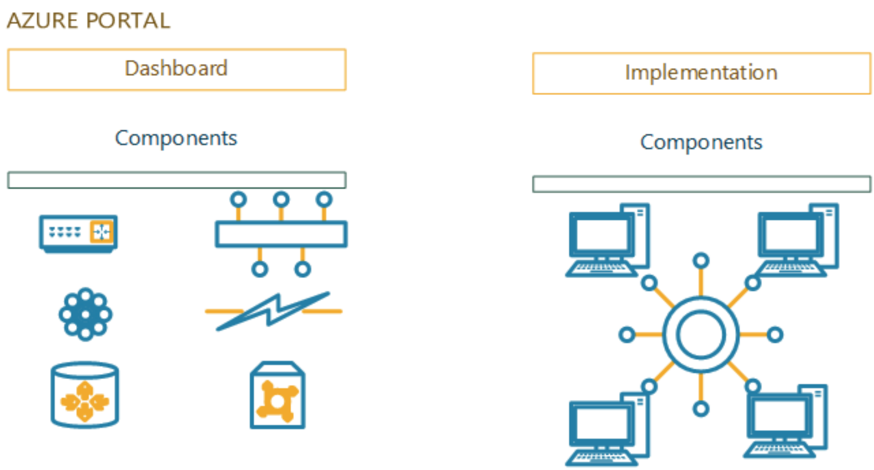


Figure 2. Azure Portal

Source: Own work.

When you're ready to run a web app on Azure, you visit the Azure portal and create a Web App resource. Creating a web app allocates a set of hosting resources in App Service, which you can use to host any web-based application that is supported by Azure, whether it be ASP.NET Core, Node.js, Java, Python, etc.

If you are deploying your app as code, many of the available runtime stacks are limited to one operating system or the other. After choosing a runtime stack, the toggle will indicate whether you have a choice of operating system. If your target runtime stack is available on both operating systems, select the one that you use to develop and test your application. If your application is packaged as a Docker image, choose the operating system on which your image is designed to run. Selecting Windows activates the Monitoring tab, where you have the option to enable Application Insights. Enabling this feature will configure your app to automatically send detailed performance telemetry to the Application Insights monitoring service without requiring any changes to your code. Application Insights can be used from Linux-hosted apps as well, but this turnkey, no-code option is only available on Windows. An App Service plan is a set of virtual server resources that run App Service apps. A plan's size (sometimes referred to as its sku or pricing tier) determines the performance characteristics of the virtual servers that run the apps assigned to the plan and the App Service features that those apps have access to. Every App Service web app you create must be assigned to a single App Service plan that runs it. A single App Service plan can host multiple App Service web apps. In most cases, the number of apps you can run on a single plan will be limited by the performance characteristics of the apps and the resource limitations of the plan. App Service plans are the unit of billing for App Service. The size of each App Service plan in your subscription, in addition to the bandwidth resources used by the apps deployed to those plans, determines the price that you pay. The number of web apps deployed to your App Service plans has no effect on your bill.

You can use any of the available Azure management tools to create an App Service plan. When you create a web app via the Azure portal, the wizard will help you to create a new plan at the same time if you don't already have one. The Azure Portal provides a wizard to create the solution with the following options: subscription, resource group, App name, publish, runtime stack, operating system, region and App service plan. To create the WEB App, the following steps must be followed (Figured 2):

On the Azure portal menu or from the Home page, select Create a resource. Everything you create on Azure is a resource. The portal navigates you to the Marketplace page. From here, you can search for the resource you want to create or select one of the popular resources that people create in the Azure portal. Select Web > Web App to display the web app creation wizard. Fill out the wizard with the following values: Subscription (Concierge), Resource Group (Sandbox resource group), Name (enter a unique name), Publish (Code), Runtime stack (.NET Core 3.1 – LTS), Operating System (Linux), Region(chose the close to you), Sku and Size (F1). Then select Review and Create.

3. THE RESEARCH METHODS

The main techniques and tools used for gathering research data include quantitative techniques:

3.1. Observation

That involved counting the number of times that a specific event occurred or encoding observational data to translate them into numbers. In this case, the difficulties in completing the laboratories requested for the evaluation.

3.2. Screening of assessment documents

Obtaining numerical data from the evaluation forms and counting of unrealized events that were considered mandatory objectives for evaluation.

3.3. Comparative experimentation

Testing hypotheses in laboratories, testing cause and effect relationships, through experience in the development of network laboratories, comparing the results in terms of performance between laboratories developed in person before the COVID-19 crisis and the performance in the development of network labs in a 100% cloud computing environment .

4. THE ANALYSIS

The investigation focused on the analysis of the results of school progress, including the final assessment of 21 students in a master's degree course in Informatics.

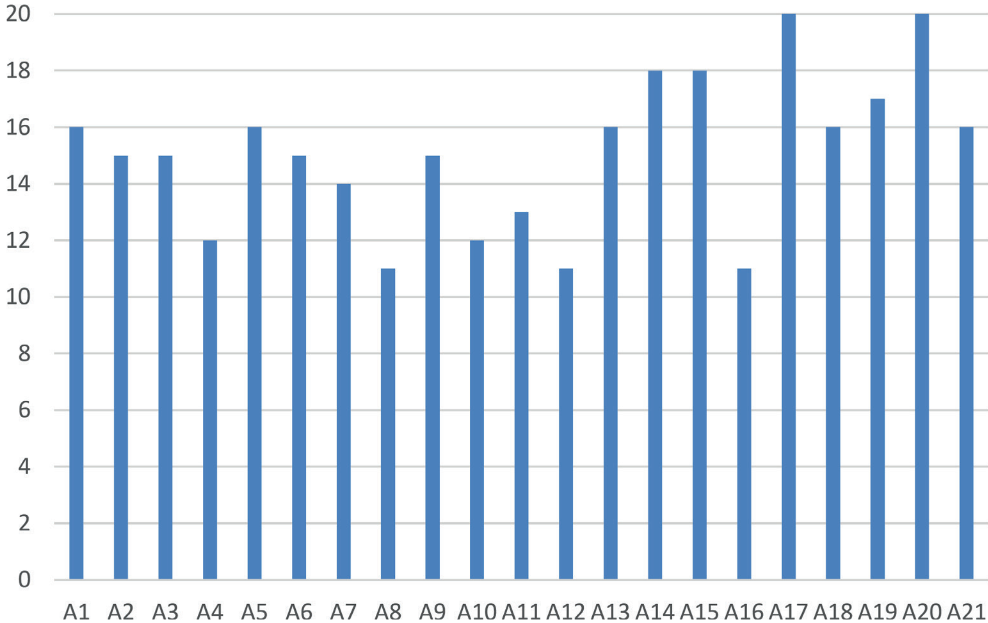
These are students of the first year of the Master's. The contextual situations were compared in relation to two Curricular Units in which both needed laboratory development in the same scientific technical area.

One of the Curricular Units, Digital Systems Architecture, from the first semester, that is, from a pre-COVID-19 period. In this period the laboratory work was in person, that is, in the laboratories of the University. The other Curricular Unit was Private Cloud Computing, already developed in the period of COVID-19, without face-to-face classes. It is important to consider that our University closed all face-to-face classes at the beginning of March, unlike many other countries, Portugal was one of the first countries to close schools and Universities, the law of university autonomy in Portugal allows University Directors to establish autonomous contingency plans, this is what happened at our institution.

In the confinement phase, students only took online classes, asynchronous classes were taught by Google Classroom, synchronous classes by Google Meet, with the exception of master's that in terms of synchronous classes used CISCO WEBEX, which was also the case for this class. In the case of this master's degree in computer science, the part of technological laboratories migrated entirely to Microsoft Azure. The laboratories developed by this class were all inserted in the area of computational infrastructure.

Analysing the evolution of the Curricular Unit of the first semester, Digital Systems Architecture, it was found that the average of the evaluations obtained was 16 values (on a scale from 0 to 20), it was also found that the standard deviation was 2.718 (cf. Figure 3).

Laboratory work in the first semester was only completed in the last week of that semester. Not all students were able to finish the laboratories on time, mainly because they were student workers and did not have the necessary time to dedicate to the face-to-face laboratories, as well as the fact that they had to miss classes for different reasons. The teacher had to extend classes for over a week for everyone to finish their work.



F i g u r e 3. Result of the final evaluation of Private Cloud Computing – Pre-COVID-19 – (the vertical axis represents the assessments and the horizontal axis represents the students)

S o u r c e: Own work.

On the other hand, the Private Cloud Computing Course Unit, was taught in the confinement period of COVID-19, all took place in Distance Learning, that is, online, the curriculum development works in the laboratory were all installed in Microsoft Azure infrastructure.

The results obtained from the analysis to the evaluation and performance of the students were truly superior in relation to what had happened in the first semester, and very specific in relation to the other similar Curricular Unit.

The average of the final evaluation was 18 values, and the standard deviation was 1.590 (cf. Figure 4). This is a significantly higher average (the fact that the general population and students were experiencing a period of enormous emotional stress, which did not occur in the first semester) should be considered here, but even so they obtained higher ratings. Another aspect to note is the differences in standard deviation between the two scenarios. The standard deviation of the second semester assessment is lower, which indicates that the general consolidation of objectives and learning, in addition to being more elevated, are more consistent and there were more students who improved their performance.

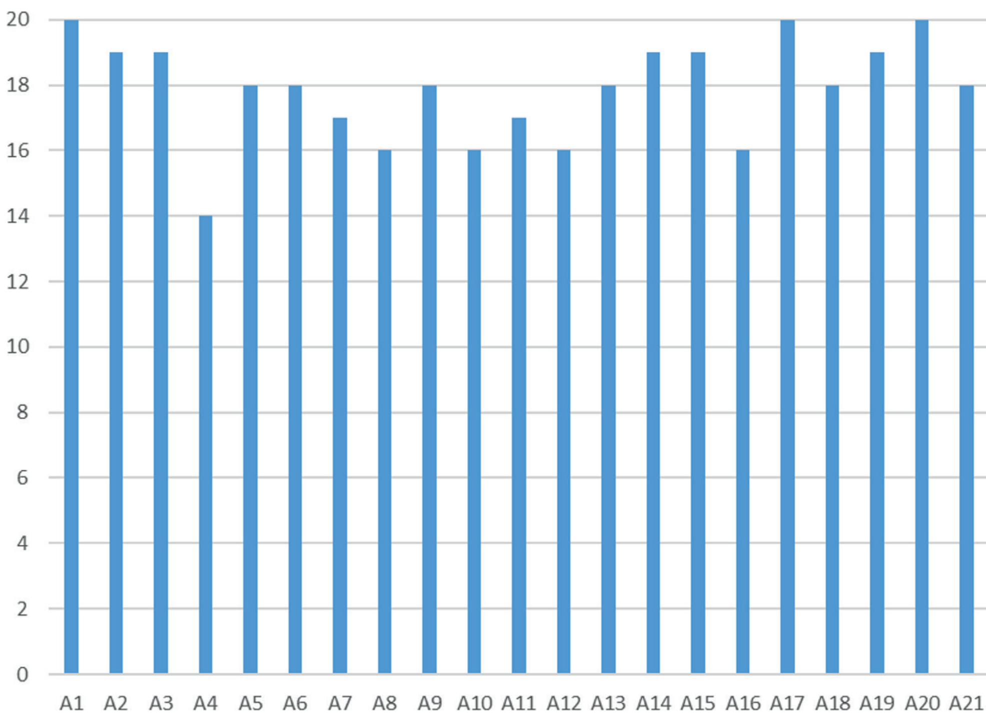
It was also found that all students finished laboratory work before the deadlines with less doubts about the contents to be developed.

This is not a quantitative aspect, but I consider it relevant and relevant, it is the opinion expressed by all students that the fact that the laboratories are in cloud comput-

ing allowed them to work at any time and repeat the tests and learning in a simpler way. Being able to easily review all the work.
In technical terms, these labs also allowed students to reset any development errors as they are using virtual machines that, due to their characteristics, allow easy to create reverse images.

5. ADVANTAGES OF CLOUD-BASED E-LEARNING

We believe that there are many advantages in laboratory teaching based on Cloud Computing for certain technical-scientific areas of Computer Sciences (RIAHI, 2015), we also recognize that this model does not adapt so well to other areas.
However, some advantages of Cloud based E-Learning should be summarized:
Low cost, E-learning computer users need not configure up for E-Learning applications. They can cloud applications via PC, mobile phone, tablet with Internet connection to run with minimal configuration (MASKARADE, 2014).



F i g u r e 4. Result of the final evaluation of Digital Systems Architecture – confinement – COVID-19 – (the vertical axis represents the assessments and the horizontal axis represents the students)

S o u r c e: Own work.

Improve performance, since cloud-based applications for E-Learning runs with super strength, super-source software is automatically updated. So, always, students received updates (VISWANATH, 2012).

Direct Benefits for students, they can take online courses, take the exam online, received feedback about the coaches, and post projects and assignments online through their teachers (PATEL, 2014).
Cybersecurity, the cloud computing providers provides some major security benefits for individuals and companies that are using E-learning solutions (MOHAMMED, 2014). All the information is more secure.

CONCLUSION

In a new paradigm in which online education or mixed teaching, both face-to-face and online, must be considered, having technologies that allow a correct teaching / learning process that achieves the objectives of obtaining skills through laboratories is a fundamental requirement.
The use of cloud computing technology, with the technological development that it had, allows, today, to give laboratory classes in the area of computer science entirely via online. As demonstrated, we can create an online laboratory on Azure and demonstrate/teach students how to develop a WEB application. On the other hand, students can use the same online infrastructure to develop their own project and put the acquired knowledge into practice. Easily set up and provide on-demand access to preconfigured virtual machines (VMs) to support your scenarios. Teach a class, train professionals, run a hackathon or a hands-on lab, and more. Simply define your needs and the service will roll the lab out to your audience. Users access all their lab VMs from a single place. For this reason, cloud computing laboratories solve problems of not accessing laboratories where students must be in person.
The study carried out using an essentially quantitative method, compared the academic results of two Curricular Units.
Both Curricular Units required the use of computer laboratories, one had access to physical laboratories and the other only had access to laboratories in Cloud Computing.
It was found that the results of evaluation, performance and ease in reaching the objectives, were more positive in the Curricular Units that used laboratories in Cloud Computing.
All this teaching activity was developed under enormous social and psychological pressure, due to the context of COVID-19. Therefore, it is a study to be deepened soon.

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INDIVIDUALISED PATHS OF MASTERING AN ELECTRONIC COURSE CONTENT

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Abstract: *The purpose of the article is to describe and analyse a practical experience in creating and testing an electronic course for first-year bachelor students with the possibility of designing individual educational paths. The article presents a model of the electronic course, provides a detailed description, and formulates the features of its practical implementation. The course is based on the idea of variability, in particular the use of diversified tasks. Experimental work showed that the leaners' biggest difficulties were related to the tasks of analysing and extracting information from authentic, non-adapted sources. However, these tasks are associated with the important competencies of the 21st century. As a result, a general algorithm for designing an individual educational path for a student in the framework of an electronic course is described; several options for individualised content acquisition are highlighted.*

Keywords: individual educational path, individualisation, electronic course, learner, competencies, network communication, educational opportunities.

INTRODUCTION

In the conditions of an open, universally accessible information, the abilities to formulate search queries and quickly extract the necessary knowledge become a priority. For that, it is necessary to acquire generalised search strategies and determine the effective ways in which to implement them: correct information requests, focused communication, interactions, and reflection. Among key competencies which are reflected in the recent research and existing educational and professional standards, several should be particularly highlighted (Lin, Shadiev, Hwang and Shen, 2020; Silber-Varod, Eshet-Alkalai, and Geri, 2020). These competencies are reflected as fundamental in the majority of competency frameworks for citizens in general as well as for representatives of specific professions (for example, teachers). In the Europass initiative, we see a category of "information processing". In the Russian Federal State Educational Standards of "Pedagogical Education", such ideas are presented in the corresponding category of "systemic and critical thinking". In the Digital Competence Framework for Educators – DigCompEdu, the category of "digital resources" appears (Redecker, 2017). It is associated with identifying, assessing, and selecting digital resources for teaching and learning. The report "Future Work Skills 2020" presented a map of professional skills of the future (Future Work Skills 2020 Summary Map). The map also highlighted information competences – transdisciplinarity, project thinking, literacy in the new media environment, cognitive loading management, intercultural competence, virtual collaboration, computational thinking, innovative adaptive thinking, and social intelligence. In the study "Competence Foresight 2030" (Skolkovo), a list of transprofessional skills and abilities was presented (Atlas of Emerging Jobs, 2015). This list contains competences of an informational nature – systemic thinking, programming of IT solutions, project management, and readiness to work in the mode of high uncertainty and a quick change of conditions. The formation of competency maps for specific areas of training and profession (educational and career paths), which should become a model for students in compiling their educational paths, becomes relevant. As an output, individualised educational products are offered that meet the needs of students and employers (Chirtsov, Sychov, and Mylnikov, 2017).

The purpose of this paper is to describe and analyse the practical experience of designing an electronic course for first-year bachelor students in an attempt to implement the ideas of individualised educational paths, the variability of tasks, information redundancy, project-based learning, and reflection.

1. AN INDIVIDUALISED WAY OF MASTERING AN ELECTRONIC COURSE CONTENT

1.1. Individualisation as an educational trend

Among current educational trends, the student-centered educational process, with the conditions for the individual development, educational choice, personal interests, and needs, is increasingly emphasised. The key idea in this context is the individualisation of learning. "Individualisation of learning is the organisation of educational conditions for the maximum realisation of the learner's subjective position in the learning process, that is, his awareness of the goals and objectives of learning, the possibility of choosing educational material, forms and methods of solving educational problems" (Samsonova, 2014, 182). "Individualisation of training is carried out by selecting content that can be adjusted, synthesised into individual programmes and elective academic disciplines, as well as by the development of students' research activities" (Yurlovskaya, 2014, 109). "An individualised organisation of training is a different content of academic work and different (if necessary) ways of presenting it (differentiation), as well as a different pace of academic work, which are used for different students taking into account their individual characteristics" (Uvarov, Van and Kahn, 2019, 87).

As a rule, teachers are responsible for the individualisation of learning, they organise the learning process, take into account the individual characteristics and needs of students, and create optimal conditions for revealing the potential of each learner (Konnova et al, 2019; Cleynen, Santa-Maria, Magdowski and Thevenin, 2020). The individualised learning preferences of a student can be reflected in the preferred formats of knowledge assessment and types of mastery materials (Simonova and Poulova, 2015). One of the options for the individualisation of learning is an individual educational path. This term has a broad meaning; however, it is most often defined as a purposefully designed differentiated educational programme that provides students with choice, development, where teachers provide pedagogical support for self-determination and self-realisation (Tryapitsyna, 2002). An individual educational path is a sequence of mastering the components of the educational content selected for a particular student (Fedotova, Valeeva, and Ahmetzyanova, 2014). When designing an individual educational path, the student is allowed to choose the content of training, its forms and methods, and types of educational activities (Kurilovas, 2019).

1.2. Features of an electronic course for individualised learning

In the study, we hypothesise that the design of individualised paths of mastering an electronic course content will support an active cognitive position of students and contribute to the development of competencies demanded by modern society (ICT competences and generalised information strategies – search, extraction, and re-coding; learning autonomy, initiative, self-organisation, increased attention to research and creative activities, self-development and reflection). The focus of attention within the designed course is to ensure that students analyse their educational needs and requirements, independently determine the goals of their educational activities, and learn to consciously and responsibly approach the solution of educational problems. The main objective of the experimental work was to develop and test a new model of the electronic course "Information Culture of a Personality". This course is implemented as part of the educational programme "Pedagogical education", profile "Computer science and information technology in education" for the first-year bachelor students of the Herzen University. The course involved 9 lectures and 17 practical classes. The methodological basis was the interdisciplinary connection of pedagogy, psychology, computer science, and sociology. The course was based on the idea of variability, in particular the use of variative tasks. As a part of the practical work, in each class, students were offered a matrix of tasks (Table 1).

All three tasks had to be completed. In-class assignments are tasks that a student selects and performs during a practical class. Invariant and variative assignments are tasks that a student selects and performs as part of the autonomous work on the course. Each student could choose the level of difficulty for each task – basic, intermediate, or advanced. Invariant tasks differed among themselves only in terms of complexity (all had a common idea). Variative tasks differed in the degree of complexity, in the form of presentation, and in the mode of assessment. These were mostly tasks that complemented, expanded knowledge and ideas of students, on a particular topic of the course; they allowed going beyond the educational programme.

Table 1

Matrix of tasks for one practical class (example)

Levels of tasks	In-class assignment	Autonomous work		
		Invariant assignment	Variative assignment	
Basic	List briefly how to search for information on the Internet.	Gather information on the topic of the study. Use various methods of information retrieval on the Internet.	Discover the importance of information literacy for the modern man. Give examples.	In the thesis form.
				In the graphical form (using ICT tools).
Intermediate	Perform a comparative analysis of methods to search for information on the Internet.	Gather information on the topic of the study. Using different methods of information retrieval on the Internet, select different types of resources: text, multimedia.	Gather information resources on the topic of "media literacy" and discover the importance of media literacy for a modern person. Give examples.	In the thesis form.
				In the graphical form (using ICT tools).
Advanced	Suggest an algorithm for efficient information retrieval on the Internet. Specify the resources that you used.	Gather information on the topic of the study. Using different methods of information retrieval on the Internet, select different types of resources: text, multimedia.	Formulate detailed recommendations for working with information search results. How to evaluate, save, and use the information found?	In-text form.
				In the graphical form (using ICT tools).

Source: Own work

For the entire course, students were offered 153 (17 × 9) tasks. Each student selected and completed 51 (17 × 3) tasks for the course. Choosing the level of difficulty of the task, students built their individual path to mastering the discipline. In this way, three "paths" could be built: yellow, blue, and green.

The "yellow path" is a way of mastering the discipline at the basic level. Tasks were offered here in the context of the subject matter being studied, they were directly related to the lecture material and were mostly reproductive, with elements of systematisation and generalisation; all tasks were within the requirements of the educational programme. "Step-by-step" activity algorithms, strict assessment criteria, and their detailed description, including work assessment parameters, are proposed. The "green path" is an intermediate level. Active tasks of the activity plan were proposed here, aimed at analysing the problem and synthesising, comparing and comparing phenomena, completing tasks at this level required additional search and analysis, summarising the results. Descriptive methodological recommendations and general assessment criteria were offered. The "blue path" is an advanced level characterised by research and creative activity associated with a broad statement of personally significant goals and objectives, understanding the importance of self-knowledge and self-development. The assessment system is flexible (peer and self-management).

The identification of patterns and features of the individual educational paths construction by students made it possible to determine how students interact with the content of the course, how active they are. Besides, it helped to reveal the degree of initiative, critical thinking, and learning autonomy, together with the nature of mastering the course material (planned, organised or chaotic, uniform or uneven).

2. ANALYSIS OF THE EXPERIMENTAL WORK RESULTS

The experimental study comprised three stages: analytical, research, and interpretational.

At the first (analytical) stage, the results of a previous study devoted to students' education activity strategies in the e-learning environment were explored (Noskova, Pavlova and Yakovleva, 2018). Diagnostic results helped to highlight three groups of learners, distinguished in terms of potential preferences when choosing tasks: students with low motivation, giving preference to the basic tasks, students with increased motivation, and students with a high level of motivation, ready to perform advanced assignments.

At the second stage of the study, on the basis of the previously obtained data analysis, the course materials were selected, a series of variable tasks was developed, and variations in the choice of forms methods and approaches for implementing educational activities were proposed. As a result, an electronic course "Information Culture of a Personality" was designed and implemented with individualised educational paths for students. In the electronic course, the conditions of the educational process were specially designed, allowing to adapt the content to the interests, characteristics, and needs of each student and to implement a personality-oriented learning approach.

At the third stage of the experimental work, a study of a focus group (20 students) within the developed electronic course was conducted.

The analysis of students' activity in the electronic course revealed several strategies for choosing tasks:

1. A constant selection of advanced tasks and their performance at a high level – highly motivated students with outstanding academic achievements within the educational programme (2 students);
2. A preferential selection of advanced tasks and their performance at a high level (2 students);
3. A variable selection of intermediate and advanced tasks and their implementation at the sufficient average level (13 students);
4. A constant selection of basic and intermediate tasks and their performance at the minimum passing score – low-motivated students with poor academic achievements within the educational programme (3 students).

The maximum number of points that a student could score for the entire course was 306 (18 points – a maximum for one topic 6 × 3; total – 17 topics). The lowest average score was obtained on the topic 9 – “Information resources in the life of a modern person” (8 points). The tasks within this topic were related to the search, analysis, and annotation of information resources: a bibliographic list of full-text articles, an annotated catalogue of scientific articles, and a digest of scientific publications. Difficulties in completing tasks of this type are not surprising for first-year bachelor students since they are at the initial stage of developing competencies in systemic and critical thinking and related skills in searching, analysing, and generalising information. The distribution of average scores for the remaining topics was fairly even, in the range from 13 to 15 points.

To study the relationships between successes in completing assignments on different topics of the course in more detail, the data were analysed in-depth: normalised indices for completing assignments for each student were calculated, and then correlations between them were established, and a cluster analysis was performed to further visualise the data. For this, the statistical package “Statistica” v. 12.0 (StatSoft. Inc., Tulsa, Oklahoma, USA) was used. The relationship between the survey questions was analysed with the Spearman’s rank correlation coefficient. All results were considered significant at $p < 0.05$.

It was found that tasks on all proposed topics could be grouped into 3 agglomerations. The first group includes tasks that are substantively related to the development of search and information analysis skills – this is the semantic core of this group. The variables combined at the closest distance are the “use of foreign-language information resources” and the “acquaintance and analysis of popular electronic libraries” ($r = 0.98$). This same thematic group is merged with the variables related to the results of the tasks “work with bibliographic lists and annotated catalogues”, “analysis of an open course on learning a foreign language”, “making links to information sources on a personal portfolio website”, “developing interactive elements of a web portfolio”, “creating of a web portfolio”. Thus, the tasks of the information (content or resource) block are included in this group.

The second group of tasks includes two subgroups. The core of the first subgroup is represented by variables related to the systematisation and visualisation of information. For example, such tasks as “visualisation – collage, infographics”, “development of online surveys and questionnaires” (these variables are merged at the closest distance, with a correlation coefficient $r = 0.98$), they are joined by the variables – tasks “formulating a system of questions for the project”, “work with mind maps”. The second subgroup is related to the interaction in the digital environment – “online discussion”, “presentation of the project results – digital tools and an oral presentation” ($r = 0.94$), “joint activities in the network”. Thus, the tasks of the communication block are included in this group.

The third group is the presentation of the process and the result of project activities. The results of the tasks “annotating the project”, “creating a motivational booklet on the topic of the project” ($r = 0.89$), “final presentation of the project” are most closely related. Thus, the tasks of the management block are included in this group.

At the end of the course, students were offered a reflective questionnaire. In general, all students noted the benefit of the studied course. In particular, the mastered digital tools for working with information would be required by them in their further educational activities, as well as in their future profession. The greatest value of the course for students was the choice of the complexity of the tasks, the possibility of self-expression in the process of performing an individual project, and group work. At the same time, students saw difficulties in a variety of tasks. Half of the students tried to cope with the difficulties on their own, and the second half preferred alternately to seek help from a teacher and peers.

Depending on the individual educational paths of students, there are several options for individualised mastering the course content:

- For motivated "successful learners", personal paths are associated with the choice of complex tasks aimed at active research and creative activity. This option of mastering the course particularly contributes to the development of such competencies as innovative thinking and creativity;
- For "average learners", with reduced working capacity and insufficient willingness to work independently and proactively, with weakly expressed motives and activity goals, personal paths mostly start with the basic level of tasks and might gradually move forward to the intermediate and advanced tasks. This option of mastering the discipline particularly contributes to the development of reflection and self-development.
- For "weak learners", lagging, unmotivated students personal paths reflect the minimal sufficient level of mastering the content. This option of mastering the discipline particularly contributes to the development of basic information strategies and self-management.

CONCLUSION

The study presented in the paper showed that at the initial stage of university education students were insufficiently ready to choose individualised educational paths; they perceived these features of learning as an additional challenge. Variability and redundancy of tasks caused them difficulties. Particularly, tasks related to working with authentic (non-adapted) sources of information were complicated. This area is important, so it should be given extra attention while working with students. At the same time, didactically untransformed information occupies the largest part of the information sources in the life of a modern person. Competencies related to productive informational behaviour in the digital environment are important competencies of the 21st century. Obviously, for the development of these new professional competencies, it is necessary to facilitate students' productive actions in the digital environment. It is necessary to expand the goals and objectives of educational activities, create conditions of information redundancy and variety of communication links, provide remote access to complex (scientific) educational materials, and stimulate independent instrumental and intellectual transformation of information. Future research directions are associated with the learning analytics methods implementation for a more detailed identification of students' individualised paths of mastering an electronic course content.

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COMMUNICATION AND COLLABORATION IN DISTANCE LEARNING

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Abstract: *The article deals with the analysis of communication and collaboration; the criteria of their effectiveness are described. Special attention is paid to distance learning, in the context of pandemic in particular. The role of communication and collaboration in distance learning has been studied. The experience of distance learning implementation in Borys Grinchenko Kyiv University has been described and the results of the students' survey on effectiveness of communication and collaboration with teachers and groupmates aimed at learning tasks fulfilment and problem solving during distance learning have been presented. IN addition, examples of communication and collaboration organization in distance learning have been provided.*

Keywords: communication, distance learning, types of communication, electronic communication, collaboration, electronic collaboration.

INTRODUCTION

Problem statement. Dynamic changes in the modern world require rethinking the current model of social communication and educational communication in particular. New sources of information, digital technologies development, different types of social network and artificial intelligence invention influence the choice of the means of communication and informational data transmission not only in everyday life, but also in the educational process. Modern worldwide challenges, including the Covid-19 pandemic, create a necessity for educational institutions to move to distance learning and set new tasks for all educational process participants, in particular to changes in learning interaction, communication and collaboration organization.
The aim of communication, especially in the learning process, is not only to transfer data from one person to another, but to render their meaning, which becomes information and knowledge itself. The result of correctly established communication must be an adequate understanding of received messages and data by those who are

involved in it. Therefore, the question of learning communication organization is important, in distance learning in particular, when the participants of the educational process have to choose correspondent methods and digital technologies for communication and collaboration to achieve learning goals when they are set correctly. The reality of distance learning during the pandemic showed that many teachers tended to avoid communication and collaboration with students and did not pay enough attention to organization of communication among students. Even if there have been tries to organize it, they could not direct it into necessary educational paths and estimate the contribution of each participant, as there was lack of experience in the organization of such learning activities and often also the rejection or often the refusal or misunderstanding of the use or digital technologies for communication and collaboration, their advantages and disadvantages.

In Borys Grinchenko Kyiv University a specialized system of teachers' qualification development was implemented which positively influenced the quality of distance learning organization during the quarantine period. That is why there is a need to share the results of learning communication and collaboration arrangement in distance learning.

Analysis of recent research and publications. In the formation of modern western theory of communication several stages or "generations" can be defined, which have some peculiarities in understanding of the communication phenomenon. In spite of the fact that there were researches carried out in the framework of different social sciences during the whole twentieth century (Shramm, 1997; Craig, 1999; Littlejohn, 2002), after World War II together with development of science and information technologies new approaches to communication phenomenon studies started to appear. It was specific for those approaches to consider communication as a way to transmit information, where the source of a message, the message itself , the recipient, the channel of transmission and noise were identified as necessary components. As an example the Shannon-Weaver mathematical model of communication (Shannon & Weaver, 1948) appropriated by communicative disciplines could be taken, where communication is described as a process of transmission and reception of information from one source to another (Craig, 1999). The model was modified in literature on communication and has become widespread as the information transmission model. This model is still widely used in communicative theory and practice, especially in public speaking and mass communication in spite of proven restrictions that accentuate linear and unidirectional character of communication (Craig, 1999; Miller, 2002; Griffin, 2003). Despite a wide range of directions in communication studies, the most important spots that are common in views on communication by different schools can be generalized. Communication is society constructing and meaning constructing process that runs in the defined context and with the help of using symbols, and during which community is created and self-perception is formed. These principles are applicable to digital and networked communication, as well as to the process that runs in an open digital social environment facilitated by verbal means of communication in most cases (texts, charts, audio and video files, digitized language text and images), which initiates the formation of internet society and a specific form of self-presentation.

Communication in education is experiencing changes due to the changes in learning objectives, implementation and utilization of new approaches to learning and rapidly changing requirements to graduates from educational institutions. Recent forced transition to distance learning has demonstrated it as the most effective way of providing equal access to education in the realities of modern life (the quarantine because of the Covid-19 pandemic), implementation of continuing education and lifelong learning, a way to democratization, humanization and variability, digitalization of the society.

In Ukraine a number of scientists work in the distance learning field for many years, among them there are: V. Kukharenko, T. Oleinik (2019), Morze, N., Varchenko-Trotsenko, L., Tiutiunnyk, A. (2018), M. Umryk (2009), O. Hlazunova, N. Morze (2008) and others. Most of their research is dedicated to study of theoretical notions of distance education, peculiarities of different LMS utilization and forms of didactic learning materials presentation. Only a few research is dedicated to the question of effective communication arrangement. Questions of distance learning as one of the directions of development of digital tools in education are addressed in research of such foreign scientists as L. Amhag, L. Hellström, M. Stigmar (2019), A. Saykili (2019), K. Harry, A. Khan (2000), A.P. Rovai (2004) and others.

Teachers' work in distance learning and by means of electronic interaction cannot be separated from communication. These two aspects are closely interconnected and interdependent. Communication and collaboration are connected in the same way. Communication is the process of messages exchange between two or more persons, interaction with the help of verbal and nonverbal means aimed at the transmission and reception of information. At the same time, collaboration assumes interconnected actions of individuals which are aimed at achieving common goals with mutual benefit for the parties involved. The question of collaboration, cooperation in education or "collaborative learning" was studied in works by famous Swiss psychologist and philosopher Jean Piaget who noted that collaboration in education plays an important role in constructive cognitive development of learners. His theory was extended in other scientific works, for example, Vygotsky's theory, where the importance of collaboration in supporting personal development is highlighted. An important contribution into modern pedagogic theory of joint learning was made by famous Ukrainian educationist A. Makarenko, who thought that the skill to communicate and collaborate with others plays the most important role in the process of socialization. The question of collaboration in learning development was studied by V. Dyachenko in the post-Soviet space (1991). However, collaboration in learning started getting real popularity only in the 1990s. Theoretical and practical background of collaboration in learning are studied in works by B. Smith, T. MacGregor (1992), M. McManus, R. Aiken (2016), L. El Hamamsy, W. Johal, T. Asselborn, J. Nasir, P. Dillenbourg (2019) and others.

In Borys Grinchenko Kyiv University, a number of scientists research the question of arrangement of educational communication and collaboration in distance learning (Morze N., Varchenko-Trotsenko L., Makhachashvili R. and others) and they are ready to share their experience of digital resources implementation as this question is not researched deeply enough including educational types of learning communication, defining its effectiveness, peculiarities of electronic communication and collaboration arrangement, etc.

The aim of the article is to analyze the ways of students and teachers' communication and collaboration skills formation in the process of distance learning, to describe the experience of digital communication and collaboration utilization in Borys Grinchenko Kyiv University, to research the results of the survey aimed at determination of needs, level of satisfaction and wishes concerning learning communication and collaboration arrangement in distance learning and at analysis of digital resources required for solution of the task. Solution of number of tasks contributed to achievement of the goal: analysis of different kinds of learning communication; utilization of digital instruments for communication and collaboration; determination of the criteria of estimation of effective students' communication in the learning process; determination of the ways to increase the positive motivation of teachers and students for electronic communication and collaboration.

1. THEORETICAL BACKGROUND

Distance learning has been implemented in Ukraine for about twenty years, starting in 2000 with state policy formation in "The concept of distance education development" and continuing with other legislative documents such as Regulations on distance education as revised in 2015 (the reading of the regulations renewal is being conducted at present) and recognition of distance education in the Higher Education Act as amended in 2019. However, distance learning has gained the highest relevance in the period of the pandemic. Distance learning is understood as individualized process of gaining knowledge, skills and ways of cognitive activity of a person, which is happening mostly by indirect interaction of remotely located participants of educational process in open environment which functions on the basis of modern psychological, pedagogical, information and communication technologies (https://zakon.rada.gov.ua/laws/show/z0703-13#Text).

Ukrainians have shown ten times higher interest in distance learning in the period of quarantine restrictions compared to the period before it according to the data of Google Trends:

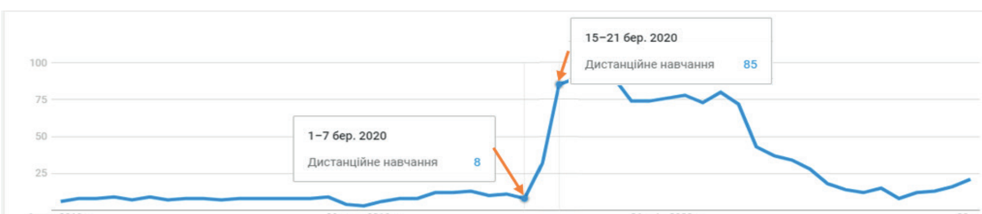


Figure 1. Interest of Ukrainians to distance learning according to the data of Google Trends

Source: https://trends.google.com/trends/explore?geo=UA&q=%2Fm%2F02h32.

Let us consider the models of distance learning organization according to Theories and Frameworks for Online Education (Picciano, 2017). Example of a teacher-led, fully online study. The course content is provided by a LMS (Learning Management System) or CMS (Content management system) along with other media and is used as needed by the teacher. The discussion board, blog, and wiki provide facilities for interaction among teachers and students, students and students, and students and content. In this course, the teacher could direct students to watch a fifteen-minute lecture available in the LMS database and then ask students to respond to a series of questions on the discussion board. Student responses can then be used as the basis for an interactive discussion board activity among students, guided by the teacher. The model also provides for reflection and collaborative activities (Figure 2). This model distinguishes students collaboration as a separate component.

F i g u r e 2. Example of a Teacher-Led Fully Online Course

S o u r c e: Picciano, 2017

Requirements towards communication tools, according to the authors' estimation, comprise:

1. Type of communication (verbal)
2. Simple interface
3. Scheduling feature
4. File sharing
5. Timing
6. Environment
7. Technical architecture.

In pedagogical publication the standard types of interaction in the educational process are determined, which do not depend on the personality of a teacher, a subject, or the peculiarities of a group of students. They are: rendering knowledge by a teacher and perception (rejection) the knowledge by students; learning activities arrangement (joint search of answers to the questions in the plan by a teacher and students; arrangement of students' independent activity by a teacher, etc.); evaluation of students' level of training, readiness for exams, future professional activity.

In the educational process communication is tightly connected to collaboration as collaboration is aimed at achieving some result, but it is impossible without communication. Collaboration always involves work in groups or pairs. There does not have to be a product as a result of communication, but collaboration requires the creation of a joint product as an important criterion.

Collaboration includes coordination of efforts that is achieved by teaming-up. Important aspects of collaboration in the educational process are making common decisions and participation of everyone in achieving common goals. Joint decisions are the decisions that determine content, process or result (product) of students' activities. Working together students have to use their knowledge to make a joint decision that influences a common result, to plan their joint decisions according to the goal, that is they have to define what and when they are going to do, which instruments they are going to use, they have to define roles and responsibilities of each member of the group, to insure own contribution into making joint decision and receiving high quality joint product.

To the main components that define electronic collaboration of educational process participants belong (Morze, Varchenko, Smyrnova-Trybulska, 2015):

- Common task that can be divided into parts;
- A list of roles that help to fulfil separate parts of a common task;
- Digital instruments for the task fulfilment;
- People involved into implementation of the common task;
- Defined competences that people involved in collaboration have to possess.

The aim of joint activity is interdependence. The indicator of effective collaboration is a combination of the main criteria: work, common responsibility, common decision making, interdependent work.

Students' activities are interdependent when all the students take part in the group work to achieve the overall result. Most interdependent operating results involve two levels of responsibility:

- *Individual* responsibility: every member of the group (team) is responsible for the task they have to perform within the framework of the main task. The role of each student in the group is important.
- *Group* responsibility: students have to work together to achieve the final product or result. Students have to communicate, discuss and agree about the process, design, conclusions and results of their activity.

Distance learning implies electronic collaboration only, which we understand as a set of actions aimed at supporting the interaction of people, who work at solving the same common tasks, in an electronic way with the help of the internet.

Two following groups belong to the main types of communicative collaboration (Morze, Makhachashvili, Smyrnova-Trybulska, 2016):

1. Relationship oriented: Affinity networks, Learning communities
2. Task oriented: Communities of Practice, Project Communities.

Accordingly, communicative collaboration quality requirement can be identified as (Morze, Makhachashvili, Smyrnova-Trybulska, 2016):

Social Cooperation:

The cooperation sequences in the online course should especially focus on the integration of discursive course settings and controversial topics. Not the social aspect is emphasized here but the active knowledge creation in argumentative

Discursive Cooperation:

The cooperation sequences in the online course should especially focus on the integration of discursive course settings and controversial topics. Not the social aspect is emphasized here but the active knowledge creation is argumentative.

Participants activities in digital communication and collaboration can be described through the competences and digital skills described in «The Digital Competence Framework» (Carretero, Vuorikari, Punie, 2017) below for the sphere "Communication and collaboration" (Table 1).

Formation of above mentioned skills and competences is possible with the help of systematic use of digital instruments and services such as e-mail, social networks, blogs, wiki, common internet documents, messengers, web-conferences, etc. That allows distance learning participants to communicate and solve collective tasks at any time and irrespective of location.

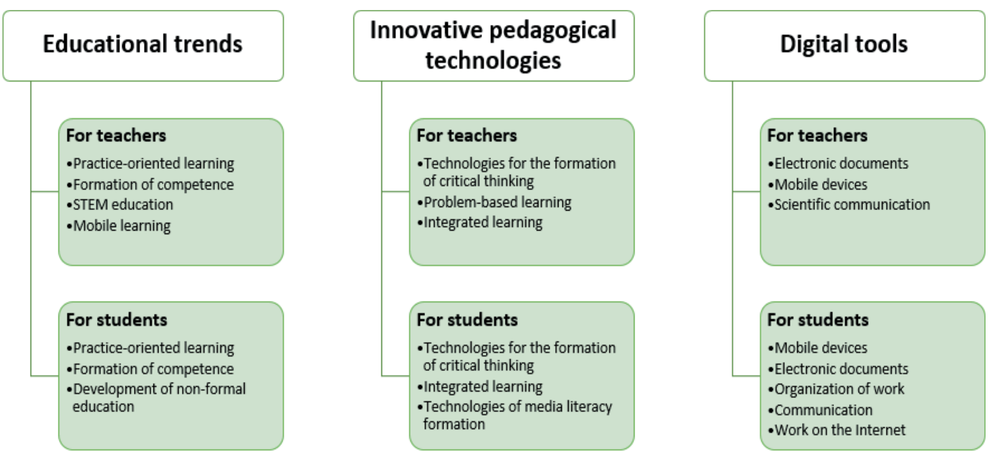
The systematic use of digital technologies in Borys Grinchenko Kyiv University faced numerous challenges because of low level of teachers and students' digital competence formation (Morze N., Vember V., Gladun M.).The received results showed that students were more interested in utilization of digital technologies than teachers (Morze N., Gladun M., Vasylenko S.). The system of teachers postgraduate education required to include studying electronic documents, instruments for scientific communication, messages exchange, learning process management, work arrangement and attention had to be concentrated on demonstration of mobile devices usability in the learning process. The model of teachers postgraduate education was designed for digital transformation of educational process (Figure 3).

Table 1

The competences and digital skills according to «The Digital Competence Framework»

Digital competences	Digital skills
Interaction with the help of digital technologies	Interact with the help of different digital technologies and understand the means of digital communication in certain context
Digital technologies exchange	Exchange data, information and digital content with other people with the help of digital technologies
Implementation of civic stance with the help of digital technologies	Take part in civil life by using state and private digital services; look for possibilities for own development and participation in citizenship with the help of digital technologies
Collaboration with the help of digital technologies	Use digital instruments and technologies for social processes, joint building and creation of resources and knowledge
Netiquette (Network etiquette)	Understand behaviour norms and know-how utilizing digital technologies and interacting in digital environments; adapt communicative strategies to definite audience and understand cultural and mental diversity in digital environments
Digital identity management	Create and manage one or several digital identities, be able to protect own reputation, work with data created with the help of several digital means, environments and services

S o u r c e: Own work based on Carretero, Vuorikari, Punie, 2017.



F i g u r e 3. The model of teachers postgraduate education for digital competence development

S o u r c e: Own work.

Teachers of Borys Grinchenko Kyiv University have a series of trainings (ICT module in postgraduate education) to increase their level of digital competence. For example, advanced training of academic staff in the Digital Module is in the following modules:
Topic 1. Modern educational trends and ways to implement innovative in the educational process technologies. 21st Century Skills and Digital Skills
Topic 2. Blended and online learning. E-learning technologies. Resources for creating content and criteria for its evaluation
Topic 3. Online services and digital technologies for effective communication
Topic 4. Online services and digital technologies for effective cooperation
Topic 5. Online services and digital technologies for formative assessment
First-year students take the course "University studios" at the beginning of their studies where one of the modules is dedicated to the work with e-resources of the university. The subject „University Studies" contains one of the modules, which is devoted to the formation of digital competence. Lecture: Information environment of the university. Practical works: Work with information resources on the Internet. Creation of Smart University. Electronic resources of the university.
In particular, every subject has an e-course where teachers place theoretical information, tasks, create forums for discussions, place links for online interaction arrangement, etc.
All above mentioned approaches allow not only to increase digital competence of educational process participants, but also to implement learning communication and collaboration during distance learning, Its effectiveness was analysed and described in the article.

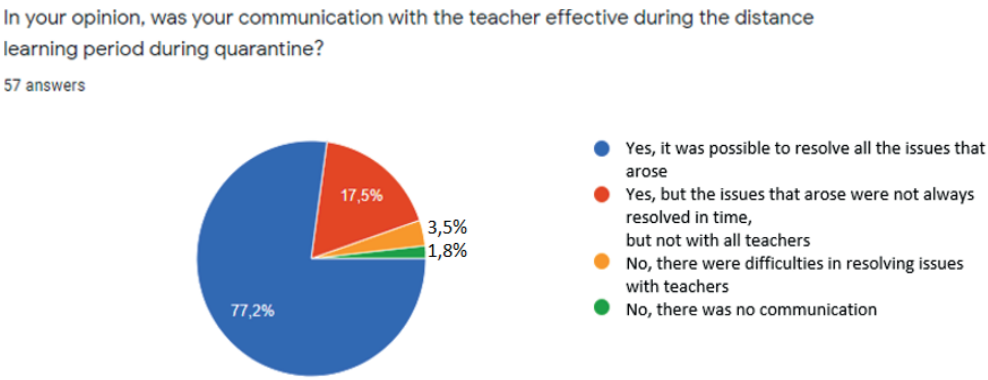
2. RESEARCH METHODS

To research the peculiarities of learning communication and collaboration arrangement in distance learning a complex of theoretical (analysis and synthesis of Ukrainian and foreign scientific, pedagogical and methodological sources on the article's topic) and empirical (survey of students on learning communication and collaboration arrangement) methods and analysis of the received data. Students of Borys Grinchenko Kyiv University took part in the survey within the framework of the Modernization of Pedagogical Higher Education by Innovative Teaching Instruments. MoPED – KA2 CBHE – 586098-EPP-1-2017-1-UA-EPPKA2-CBHE-JP.

3. RESEARCH RESULTS

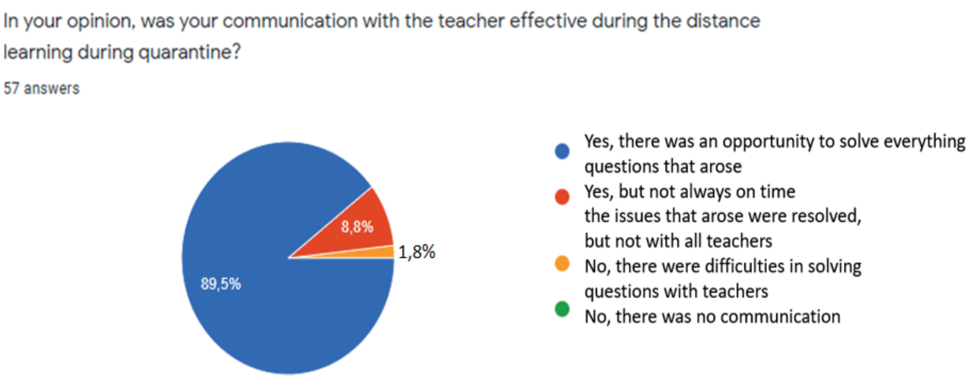
To define the needs, the level of satisfaction and wishes considering learning communication and collaboration arrangement in distance learning and analysis of digital instruments for educational goals achievement the survey of students was carried out (https://docs.google.com/forms/d/1xotMSAWnC6cunWEeTIjKQE7kWZhBC7RMCpmdqn879-Y/edit#responses). 57 respondents, who studied distantly, took part in the survey (73,7% Bachelor degree students and 26,3% Master degree students of Pedagogical Institute, Faculty of Information Technology and Management, Journalism Institute, Institute of Human Sciences). They were offered to evaluate the effect-

iveness of interpersonal, group and mass communication and collaboration, project work arrangement and digital instrument utilization to support the activities.
The students noted a high level of effectiveness of communication with teachers in the period of distance learning during the quarantine (Figure 4).



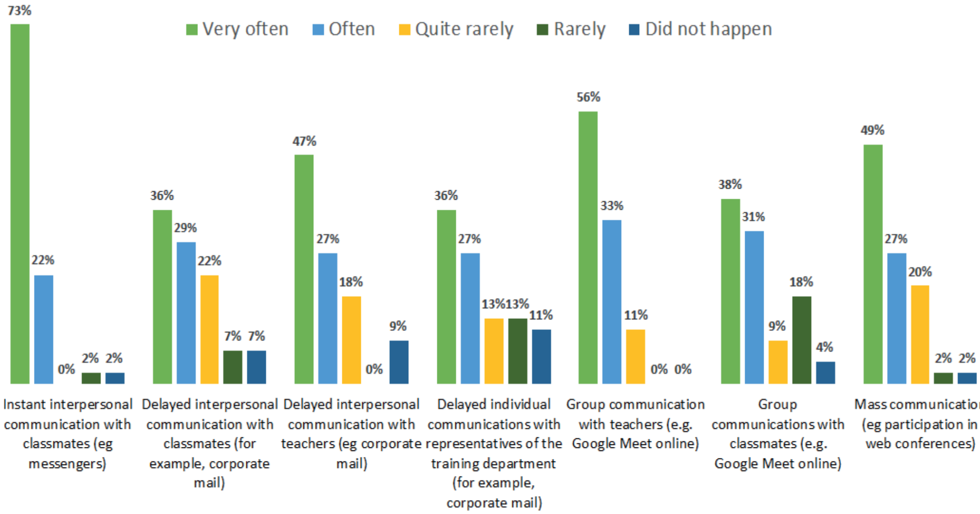
F i g u r e 4. Results of the survey on effectiveness of communication with teachers
S o u r c e: Own work.

At the same time, in general the students did not have any difficulties in answering questions with groupmates (Figure 5).



F i g u r e 5. Results of the survey on effectiveness of communication among students
S o u r c e: Own work.

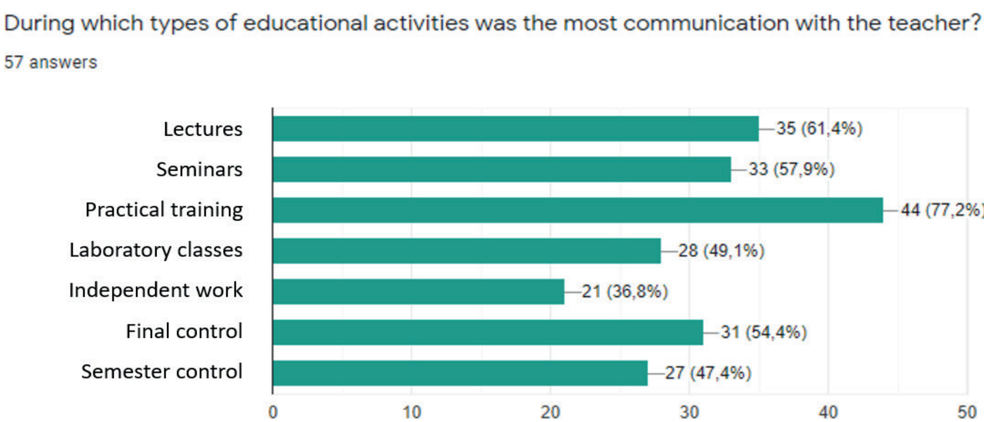
The survey showed that there was a high level of involvement students into instant interpersonal communication with groupmates (73%), group communication with teachers (56%), mass communication (49%) and delayed interpersonal communication with teachers (47%). We have to note low frequency of communication between students and representatives of (educational units (no communication – 11%, rare communication – 13%) (Figure 6).



F i g u r e 6. Frequency of different types of communication arrangements during distance education

S o u r c e: Own work.

The questionnaires analysis demonstrates even distribution of communication with teachers according to types of learning activities. The students had possibility to communicate with teachers not only during lectures, but also in the process of laboratory classes, practical work execution, summative and semester assessment (Figure 7). This option becomes available thanks to utilization of different groups of digital resources, which were used by teachers for distance learning during quarantine (Table 2).



F i g u r e 7. Results of the survey on educational activity with most communication with teachers

S o u r c e: Own work.

Table 2

Utilization of digital instruments for communication with teachers

Phone calls	31,6%
Mesengers	87,7%
Social networks	29,8%
Online Meetings	91,2%
Email	73,7%
Forums im = n e-course	56,1%

For collaboration arrangement students prefer online meetings (21%), collective documents, presentations, spreadsheets (18%) and social networks (14%) (Figure 8).

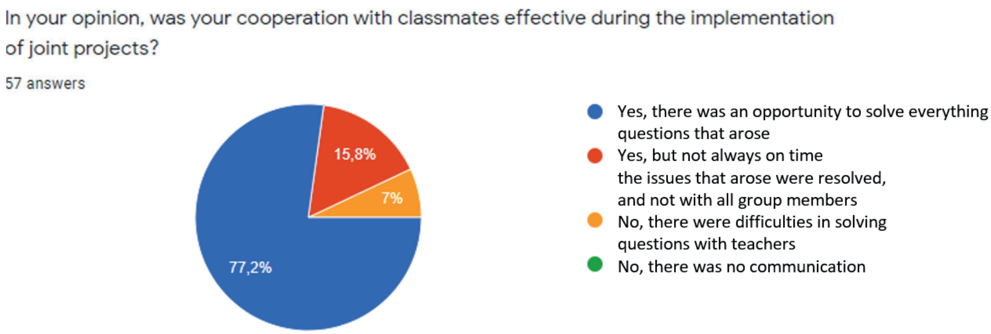


Figure 8. Digital instruments for collaboration

Source: Own work.

In the survey the students indicated the number of advantages and disadvantages of electronic communication. The main of them are listed below.
Advantages:

- Quick access at any time.
- All information is stored in digital form.
- All students receive information from teachers simultaneously, there is a possibility to ask questions and receive answers.
- Calm environment for the material perception and learning.
- Fast delivery of information of any volume and for different distances.
- Possibility to ask questions at any time, promptness of feedback.
- Possibility to choose the time for communication which is beneficial for multitasking.
- Skill to adapt quickly, communicate with the help of different means, keep in touch.
- No extra time and money expenses for commuting.
- Understandable and available for everybody volume of tasks, deadlines, which allow students to plan their time better.
- It is convenient to use and reproduce learning materials at the time comfortable for learning.

- Creation of virtual communities, involving everybody into collaboration, possibility to take into account individual peculiarities and learning styles of students.
- Absence of disturbing factors.

Disadvantages:

- Absence of direct personal contact, difficulties in exact rendering of information, interpretation of
- emotions and feelings.
- Technical problems.
- Distraction in the process of work with internet resources.
- More independent work.
- Many tasks.
- Not everything is understandable.
- Lack of computer literacy and psychological readiness.

CONCLUSIONS AND FURTHER RESEARCH PERSPECTIVES

The research of the problem of learning communication and collaboration arrangement in distance learning show that effective digital interaction of all learning process participants can be provided by:

1. Preparation of regulations at the university level to provide corresponding conditions for distance learning.
2. Existence of the university's educational policy on digital transformation of educational process.
3. Systematic teacher postgraduate training on using digital instruments for learning communication and collaboration arrangement in distance learning.
4. Availability of required software and hardware for all educational process participants, in particular, LMS and digital instruments for communication and collaboration.
5. Constant analysis and choice of digital instruments groups which would satisfy the needs of learning process participants.
6. Periodic analysis and quality evaluation of educational process to define strengths and weaknesses.

We consider that the perspectives of fruitful scientific, educational and personal communication of teachers and students, and among students are in utilizing chat bots, big data for the analysis of their interactions and the implementation of adaptive learning elements.

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E-COURSE "INTERNET RESOURCES FOR CREATING MATHEMATICAL LEARNING AND GAME CONTENT FOR PRIMARY SCHOOL CHILDREN"

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Abstract: *The article presents the structure and content of the e-course "Internet resources for creating mathematical learning and game content for primary school children". The aim of the course is to introduce teachers to online services that help organize the distance learning of mathematics: services for creating a virtual classroom and filling it with interactive exercises and other educational content (LearningApps, Google Classroom, Classtime, Classdojo), services for organizing a distance lesson (Padlet), and services for conducting a distance lesson in the form of a conference (Zoom). The course is structured in 5 modules, each of which is dedicated to a separate Internet resource. Possibilities of using templates for the creation of tasks and class content in connection with separate kinds of mathematical tasks for an initial course in mathematics and realizing each of the stages of a math lesson in primary school are considered on specific examples within each module. E-course students received both theoretical knowledge about working in the service and practical advice from teachers who have experience with it. The course was attended by more than 400 students who provided positive feedback about it. The course is also implemented in the process of methodological training at the South Ukrainian National Pedagogical University named after K. Ushynsky, Vasyl Stefanyk Precarpathian National University and Izmail State University of Humanities. These universities take into consideration the results of non-formal education in assessing the academic achievements of students in the discipline "Methods of teaching mathematics in primary school".*

Keywords: ICT, e-course, online service, training for future primary school teachers.

INTRODUCTION

On August 10, 2018, the Order of the Ministry of Social Policy of Ukraine № 1143 approved the professional standard "Primary school teacher of secondary comprehensive educational establishments", which determines teachers' job functions as well as competencies that a primary school teacher must have to perform these functions. One of the job functions of a primary school teacher is to provide and support the education, upbringing and development of school children in the educational environment and family (job function B). To perform it, the teacher must have the ability to select appropriate methods, tools and forms of teaching in accordance with the set goals and objectives of the lesson, other forms of learning taking into account the specific content of educational material and school children's individual characteristics (On approval of the professional standard, 2018).

Scientists have proved in numerous studies that in the traditional organization of the learning process, the use of ICT significantly increases the efficiency of this process. Therefore, the set of teaching aids should include digital tools (Skvortsova, Britskan, 2019) (Kuzminska, Morze, Smyrnova-Trybulska, 2019).

In previous studies (Skvortsova, Ishchenko, Britskan, 2020) we found that 78% of primary school teachers in Odesa region (Ukraine) constantly use ICT in their work, 22% – periodically, but the usage of ICT generally means typing computer materials (93%), searching for information on the Internet (96% of teachers); conducting lessons using computer equipment (98%).

Obviously, in order for a teacher to use digital tools in his work, he must have ICT competency. To determine teachers' ICT skills, in the spring of 2019 we conducted a pilot survey of primary school teachers in Odesa region, they were students of advanced training courses of Izmail State University of Humanities (Skvortsova, Britskan, 2019). The survey involved 30 teachers who claimed that they all own a computer and have experience in using information technology in their professional activity. Although 80% have good skills (5 points on a five-point scale) of working on the Internet, only 10% have 5 points for the skills of working in a text editor Microsoft Word, 10% – for the ability to create presentations, 20% – for the ability to process graphics, 10 % – for the ability to perform calculations using a spreadsheet, 10% – for the ability to install the necessary software, 10% – for the ability to blog, 10% – for the ability to work in professional online networks, 10% – for the ability to create Web-sites. Thus, the ICT competencies of primary school teachers in Odesa region of Ukraine require development.

Studying the readiness of future primary school teachers and teachers of advanced training courses to use ICT, we found that 70% of students of advanced training courses (Skvortsova, Britskan, 2019) and 94% of future primary school teachers (Skvortsova, Britskan, 2018) consider it appropriate to use presentations in lessons, because they are a powerful tool that allows the teacher to visualize the learning content.

It should be noted that the issue of creating and using multimedia presentations has been comprehensively researched in pedagogical science. In particular, the features of the process of information perception and means of facilitating the perception of

educational information, which requires a special design, were studied by Lin (Lin, 2018). According to the results of CSEM analysis, scientists have identified the 5 most effective tools for creating multimedia presentations: MS Power Point, Prezi, Impress LibreOffice, SlideDog, ClearSlide / SlideRocket (Smyrnova-Trybulska, Ogrodzka-Mazur, Szafranska-Gajdzica et al., 2016). The system of requirements for multimedia presentations was developed by Skvortsova and Haran (Skvortsova, Haran, 2018): *requirements for visual and audio series of multimedia presentations, requirements for the text presented on presentation slides, requirements for presentation design*.
Thus, teachers have access to the recommendations of scientists to create multimedia presentations, but, in fact, their creation requires from the teacher skills in Power Point, etc., which, unfortunately, are not sufficient to develop good educational content.
It is also possible to increase the efficiency of teaching mathematics in primary school by using online services for teachers. Our research (Skvortsova, Britskan, 2018; Skvortsova, Onopriienko, Britskan, 2019; Skvortsova, Britskan, 2019; Britskan, 2019; Britskan, 2020) focuses on preparing teachers to use Web 2.0 services: LearningApps, H5P, Plickers, GIMKIT, Google Form. Our work contains practical recommendations for teachers on the use of these services, in particular in the process of teaching mathematics. We organized and conducted experimental training of teachers to work in these services and obtained results that prove the effectiveness of these Web 2.0 services in teaching primary school children (Skvortsova, Britskan, 2018; Skvortsova, Onopriienko, Britskan, 2019; Skvortsova, Britskan, 2019; Britskan, 2019; Britskan, 2020).
Based on the fact that primary school teachers' ICT competency is insufficient, the possibilities of them using various digital tools are quite limited. This thesis is confirmed by the analysis of primary school teachers' questionnaires, where they had to assess their own skills to work in professional online services: only 10% of teachers are fluent in using some of them, 10% rated their skills as 4 on a five-point scale, 10% – as 3 , 20% – as 2 and 50% – as 1 (Skvortsova, Britskan, 2019). Therefore, it is not surprising that only 24% of primary school teachers create educational and game content using Internet resources (Skvortsova, Ishchenko, Britskan, 2020), but 80% of teachers (Skvortsova, Britskan, 2019) consider it effective to use interactive exercises in teaching primary school children – representatives of the digital generation.
Thus, the appropriateness of using ICT as a means of improving the efficiency of the educational process is undoubtful, but the question of teachers' readiness to work with digital tools remains unresolved. The results of the survey of primary school teachers (Skvortsova, Britskan, 2019), (Skvortsova, Ishchenko, Britskan, 2020), demonstrate the urgent need for taking measures to prepare teachers for the use of ICT in the process of teaching primary school children.
The urgency of training primary school teachers for the use of ICT in the educational process has gained new meaning in 2020, when the quarantine was introduced due to the Covid19 pandemic, and educational institutions had to turn to distance learning. Teachers were forced to increase their ICT competency in the context of conducting online lessons, creating interactive tasks, organizing a virtual classroom and keeping a virtual journal.

Based on the needs of the educational community in the spring of 2020, we prepared and conducted a distance course for primary school teachers in Ukraine, which aimed at familiarizing teachers with online services that will help organize distance learning in primary school, including mathematics.

The aim of the article is to present the content and organization of the e-course "Internet resources for creating mathematical learning and game content for primary school children", as well as the analysis of feedback from teachers – students of the course. To achieve the aim, a set of theoretical and empirical research methods was used. To understand the level of primary school teachers' readiness to use ICT in professional activity, empirical methods were employed – a survey (questionnaire) of primary school teachers. Among the theoretical, the following methods were widely used: analysis and generalization of the data of teachers' questionnaires, comparative analysis of research results on the use of ICT in the educational process; which allowed to determine the peculiarities of creating educational and game content in mathematics for primary school children; comparative analysis of available e-courses on the use of certain services in the work of the teacher, as well as synthesis and theoretical modeling in the process of developing an e-course. The leading role was played by the pedagogical experiment, which confirmed the effectiveness of the developed e-course.

1. E-COURSE "INTERNET RESOURCES FOR CREATING MATHEMATICAL LEARNING AND GAME CONTENT FOR PRIMARY SCHOOL CHILDREN"

1.1. The aim and objectives of the course. Course program

The aim of the course is to familiarize teachers with the possibilities of online services for organizing teaching mathematics to primary school children, including distance learning. As a result of taking the e-course, students of the course are expected to learn the following:

- selecting an online service with the required functions to create educational content;
- creating educational content and present it to school children;
- organizing training using online services;
- algorithms of school children's work with online services;
- methodological features of using the opportunities of online services for organizing mathematics lessons.

The course is structured in 5 modules; each of them is dedicated to a separate Internet resource (https://zmist.op.ua/courses/internet-resursi-dlya-stvorennya-navchalnogo-ta-igrovogo-kontentu-z-matematiki/?fbclid=IwAR2R_1Gwd4S39TIqf1crX6OHBaKrIfUO0JMW8M2-7xU0bVqIC9FRsJ1zaQA).

Each topic is considered according to the plan:

1. Basic information about the service. Comparison of service opportunities with those discussed earlier.
2. Registration and profile settings.
3. Review of possible templates. Templates that should be used in teaching mathematics to primary school children.

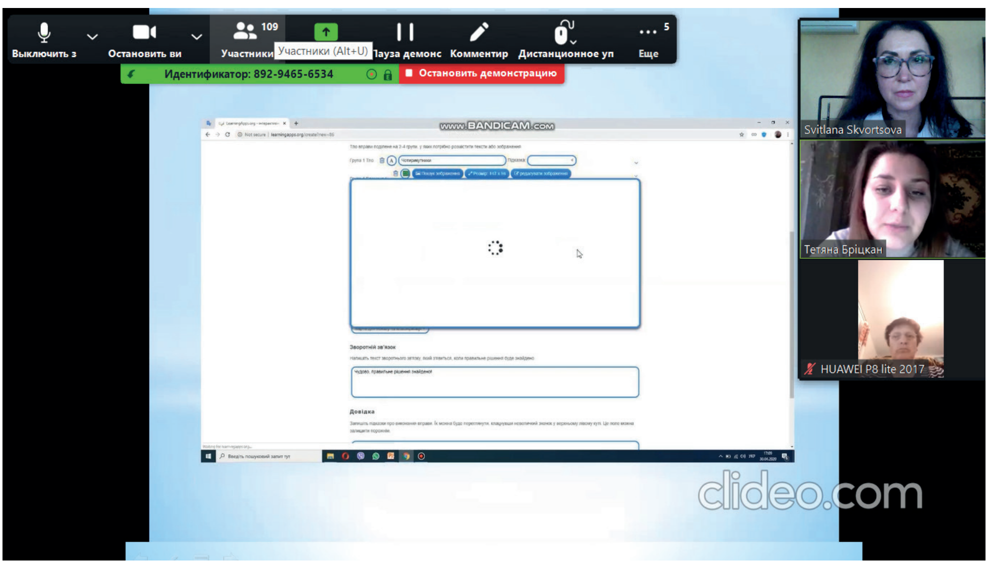
4. Learning to create tasks in each of the templates.
5. Organization of teaching mathematics using the opportunities of the service.
6. Organization of a virtual class (if possible).
7. Algorithm of the schoolchild’s work with the service.
8. Virtual magazine.
9. Presentation of the experience of using this service by a primary school teacher.

This course is addressed to primary school teachers, school methodologists, representatives of private educational institutions, educators of senior preschool groups, students of higher pedagogical educational institutions, parents of primary school children.

1.2. Teaching online the course “Internet resources for creating mathematical learning and game content for primary school children”

The e-course “Internet resources for creating mathematical learning and game content for primary school children” (hereinafter – the course) lasted from May, 4, 2020 to June, 1, 2020. The teachers of the course were Doctor of Pedagogical Sciences, Professor, Corresponding Member of the National Academy of Pedagogical Sciences of Ukraine, Head of the Department of Mathematics and Teaching Methods of the South Ukrainian National Pedagogical University S. Skvortsova, and postgraduate student of the Department of General Pedagogy, Preschool, Primary and Special Education of Izmail State University of Humanities T. Britskan.

120 teachers took part in the course. 110 people listened to the webinar on a regular basis (Figure 1), others – joined the webinars periodically due to unstable Internet connection. After the online webinar, the video of the webinar was uploaded on the Zmist.ua platform. Some teachers were trained by watching these videos. In total, as of August 2020, 715 students are participating in the e-course.



F i g u r e 1. Webinar screen dedicated to the LearningApps service

S o u r c e: own work.

The e-course learning has several stages:

- registration – the participants fill in the registration form and get access to the online broadcast of the course;
- mobility – the courses were held using the Zoom system;
- communication – in the chat, the participants asked questions to speakers, talked to other students of the course and quickly assessed their level of knowledge;
- confirmation of their knowledge – ordering a certificate of completing the course.

During the webinars, the speakers drew attention to the possibilities of the new service compared to those considered in previous webinars in paid and free versions, the organization of a virtual classroom and presentation of school children's results in a virtual journal, the possibility of creating both interactive exercises and exercises with open-ended answers.

Teachers had the opportunity to observe the actions of their tutors to configure the teacher-user profile, together with the speakers to view libraries of ready-made exercises, to analyze a bank of templates for creating tasks.

The templates of each service were compared with similar templates of other services, emphasis was placed on common and different features, on the ease of recording. Templates were also analyzed to create tasks in different formats (text, picture, video, etc.). During the course, students analyzed the possibilities of creating various mathematical problems for organizing oral questioning of schoolchidlren, mathematical dictation, oral counting, problems on restoration of true equations, problems on finding values of expressions in several actions, finding unknown components of arithmetic actions, solving equations and inequalities, work on problems of geometric content. Also, the speakers analyzed the possibilities of using the tasks created in each of the services at certain stages of the mathematics lesson: (1) updating basic knowledge and methods of action; (2) formation of new knowledge and methods of action; and (3) formation of abilities and skills, as well as consolidation.

During the webinars, the course students followed the actions of the speakers to create exercises in each of the templates, followed the QR-code to the created task, and in the webinar chat asked the speakers about the features of displaying certain tasks in the service.

It was noticed that due to the peculiarities of the services, it is not always possible to submit a task / interactive task in the form as it is presented in a textbook, study or workbook. Some templates provide only the text form of the task, some templates require reformatting the image with the task screen, and so on.

Attention was also paid to the advantages and disadvantages of various templates of a particular service to perform a particular task. Students had the opportunity to directly review the options created in different templates of tasks and draw conclusions about the feasibility of a particular template for a particular type of mathematical problem.

After creating a task online in a separate template, course the participants received practical advice on choosing a specific template for creating tasks depending on the type of task and the stage of the lesson. The speakers gave recommendations on the peculiarities of the options for setting the task, on how to move students to this task. All these recommendations were positively assessed by the teachers and they gratefully responded with comments in the chat. Suggestions, as well as the procedure, were reflected in step-by-step algorithms for creating tasks in a specific template following which teachers could develop tasks independently. It should be noted that the step-by-step algorithms were accompanied by screenshots from the screen, which illustrated the steps to create tasks.

Also, during each webinar, students learned about the algorithms of creating a virtual class or group of users, and inviting students to it. The nuances of getting school children to the service, receiving tasks and options for sending school children’s work, if the tasks were not interactive, the possibility of involving parents in the results of the child’s learning were revealed. Some attention was paid to the analysis of the form of presentation and functions of the virtual journal, teachers were offered life hacks on its use. Teachers positively assessed the provided step-by-step memos and algorithms for creating tasks and algorithms for school children in the services LearningApps, Google Classroom, Classtime, Classdojo, Padlet, Zoom.

2. CONDUCTING THE E-COURSE “INTERNET RESOURCES FOR CREATING MATHEMATICAL LEARNING AND GAME CONTENT FOR PRIMARY SCHOOL CHILDREN”

During the webinar on topic № 1. “Creating interactive exercises in mathematics with the help of the LearningApps service”, it was noted that modern primary school children are representatives of the digital generation and some key educational problems caused by their stay in the virtual world were outlined. It was proved that moderate use of ICT in the educational process facilitates the assimilation of educational material by primary school children. It was also noted that the maximum duration of continuous work with computer equipment for students of grades 2–4 is 15 minutes with mandatory performance of a set of exercises for eye rest in accordance with state sanitary rules and regulations “Arrangement and equipment of computer rooms in educational institutions and the mode of school children’s work on personal computers” of Ukraine (DSanPiN 5.5.6.009-98). Next, the basic material on registration and use of the LearningApps service was provided. The features of working with each template were determined in the guides and algorithms for creating interactive exercises. Each template was supplemented with QR codes of the created interactive exercises. It was mentioned that the created interactive exercises in this service can be used only at the stages of the lesson of mathematics “Updating basic knowledge and methods of action” and “Consolidation. Formation of skills and abilities”. It was shown which templates can be used to create interactive exercises for the above mentioned stages of the mathematics lesson and the corresponding QR-codes of interactive exercises were demonstrated. The peculiarities of creating a virtual class in the LearningApps service were outlined and the QR-code for the created virtual class, where all materials and examples of interactive exercises were placed, was provided.

The webinar on topic № 2. “Peculiarities of using Google Classroom in teaching mathematics to primary school children” began with coverage of the results of research by domestic and foreign scientists on the impact of gadgets on child development. Information on the positive and negative impact of gadgets on child development was provided. Summarizing all the results, preference was given to the use of ICT in the educational process in primary school. Afterwards, the basic material for registering and creating a training course in the Google Classroom service was provided. The example of covering all stages of a mathematics lesson in the 2nd grade on the topic: "Discovering the method of multiplication and division by ten" demonstrated the templates for creating tasks in Google Classroom and the ability to fill the course with other content. The peculiarities of creating a virtual class in the Google Classroom service were outlined and the class code, where all the tasks of the specified lesson were placed, was given. The peculiarities of entering an electronic diary in this service were outlined.

The webinar on topic № 3. "Peculiarities of using the Classtime service in teaching mathematics to primary school children" began with presenting basic information about this service based on the comparative characteristics of already studied services, including LearningApps and Google Classroom. Peculiarities of working with each template were outlined in the guides and algorithms for creating interactive exercises and open-ended tasks. The comparative characteristics of the templates of the studied services, in particular LearningApps, Google Classroom and Classtime, were presented; with the help of them it was possible to create interactive tasks and open-ended tasks. A link to the created session, which contained examples of tasks created in Classtime, was provided. The webinar ended with a speech by a primary school teacher, NUS coach Hanna Zastavska, who demonstrated the created sessions in mathematics and underlined certain peculiarities of working with the service.

The webinar on topic № 4. "Peculiarities of using the online Padlet board in teaching mathematics to primary school children" began with the presentation of basic information about this service based on comparative characteristics of already studied services, including LearningApps, Google Classroom and Classtime. The peculiarities of the choice of virtual board templates and the technology of filling it with educational material and interactive tasks were highlighted. The algorithm for preparing a mathematics lesson in the Padlet virtual board was demonstrated. There was a link to a mathematics lesson in 2nd grade on the topic: "Learning the rules of how to perform actions in expressions", created on the Padlet virtual board. The webinar ended with a speech by primary school teacher Ryma Rudenko, who used this service during distance learning in the spring of 2020, and showed her own virtual boards in the Padlet service.

The webinar on topic № 5. "Classdojo in teaching mathematics to primary school children. Zoom service for online mathematics lessons" began with a comparative description of the studied services according to the following criteria: lesson organization, filling the lesson with tasks, school children's answers, checking tasks by the teacher. The students received basic information about working and creating tasks with answers of various formats in the Classdojo service. The speakers provided a link to a mathematics lesson in 2nd grade on the topic: "Complex problems for multiple comparison", created when using the Classdojo service. The review of this service ended with a speech by primary school teachers Oksana Zamosyanchuk and Yulia Grzegodska, who shared their experience of work with this service. The webinar continued with a presentation of basic information about working in the Zoom service and a demonstration of presenting tasks based on a mathematics lesson in the 2nd grade “Solving problems to find the sum”. Algorithms of school children’s work in this service were described. The review of this service ended with a speech by a primary school teacher Victoria Galushkina, who shared her experience of work with the Zoom service in the paid version.

It should be noted that each webinar lasted more than 2 hours. After the main part, teachers stayed in to exchange views, give practical advice and solve problems on working with online services.

Thus, the distinguishing feature of the course is: (1) comparative analysis of the opportunities of each service with others, which was considered in previous webinars; (2) comparative analysis of templates for creating exercises in each service; (3) step-by-step algorithms for creating tasks in each task of the service; (4) algorithms for creating a virtual class; (5) algorithms of school children’s actions; and (6) analysis of the structure and functions of the virtual journal and life hacks on its formation.

Also, a significant difference between our course and other similar courses is that at the end of the webinar, after reviewing a service, there was a presentation of practical experience by primary school teachers of Ukraine: Elena Popkova and Anna Zastavskaya from Zaporizhzhia, Julia Grzegodska from Lviv, Oksana Zamosyanchuk from Odesa region, Vita Galushkina from the city of Kyiv, Ryma Rudenko from the city of Kryvyi Rih.

The participants of the e-course positively assessed the fact that the speakers highlighted both the advantages and the disadvantages of using these services; difficulties they may face in using them. On the example of primary school teachers’ performances in webinars, the participants could see that the selected services can be implemented in the educational process of primary school, reviewed the tasks created by the teachers, electronic journals in mathematics, children’s work. The feedback provided in the chat indicated the content and availability of information on working with online services.

After each webinar, the course students left their feedback in the chat. In the reviews, the teachers noted the benefits of the information obtained for their own practical activity (Vira Kovaliova: “Thank you for this course and for your work! The benefits of knowledge I gained with colleagues during this course can not be overestimated”, Irina Kulak: “Thank you! Very interesting and useful information. There is something to work on”, Svitlana Sheiko: “Thank you! What we need now is to master it”, Natalia Mozhaieva: “We will learn to use these services. Very exciting and interesting”…), accessibility, logic and systematic presentation information by speakers (Olha Davydenko “Thank you! Very interesting and accessible”, Svitlana Stepanovna: “Thank you! It was very interesting! A lot of useful information”, Polina Sokolovskaia: “It was a series of the most meaningful and detailed webinars on distance education”, Stella Stolper: “Dear speakers! Thank you for the tremendous work you have done to familizarize us (teachers) with various services”). Teachers noted that although they had some experience of work with a particular service, they learned a lot for themselves.

Feedback from teachers proves the relevance of the work and obtaining specific recommendations for the use of these services in teaching mathematics in primary school. It should be noted that the students of the course were not only primary school teachers of Ukraine, but also future teachers from the South Ukrainian National Pedagogical University named after K. D. Ushynskyi, Precarpathian National University named after V. Stefanyk and Izmail State University of Humanities. These universities take into account the results of non-formal education in assessing the academic achievements of students in the learning course “Methods of teaching mathematics in primary school”; thus, the certificates they are awarded by the platform Zmist on completing the course “Internet resources for creating mathematical learning and game content for primary school children” will be taken into consideration during the final certification of students in the discipline “Methods of teaching mathematics in primary school”. The questions of recognizing learning outcomes obtained in non-formal education are regulated by the university regulations. In particular, in Izmail State University of Humanities it is the “Regulations on the organization of the educational process” (paragraph 8.17) and the “Regulations on study according to the individual schedule of higher education students of Izmail State University of Humanities”. Within the block of elective disciplines, a higher education student can be rewarded with credits obtained during mass open online courses posted on the platforms of Prometheus, Coursera, EdX and others, including Zmist.ua, with a certificate. On the basis of the application and the certificate submitted by the applicant for higher education, the dean’s office issues an order appointing a board, which determines the form and term of certification to recognize the learning outcomes acquired during the course. The results of the attestation are entered by the board in the credit-examination list issued by the dean’s office and the individual study plan of the higher education applicant. Similar normative documents have been approved in South Ukrainian and Precarpathian universities. Students of these universities took the e-course as an individual task in accordance with the study program of the discipline “Methods of teaching mathematics in primary school”.

CONCLUSION

The professional activity of a modern primary school teacher is impossible without the use of ICT, in particular online services. The results of teacher surveys we conducted in the previous stages of the study indicate that they have basic knowledge, ICT skills and abilities, but herewith they demonstrate the lack of ability to work with online services for creating educational and game content.

We studied the possibilities of free online services or services that provide a free version: LearningApps, Google Classroom, Classtime, Padlet, Zoom, Classdojo, Liveworksheets, Wizer.me, H5P, Lino it, etc .; and outlined both the advantages and disadvantages of their use in teaching mathematics to primary school children. Peculiarities of presenting mathematical problems by means of the specified services were analyzed. The aspect of combining these services was considered and the question which services can complement or replace each other was discussed.

Thus, for the optimal use of various online services by teachers, we developed and conducted a course "Internet resources for creating mathematical learning and game content for primary school children". The aim of this course is to familiarize teachers with online services that help organize distance learning in mathematics: services for creating a virtual classroom, its filling with interactive exercises and other educational content (LearningApps, Google Classroom, Classtime, Classdojo), services for organizing a distance lesson (Padlet) and services for conducting a distance lesson in the form of a conference (Zoom).

The developed e-course was of interest to primary school teachers, school methodologists, representatives of private educational institutions, educators of senior preschool groups, students of higher pedagogical educational institutions, parents of primary school children. After the webinars in the chat, we received listeners' positive feedback on the topic and the course as a whole.

Videos of the webinars are posted on the Zmist.ua platform. As of August 2020, the participants of the e-course are 715 students who took an active part in the discussion of the material during the webinars and left positive feedback on the work done. The course is also introduced in the process of methodological training at the South Ukrainian National Pedagogical University named after K. D. Ushynskyi, Precarpathian National University named after V. Stefanyk and Izmail State University of Humanities by taking into account the results of non-formal education in assessing students' achievement in the discipline "Methods of teaching mathematics in primary school".

We see prospects for further research in continuing to study the peculiarities of other online services, which can also be used to create educational and game content in mathematics for primary school children and develop the next course for primary school teachers in Ukraine.

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CONNECTION BETWEEN ONTOUML AND KNOWLEDGE REPRESENTATION MODEL OF STUDENTS' ACTIVITIES

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Abstract: *In every focused system, e.g. the Learning Management System (LMS) Moodle, it is possible to select relevant entities (students, teachers, study resources, assessment, test and other activities) and their relations (associations). A conceptual model in OntoUML is suitable for the entities representation. It is possible to feel a knowledge decision process as a non-determinist finite automaton where entity state transitions are inspected. A way of entity state transition (needed data and conditions) is represented by guideline (procedural) knowledge representation model (like as GLIKREM). This paper aims to describe the possibilities of the conceptual model of the focused system designed in OntoUML and the Guideline Knowledge Representation Model (GLIKREM) for the Knowledge Representation Model of Students' Activities (KRMSA) based on knowledge and models of students' activities in a Moodle system. This article describes a link between OntoUML as a conceptual model and GLIKREM as a procedural knowledge model base with the aid of the main components of both models.*

Keywords: knowledge representation model, conceptual model, students' activities, decision process, OntoUML, Moodle.

INTRODUCTION

At present, the distance form of education is becoming more and more important. More and more courses are being taught with the support of electronic systems (e.g. LMS

Moodle) to provide students with new forms of electronic study materials, but also to provide feedback in the form of attendance records, records of studied materials and evaluation of individual projects and tests.

As the number of electronic courses grows, so it increases a suitable model requirement for representing the student¨s way through such a course. As the courses change, so does the role of the teacher toward the course guide and consultant (Koķe, 2003). A suitable model for the student's way through the course is a valuable tool for the teacher where the implementation of the model in the current LMS can automate many activities.

One of the usable models is GLIKREM. This model is originally intended to represent medical guidelines (Peleška, 2005) but is suitable for representing any procedural knowledge. The second suitable model is OntoUML, which is an extension of UML2 towards ontologies. OntoUML is primarily intended for (ontologically) a more accurate description of the investigated domain, especially data types and relationships between them. However, the resulting model in OntoUML is relatively easily convertible to an implementation model (Rybola, 2016) and can thus be the cornerstone of applications in the background of the primary LMS or applications of subject domain ontologies (Stoyanova-Doycheva, 2019). Knowledge Representation Model of Students' Activities described in this article uses elements of both mentioned models.

1. METHODS

1.1. OntoUML

OntoUML is an example of a conceptual modelling language which has been designed to comply with the ontological distinctions and axiomatic theories put forth by a theoretically well-grounded Foundational Ontology (Guizzardi, 2005). The conceptual model in OntoUML can then be transformed into various implementation models, typically relational or object (Rybola, 2017).

Types (classes) in OntoUML are based on the UML2 concept of classes as a description of common properties shared by certain entities (instances of the class). Attributes represent more or less intrinsic properties shared by instances of the class. Class instances already contain specific attribute values.

Types can be in a specialisation or association relationship with each other. Specialisation defines the taxonomic structure of types in which all attributes of a class are inherited through a chain of specialisation. Classes sharing a common supertype can be grouped in a so-called generalisation set. Two meta-attributes can be used a more robust semantics to a generalisation set, namely, the complete and disjoint meta-attributes.

- ***Complete*** – If a generaliz = sation set is complete, the subtype exhausts the instances of the common direct supertype. There is no instance of the supertype, which is not an instance of one of the subtypes participating in the generalisation.
- ***Disjoint*** – If a generalisation set is disjoint if all the subtypes participating in the generalisation are mutually exclusive. The intersection between any of these subtypes is always empty.

Associations are generally n-ary relations (but mostly binary) those bind entities together. Associations in OntoUML have the same meaning and notation as UML2.

The association is specified by an (optional) role name and (mandatory) multiplicities on both sides of the association. An arrow indicates the reading direction supplements the association. Specific multiplicities are determined by conceptual analysis of the problem domain.

Identity. Identity plays a crucial role in OntoUML. The principle of identity tells how to identify an object (instance of some type) during its entire existence, regardless of its (arbitrary) changes. It is, therefore, identity in terms of our perception, i.e. how we can clearly distinguish two objects from each other. This concept is fundamentally different from the usual identity in the object concept (object ID). Based on the (ontological) identity, we then define two main categories of types:

- ***Sortal type*** – Sortal type provides categorisation and has its own (ontological) identity.
- ***Non-sortal type*** – Non-sortal types have not an (ontological) identity and therefore represent abstract concepts in terms of our perception. We use them to categorize sortal types according to various properties and relationships. In terms of implementation, of course, each sortal type needs an identity, e.g. object ID.

For further categorisation of object types, it is necessary to explain the basic concepts of the so-called modal logic as an extension of predicate logic. From predicate logic, modal logic uses existential (there is at least one element such that…) and universal quantifiers (for all elements…).

Also, modal logic introduces the concept of the world. To put it simply, the world in modal logic represents a specific configuration of reality in time or space. Two more quantifiers are being introduced for worlds:

- Quantifier □ – In all worlds…
- Quantifier ◊ – In some world (at least in one)…

Modal logic makes it possible to distinguish between classifications and invariant relations and those, which may change depending on the context. The categorisation of types also follows from modal logic:

- ***Rigid type*** – Type T is rigid for each instance of x just when x is necessarily (in all worlds) an instance of type T. If x is an instance of type T in some world, then x must be an instance of type T in every possible world.
- ***Anti-rigid type*** – Type T is anti-rigid for every instance of x just when it is possible (in some world) that x does not have to be an instance of type T. If x is an instance of type T in some world, then there may be some other world where x is not an instance of type T.

The categories of all types in OntoUML are based on the (ontological) identity principle and modal logic and are listed in Table 1.

1.1.1. Sortal types

The <kind> and <subkind> types simply correspond to classes and subclasses according to the UML2 concept. There is a subtle difference between <kind> (type) and <subkind> (subtype) that UML2 does not distinguish, but OntoUML does. The <kind> type has and provides an ontological identity, while the <subkind> type does not have its own identity; it takes it from the <kind> type. In OntoUML, each sortal type can have only one (ontological) identity, so type <kind> cannot be a subtype of another type <kind>. In the resulting model (see Figure 5), the type is <kind> Person (where the identity can be, for example, a personal number or login) or Course (the identity is the course code).

The <role> type is subject to a so-called relational dependency. The type T is relationally dependent on the type P via relation R just when for each instance x of the type T there exists an instance y of the type P such that x and y are related via R. All instances of a <role> type are of the same <kind> type, e.g., all Students (<role>) are Person (<kind>). A <role> type cannot be a supertype of any rigid type. In the resulting model (see Figure 5), the type <role> is a Student belonging to the type (<kind>) Person, who studies some type (<kind>) Course, and his role is thus valid in this "world" (course). Similarly, the role Teacher has tied to the "world" of the Course type that this teacher teaches.

The <phase> type is defined as an anti-rigid specialisation of the <kind> or <subkind> type such that the specialisation condition is intrinsic. Phases are always defined in a so-called phase partition. The phase partitions are always disjoint and complete generalisation sets. In the resulting model (see Figure 5), the type <phase> is the passed or non-passed of some of the course activities (types <kind> Chapter, Project, Test or Exercise). Which phase (type <phase>) the respective type <kind> enters depends on the fulfilment of some internal condition (e.g. obtaining a specified minimum rating). Simply put, the <phase> type can be thought of as the state of the corresponding <kind> type.

Table 1

Categories of Types in OntoUML

Category of Type	**Supplies an identity**	**Has an identity**	**Rigidity**	**Dependence**
SORTAL				
<kind>	+	+	+	–
<subkind>	–	+	+	–
<role>	–	+	– (anti)	+
<phase>	–	+	– (anti)	–
NON-SORTAL				
<category>	–	–	+	–
<roleMixin>	–	–	– (anti)	+
<mixin>	–	–	– (semi)	–

Source: Own work based on Guizzardi, 2005.

1.1.2. Non-sortal types

The <category> type is a rigid non-sortal representing the necessary (in the modal sense) property instances of different types. Categories form the uppermost layer of object types of ontologies and are therefore always defined as abstract classes, like all non-sortal types. That means that all <category> types must have some sort of sortal subtype (usually <kind>). The <kind> type can be a subtype of multiple <category> types, and the <category> type can be a supertype of multiple <kind> types. In this case,

all <kind> types in the category must be disjoint (form a disjoint generalisation set). Otherwise, instances of their intersection would inherit multiple (ontological) identities. The <roleMixin> type is an anti-rigid and relationally dependent non-sortal representing (in the modal sense) the properties of instances of different types. The <roleMixin> types are used to categorise the instance of the <role> types. However, the <roleMixin> type cannot be a <category> supertype, because no anti-rigid non-sortal can be a supertype of a rigid one.
The <mixin> type is a semi-rigid non-sortal representing properties that are (in a modal sense) necessary for some instances but possible for some other instances. Each <mixin> type must be a rigid type supertype (typically <kind>) and an anti-rigid type supertype (typically <phase>). Since all <kind> types are disjoint, all subtypes of <mixin> type form a disjoint generalisation set.

1.2. GLIKREM

The Guidelines Knowledge Representation Model (GLIKREM) is based on a Guidelines Interchange Format model which was published in a GLIF3.5 specification (Boxwala et al., 2004). GLIKREM contains some changes and extensions to the definition and implementation of the original GLIF model, which allow more accurate modelling of procedural knowledge as a graphical model which describes a process structure of the decision algorithm (Buchtela et al., 2010). GLIKREM also includes a parameter model, which serves as an interface between the graphical model and real data.

1.2.1. Main parts (steps) of the graph

The GLIKREM created in a construction stage is an oriented graph (see Figure 1) which is composed of five main parts (steps):

- ***Action steps*** specify actions that are to be performed. It can be a study of some resource, submission of the completed task, performance of the test etc. Action step also may name sub-guidelines (subgraph), which provide detail for the action.

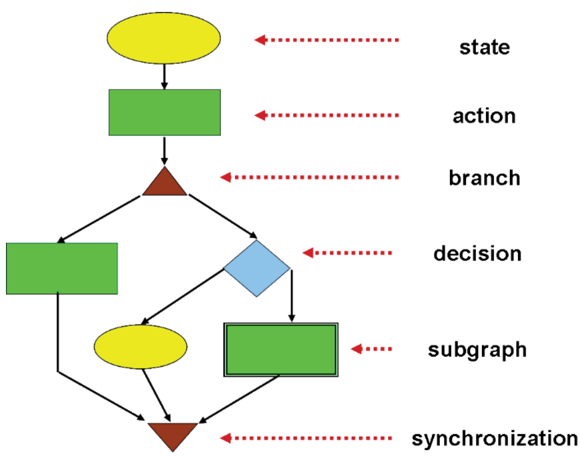


Figure 1. Main parts (steps) of GLIKREM

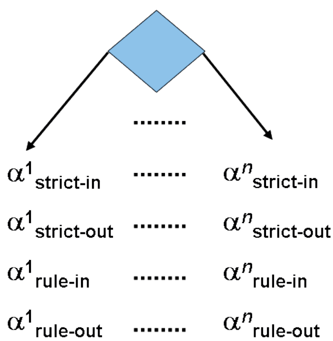
Source: Own work.

- ***Decision steps*** are used for conditional branching. This step is used when branching is determined by evaluation of defined logical criteria based on data items. If the decision cannot be made automatically, the user can select himself the follow-up part of the graph.
- ***Branch and synchronisation steps*** enable concurrence in the model. Guideline steps that follow the branch step can be performed concurrently. Branches with root in a branch step eventually converge in a synchronisation step. In this step, all branches are synchronized after evaluation of the synchronizing condition.
- ***State steps*** characterise surveyed object states after the execution of the previous steps or at the beginning of the model.

1.2.2. Decision criteria

Each decision step specifies four criteria of condition for each decision option (see Figure 2). The subsequent flow of the model is automatically or manually chosen based on the evaluation of these criteria:

- ***Strict-in*** – if a *strict-in* is true, the control flows to the guideline step that is specified by that decision option's destination.
- ***Strict-out*** – if a *strict-out* is true, the decision option's destination is forbidden. The *strict-out* can be but don't have to be opposite of *strict-in*.
- ***Rule-in*** – if a *rule-in* is true, it is only recommended to flow to the guideline step that is specified by that decision option's destination. The user should select himself one of the next steps with positive *rule-in*.
- ***Rule-out*** – if a *rule-out* is true, the decision option's destination is not recommended, but it is not forbidden. The user shouldn't select one of the next steps with positive *rule-out*.



F i g u r e 2. Decision criteria in a decision step

S o u r c e: Own work.

The *strict-out* criterion is evaluated at first. If the *strict-out* criterion (of some option) is evaluated as true the rest of the criteria (of this option) is not assessed. This option is forbidden. In the opposite case, the *strict-in* criterion is evaluated. If both of *strict-in* and *strict-out* criteria are false, the *rule-in* and *rule-out* criteria are evaluated. The ranking of *rule-ins* and *rule-outs* (of all option's criteria) is left to the users who may use their clinical judgement or develop their ranking schemes.

1.2.3. Criteria evaluation

When evaluating the criteria (*strict-in*, *strict-out*, *rule-in*, *rule-out*), it often happens that input parameter values are not known. Therefore, the criteria are evaluated in three-value logic. The logic formulas contain variables from a model of parameters (Veselý, 2006) and logic or relational operands.
If these rules are thoroughly applied, the user can insert missing data when it is necessary. If a *strict-in* criterion of some option (destination) is true, the evaluation of other option criteria is not needed. The amount of essential data is dependent on the order of single option evaluations. Therefore, it is necessary to set an order of assessment, i.e. to set a priority of decision options. A specialist chooses the priority of each option.

2. RESULTS AND DISCUSSION

The students' way through an electronic course (e.g. realized in LMS Moodle) can be described using the Knowledge Representation Model of Students' Activity (KRMSA). The KRMSA design consists of both a graphical model (GLIKREM) of the student's progress and its transformation into the OntoUML model. A sample KRMSA design is made for a model situation of a hypothetic course in LMS Moodle.

2.1. Model situation

The subject of the research is a full-time student, the aim of which is to obtain credit from a hypothetic course for one semester. To complete the course (achieve the goal), the student must meet the following conditions (C1 – C4):

- C1 – To study ten chapters with theory related to the subject. There are several control questions at the end of each chapter that the student must answer correctly (he can answer in several attempts).
- C2 – To adequate attend at exercises. It is necessary to get at least 70% participation in exercises.
- C3 – To submit an individual project. The student submits the project itself on a given topic. The student must obtain a grade of at least 70%. It is possible to make one repair in a separate project.
- C4 – To pass a credit test. The student achieves a control test of the discussed issues. Successful completion of the test means obtaining at least 70% of the possible evaluation. The test can be passed in a maximum of two attempts.

The course of study, i.e. attendance and results of partial conditions, is recorded in the system for the support of electronic education (Moodle). In the same system, the student has the necessary study materials (theoretical chapters) and feedback tools (project submission and electronic test).

2.2. GLIKREM of model situation

The model situation will be shown in GLIKREM as four parallel branches, one branch for each condition C1 – C4 (see Figure 3). The first branch represents the study of ten chapters (k_i), the second branch of completing 14 exercises (c_i), the third branch of achieving a separate project (p) and the last branch of passing a credit test (t). The dotted lines indicate the repetition of the same structure, i.e. ten times the study of the chapter and 14 times the completion of the exercise.

- C1 – Study of a chapter (k_i). The student repeats the study of the chapter k_i until he answers the control questions correctly, i.e. until the strict-in criterion of the branch κ_{i1} is true.
- C2 – Completion of exercises (c_i). The student either participates in each exercise (true strict-in criterion σ_{i1}) or does not attend (true strict-in criterion σ_{i2}). The teacher records attendance (non-attendance).
- C3 – Completion of the project (p). The student completes the project if the strict-in edge criterion π_1 or π_3 is met. Both strict-in criteria are defined by the condition evaluation (p) ≥ 0.7. The strict-in criteria of branches π_2 and π_4 are a negation of the strict-in criteria of edges π_1 and π_3.
- C4 – Passing the test t. The student successfully passes the credit test if the strict-in edge criterion τ_1 or τ_3 is met. Both strict-in criteria are defined by the condition evaluation (t) ≥ 0.7. The strict-in criteria of branches τ_2 and τ_4 are a negation of the strict-in criteria of edges τ_1 and τ_3.

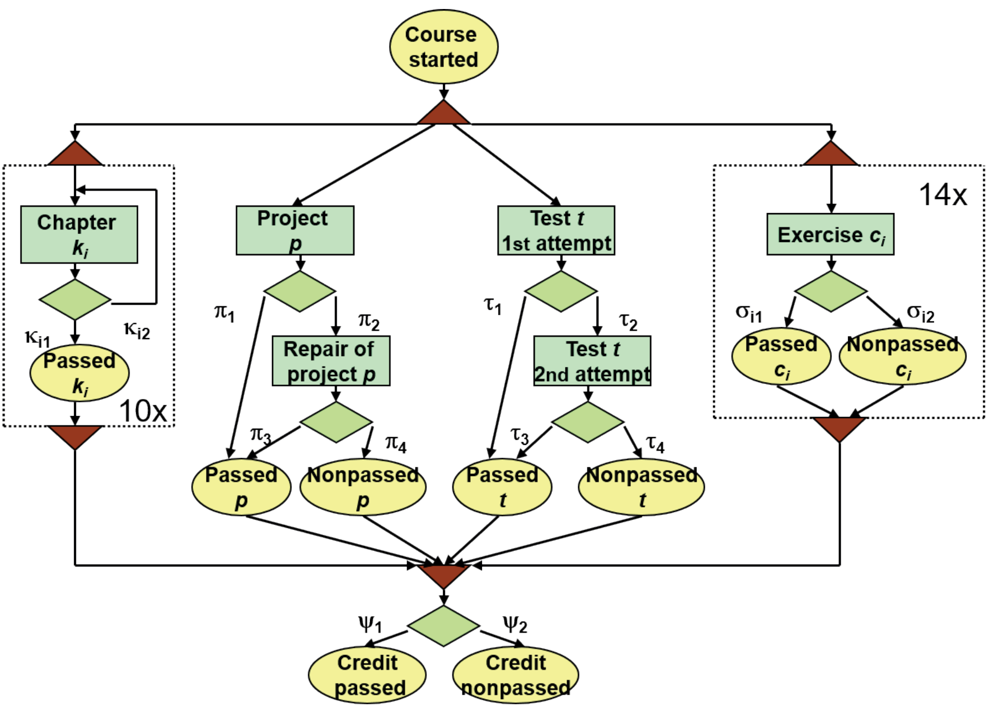


Figure 3. GLIKREM of model situation

Source: Own work.

Credit. The student gets the credit if the strict-in criterion of the edge ψ_1 is met, i.e., the student completes the study of all chapters (k_i), completes at least 70% of exercises, or completes the project p and successfully passes the test t. The strict-in cri-

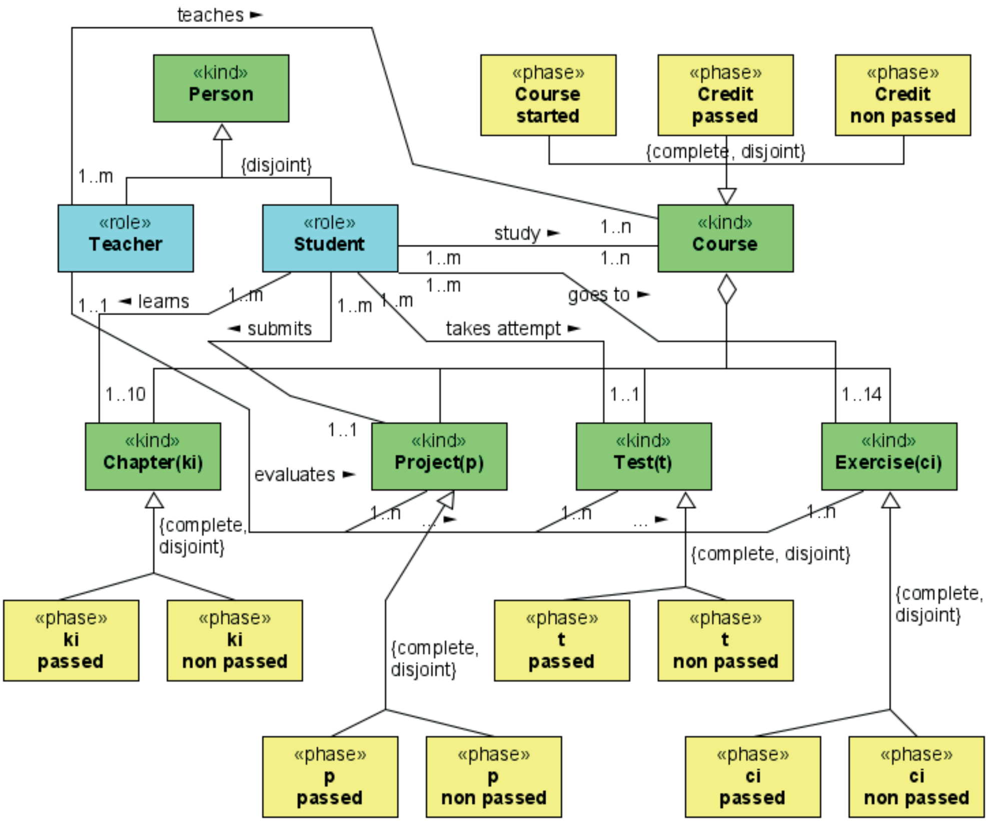
terion of an edge ψ_2 is defined as a negation of the strict-in criterion of an edge ψ_1. All strict-out criteria are, in all cases, a negation of the strict-in criteria.
The rule-in and rule-out criteria are not used at all for this model situation. However, these criteria could be used, for example, as a recommendation for the student to re-study the study materials (Chapters) in case he fails to obtain the necessary test evaluation on the first attempt (rule-in criterion of edge τ_2). Studying the chapters again is not obligatory for the student (strict-in), but only recommended (rule-in).

2.3. OntoUML conceptual diagram of the model situation

When transforming GLIKREM to a model in OntoUML notation, it is necessary to find all relevant types (OntoUML) based on the analysis of individual steps and parameters in GLIKREM. In this process, the following rules can be generalized:

- Action steps are usually converted to <kind> (or <subkind>) types or relationships between <role> types.
- The state steps are converted almost exclusively to the <phase> types of the corresponding <kind> types.
- Decision steps, including decision criteria, will be applied only during the implementation of the OntUML model, i.e., during its transformation into a specific implementation model. The same applies to the branch steps and synchronisation steps.

The result of the GLIKREM transformation of the model situation into OntoUML is shown in Figure 4. For clarity, the model in OntoUML is not complete, i.e. it does not contain all the elements (types), attributes and association between types that would be necessary for its implementation.
When transforming a model situation with GLIKREM into OntoUML, it is necessary first to define the basic types <kind>, which are the Person and Course types. Two types <role> Teacher and Student are set for the Person supertype, and both roles have a relational dependence on the Course type.
For the Course type, three <phase> types are defined, which represent the state steps of GLIKREM Course started, credit passed, and Credit non passed. The Course type consists of the <kind> Chapter, Project, Test, and Exercise types corresponding to the action steps of GLIKREM of the same name. For each activity, two types <phase> Passed and Non passed are defined, representing the respective state steps in the GLIKREM model situation. The first and second test attempts are implemented as an Attempt attribute of type <kind> Test.
All decision conditions (or criteria) and the actual process of transition between phases (types <phase>) are implemented in the corresponding methods of the respective taps <kind>. The mentioned elements (steps) of GLIKREM, i.e. decision steps and synchronisation steps including decision criteria, are not transferred to OntoUML at the conceptual level of the model, but only subsequently in the phase of transfer to a specific implementation model.



F i g u r e 4. The model situation in OntoUML notation

S o u r c e: Own work.

CONCLUSION

This article proposes a Knowledge Representation Model of Students' Activities (KRMSA), which describes a model situation of a student passing an electronic course and obtaining credit from this course. The resulting KRMSA model situation is based on the Guideline Knowledge Representation Model (GLIKREM) and its subsequent transformation into a conceptual model in OntoUML notation.

From the conceptual model in OntoUML, it is then possible to derive a specific implementation model usable, for example, for automatic student evaluation in a given course or as the basis of decision support systems in the background of LMS Moodle. The resulting model is based on the described model situation but is easily adaptable to any other situation according to the requirements for completing the course.

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E-LEARNING TO ENSURE EDUCATIONAL SERVICES' QUALITY IN UNIVERSITY DISTANCE LEARNING

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Abstract: *The high-tech industry and the development of applicable online tools are inspiring various institutions and individual educators to change teaching and learning approaches and methods, especially in higher education. Borys Grinchenko Kyiv University has been implementing distance learning technologies as one of the components of blended learning for 10 years now. Today's challenges for world pedagogy have shifted the emphasis to the need for speedy introduction of distance learning technologies at all stages of education. It is important not only to organize distance learning, but also to ensure sufficient quality of educational services and to design objective assessment technology. The article summarizes the experience of BGKU in organizing e-learning to provide distance learning for students and its impact on improving the quality of educational services. Also it presents the analysis of using various services and tools for organizing the educational activity of students in e-learning. Several options for organizing and conducting summative assessment as combined online-exams in the implementation of e-learning are described. Recommendations for the use of online tools and services to disseminate positive experiences in ensuring the quality of educational services are provided.*

Keywords: e-learning; quality of educational services; tools; distance learning; assessment; services for e-learning.

INTRODUCTION

Education, which is one of the universal values in all conditions, both favorable and critical to the world community. It needs change due to the rapid development of digital technologies. Thus, modern online tools and services are being introduced into the educational space, forcing them to change approaches and methods in teaching and learning, especially in higher education. More and more attention is paid to lifelong learning The lifelong learning's value, which includes formal, non-formal and informal education, is expressed as an idea, a principle of learning, the quality of the educational process.

The book *Universities in the Networked Society: Cultural Diversity and Digital Competences in Learning Communities* (Smyrnova-Trybulska, Kommers, Morze, & Malach, 2019) is devoted to the study of the impact and effectiveness of the use of digital technologies in lifelong learning. In it, scientists from around the world mark the importance and relevance of the use of e-learning, MOOCs, and the importance of increasing the academic staffs' digital competence for the quality of education. Improving the quality of educational services requires not only upgrading the higher education curriculum, but also changes to the in-service training staff. E-learning competencies are described in research by Roszak, Mokwa-Tarnowska, Kołodziejczak (Roszak, 2019); digital competencies of modern teachers are described in research by Morze (Morze, 2019); while the use of MOOCs for professional development are described by Smirnova-Trybulska (2019). Also, universities are introducing joint innovative master's programmes "E-Learning in Cultural Diversity" (Smyrnova-Trybulska, 2019), in which the key is to develop the professional competence of masters in the design and management of e-learning for different age groups, preparation of masters for the implementation of the educational process in the electronic educational environment using modern digital technologies (Morze, 2017).

Today's challenges have shifted the emphasis in world pedagogy to the need for the rapid introduction of distance learning technologies at all levels of education. It is important not only to organize distance learning, but also to ensure sufficient educational services' quality and design objective assessment. The need becomes especially urgent for a qualified, professional organization of distance learning with e-learning, which are flexible, dynamic and accessible 24/7/365 and stand up from the experience of blended and online learning.

In BGKU, e-learning is implemented using a variety of available digital tools in combination with the use of LMS Moodle, which is an integral part of the implementation of blended learning and a key system for providing high quality educational services in distance learning.

1. FEATURES OF UNIVERSITY EDUCATION IN THE COVID-19 PANDEMIC

1.1. Ways to organize the teaching

The world community and leading educational organizations are actively working to find the best ways to organize training in an extreme situation.

International and Ukrainian experts have urgently developed documents on how to organize training in the context of the COVID-19 pandemic: OECD. A framework to guide an education response to the COVID-19 Pandemic of 2020 (OECD, 2020); Recommendations for the blended learning introduction to institutions of professional higher and higher education (MES of Ukraine, 2020); Challenges and international organizations' responses of to overcome the problems in education caused by COVID-19 (Ovcharuk, 2020); Results of the online survey "Teachers' needs to improve the professional level on the use of digital tools and ICT during quarantine" (Ovcharuk, Ivanyuk, 2020).

The latest normative documents of Ukraine offer blended learning and explain the principles of blending and the role of distance learning as a separate form of education through indirect interaction of subjects through online technology. (MES of Ukraine, 2020). In Ukraine distance learning technologies have previously been used in the university teaching, but occasionally for approbation. Distance technologies in the teaching are defined as "distance learning" (DL), where knowledge is delivered to the student using specific platforms and tools, such as Moodle, Google Classroom, Zoom, Skype, Google Suite/Docs, etc. (Sosnytska, 2020). The DL toolkit allows communication between the teacher and students, the performance and checking of tasks, attendance control, the organization of the semester, certification, etc.

Due to distance learning, there are open educational structures of different purposes and scope: national and international. Students have the opportunity to study at any university in the world, in some even to receive certificates or diplomas. Everyone gets the opportunity to lifelong education, for continuous enhancement or a radical change of occupation. Ukrainian researcher Morze (2016) defines DL as an educational technology in which communication between a teacher and distant students takes place using digital technologies. Besides, she identifies e-distance learning, in which participants and organizers of the educational process interact both synchronously and asynchronously as a kind of distance learning. In addition, Morze singles out as a kind of distance learning, e-distance learning, in which participants and organizers of the educational process individually interact in synchronous and asynchronous.

1.2. Using distance learning

University strategy effects on the quality of education while using DL, including a clear vision for the management of active involvement of teachers and students, in the form of relevant documents regulating the use of DL to encourage teachers and students; taking into account the work on content design in the individual plans of teachers. Thus, in the report "Framework Guidelines for the Response of Education to the to the COVID-19 Pandemic" (Reimers & Schleicher, 2020), the authors believe that the educational institution's policy to support the effective use of digital media is important and decisive in the implementation of DL. Finally, such a policy will help reduce the destructiveness of education caused by the pandemic. DL and e-learning provide the greatest versatility and interoperability.

DL is actively used in blended learning, which is the integration of distance learning and full-time education, mixing learning materials online and group learning with a teacher, the flipped classroom or flexible blended teaching and learning model, where students have a high level of autonomy and flexible schedule personalized to their own needs. DL gives students and teachers access to a variety of resources to organize the educational process in an acceptable and adequate form; provides intensification of the education system, the opportunity to develop creative and intellectual abilities of each student by means of open online resources; and the possibility of lifelong learning. DL can be effectively implemented in the form of e-learning, which allows one to maintain the quality of educational services in the normal functioning of the university and in the current situation, i.e. in a pandemic.

1.3. The impact of e-learning on the quality of educational services

High-quality and conscientiously organized e-learning is transparent, open, accessible and objective. To organize it, you need to use a convenient LMS and additional tools to ensure quality online communication.

The KUBG e-learning system is organized in such a way that each student has a personalized entrance and access to e-learning courses (ELC), which are created by university teachers for e-support of disciplines.

Students can track their personal progress in the course, see the rating for a certain task among those who performed this task without opening the grades of other students. The student is set to be successful due to the fact that all learning outcomes are recorded in the e-learning system, information on the evaluation of tasks performed by the teacher is open, activity is constantly monitored. The student is interested and encourages the teacher to make the materials relevant and presented in an understandable form. Teachers, in turn, try to contribute essential structured information with the latest scientific data, current requests for professional realization of students to their ELC. Also, the quality of ELC is influenced by the students' ELC assessment, which results affect the teacher's rating. Another important quality component is the ELC certification at the university level, which consist by three expertise's types: content, resource examination and technical. The using level of certified ELCs in the educational process is also part of the teacher's rating.

These points, the needs of students on the one hand and the creativity of teachers on the other, are mutually motivating factors to improve the quality of education.

2. UNIVERSITY EXPERIENCE IN THE DEVELOPMENT OF E-LEARNING

2.1. E-learning as the learning process support in the implementation of blended learning

BGKU has been implementing blended learning for almost 10 years through a combination of e-learning and traditional teaching in the form of lectures, laboratory and practical work, seminars, etc. E-learning at university is based on an e-learning system deployed in the modular object-oriented distance learning environment – Moodle. The unified structure of an e-learning course, adapted to the students' needs, is provided for each curricular discipline. This structure is described in the Regulations on ELC, approved the Rector and is as follows: unit with general information about the discipline; training materials and guidelines for each content module; tasks for independent work of applicants; evaluation of content modules; summative assessment in the form of an examination.

Until this year, e-learning was focused primarily on the organization of interaction between teacher and students as e-support disciplines. At the moment, e-learning in combination with additional online communication tools is becoming the main environment for the implementation of the educational process in compliance the of educational services' quality.

The e-learning formation process as a support of the educational process in the blended learning implementation also continues in the direction of teacher's professional development on the principle of lifelong learning. Objective staff turnover, improvement of methods and technologies, the emergence of new tools, updating the fleet of gadgets requires teachers training as teaching; leadership; use of digital technologies; scientific research, etc.

2.2. E-learning at BGKU during the pandemic

For the quarantine period in BGKU a temporary classes schedule was created with maximum consideration for distance learning opportunities. Almost 80% of the disciplines from the class schedule are provided with their own e-learning courses created in the university e-learning system, which functions on the basis of LMS Moodle. There are also other services and platforms for organizing the educational process, such as Coursera, Google Apps for organizing video classes (lectures, workshops, seminars), the Classroom is used to speed up file sharing between teachers and students. Additionally, for online communication we use Viber, Telegram, WhatsApp. On a daily basis, university administrators monitor the implementation of the class schedule, students' and teacher's participation in the work on remote and online platforms.

By the data of internal monitoring, 6343 university students should take part in distance learning, but only 98% actually joined: have problems with Internet access or no Internet connection – 0.6% of students; 0.4% of students have technical problems; receive tasks, but do not complete them – 0.4% of students; sick – 0.1%; other reasons – 0.2% of students.

The period April, 2020 was chosen for our study, when the educational process was partly adapted to extreme conditions. During this period, according to the approved class schedules, 1473 disciplines were taught at the University. According to the analysis, 76% of all disciplines of this period were taught through an e-learning system using developed ELC, built-in chats and forums.

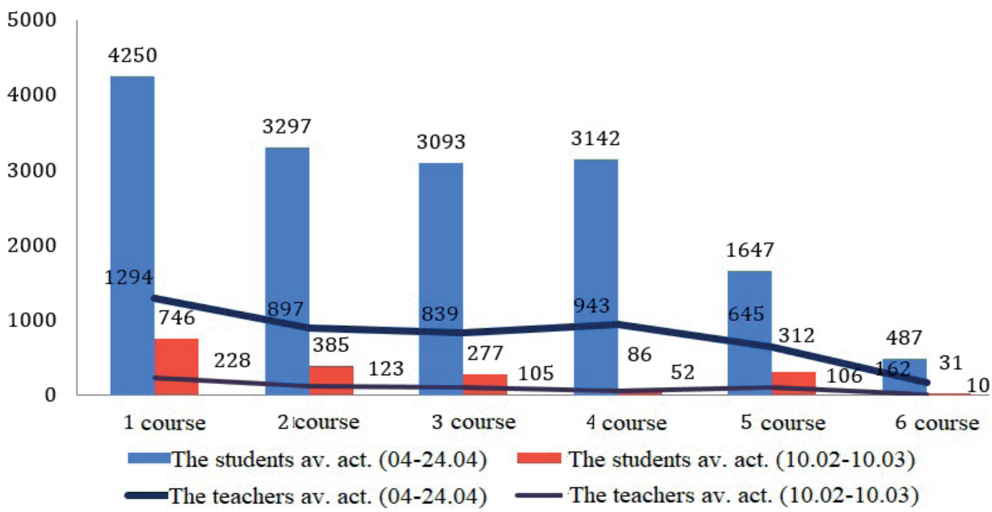
In total, the university used other services and apps – not the e-learning system – to organize classes in 342 disciplines, which is 23% of total number of disciplines. 96 disciplines (28%) were taught exclusively through corporate mail, 23% – corporate mail + messengers + video conferencing; Google Meet was used for 36% of disciplines, 11% via Zoom, 1% – via Google Classroom and Skype, 1% – Webex, Google Drive, and Cloud.

Considering that 76% of disciplines are provided by ELC, the level of its development is analyzed. According to the results of the analysis, the average level of ELC filled with quality content is 57%.

For a bachelor's degree, the average level of ELC development is 48%, while for a master's degree – 75%. However, despite the huge number of ELCs submitted for certification during the year, only 11% of ELCs were certified. The quality of education is ensured by the procedure of expert evaluation of ELCs, which receive the status of certified with positive results. In general, only 9% of certified ELCs were used for education BA students in a certain period, and 18% at the master's level. Analyzing the provision of certified ELC 1–6 course we have: 1 course – 13%, 2 – 11%, 3 – 31, 4 – 2, 5 – 16, 6 – 57%.

Two periods: the beginning of the semester – from mid-February to mid-March and April, when both students and teachers in general were able to organize the process of distance and online learning in quarantine, were selected to analyze the average activity on ELC, which were used according to schedule to provide educational process. In general, the average level of students' activity in April increased 8 times, and teachers' – 7 times.

The work of students and teachers in the final courses (4 and 6) at the beginning of the semester in certain disciplines on the schedule was almost not carried out, which is probably due to the work of students in classrooms. During the quarantine, work in the e-learning system was successfully carried out, which is confirmed by a significant increase in the average activities of students and teachers. In the fourth course, the activity of students increased 37 times, teachers – 18 times (Figure 1).



F i g u r e 1. The average activities of students and teachers in ELC

S o u r c e: Own work.

This growth is explained by the intensification of the design of teaching resources by teachers in the e-learning system, the preparation and use of ELC. A series of video instructions for creating video lectures, organizing video conferencing using a variety of online tools, recommendations and short videos on organizing and conducting distance and online classes were developed to help teachers by researchers of IT Lab in Education (https://cutt.ly/VfwEhFP). Preference was given to a combination of e-learning system and Google suite services, familiar to students and teachers, which are available through corporate mail.

3. ORGANIZATION OF THE STUDENTS' ACADEMIC ACHIEVEMENTS ASSESSMENT PROCESS

3.1. Summative assessment online

The organization of assessment is very important in modern-day conditions, because you need to be confident in identifying the student and demonstrating his understanding of the discipline's content. The use of proctoring system, observation of the student and his computer screen, is quite common in world practices. As a whole, proctoring is a control procedure on an online exam or test, where the whole process is monitored by an administrator – a proctor who monitors students' actions with a webcam and sees what is happening on their computer monitor, which allows to confirm the student's identity, objectively assesses his knowledge, eliminate cheating and other tricks on the exam.

The most common solutions in the world are:

- Certify – a feature is the real monitoring, during which teachers observe students live, and students take the exam. To identify violations and resolve disputes, it is possible to record and review the exam process.
- Proctorio – a complete integrity platform that easily integrates with Moodle, scans suspicious student behavior, identifies plagiarism and verifies identity.

The Certify assessment platform supports various innovative methods of supervision, such as:

- Live proctoring, i.e. real-time proctoring (observation), means that students are monitored in real time using multiple streams (webcam, mobile camera and computer screen). One proctor can control and interact in writing with several students at the same time.
- Recording and review – recording and review tests provide more flexibility, as they can be done anytime, anywhere. The entire test session is recorded from several angles with the same streams as for direct work: webcam, mobile camera and computer screen of the candidates. These recorded exam sessions are made available in the reviewer's panel for review and documented by certified proctors.
- Automated proctoring – a fully automated proctoring solution, without planning, and with round-the-clock availability.

The presentation of these two solutions, which was joined by all top managers, was commissioned by the University. Several employees were given the opportunity to feel like students. The participants had to add to the system an identity document and set up a phone camera to permit observation. After that, they were allowed to take a test exam, the results of which were demonstrated during the planned online event. Participation in the decision demonstrations confirmed their relevance and importance for remote exams, however, according to the authors, there are a number of caveats: lack of quality Internet connection for teachers and students; not all teachers have a PC with cameras at home; difficulty in mastering new solutions; fear of take in and using new solutions; underestimation of exam results, especially with automatic proctoring; time frame for tender procurement, execution of contracts, receipt of products, training of teachers on their use. Given the above concerns at the university, it was decided to conduct current and final certification using familiar to teachers and students' tools.

3.2. Summative assessment organization by combined online exams in BGKU

University administration recommended the combined form of the exam – testing and examination/interview/demonstration of practical skills, for exams during the test session (for students of all courses and forms of study) taking into account the specifics of the discipline can be chosen form of testing and testing + interview, interview. In fact, students take the test, being in direct contact with the teacher, then pass an interview (survey, demonstration of practical skills, etc.). The recommended options for conducting a combined exam online are to use the Google Meet or Webex Meetings resources in combination with an e-learning system. The technical features of this exam are: the presence of a webcam, and access from a computer or laptop. For the successful implementation of such certification, to help teachers and students, appropriate recommendations were developed in the form of step-by-step instructions and videos, which were posted on the BGKU website and a specially created YouTube channel (https://cutt.ly/VfwEhFP). In addition to video fragments prepared to help teachers and students, video lectures of teachers recorded in special distance learning studios were placed on it. Three training sessions and more than 100 individual consultations on the use of tools to ensure the quality of activities and the objectivity of the summative assessment were conducted for teachers who needed help.

4. RECOMMENDATIONS FOR ENSURING THE EDUCATIONAL SERVICES 'QUALITY USING E-LEARNING

4.1. Basic recommendations for conducting training sessions using online tools

For online lectures, webinars, etc., about 20 available and free resources and platforms were analyzed. As a result, university teachers are recommended to use: Google Meet, Webex Meetings and Zoom (see Table 1).

Online lectures given by teachers should be visualized, for example in a PP presentation in compliance with the basic rules of quality presentation and the use of corporate style of the university. It is recommended to organize a lecture or webinar in advance in the selected resource and send invitations to participants by corporate mail, as well as a link to the organized lecture or webinar to place in the ELC, which is e-support for this discipline.

As the organizational points, attention was focused and it was recommended to teachers: to join the lecture 5–10 minutes before and wait for the students to join; in the window of the online lecture, get acquainted with students' roster; send text messages in chat; ask participants to turn on the microphones only if they need to give the information/question; visualize the lecture, and choose a convenient version of the presentation: "Window" or "Your entire screen"; use video, not just audio, when conducting an online lecture or webinar; follow the rules of cropping, choose a business style of clothing and makeup; and after the event, add a link to a video recording in the ELC as support to the discipline.

Table 1

Online tools for classes

Tools	Pros	
Google Meet	connected to a corporate account; free; does not require additional registration; not limited in time; ability to record a session; possibility to demonstrate the screen of the teacher and students; polylingual titles; a large number of participants; the ability to download videos for editing in available editors	no whiteboard; without a waiting room; group remote interaction cannot be organized
Webex Meetings	setting up a personal room with one link for lectures and a separate link for the exam; save and convert video in the cloud; the ability to download videos for editing in available editors	requires installation for the organizer and speaker;
Zoom	free account for up to 100 participants; white board for joint work; availability of simultaneous translation; availability of a waiting room to prevent unwanted participants; Subscribed subscription allows 3000 participants; allows you to deploy virtual hybrid audiences; integration with Moodle	the full version requires a prepaid subscription free account for a 40 minutes' session

Source: Own work.

4.3. Recommendations for conducting a combined exam using online tools

The academics staff of BGKU carried out an objective and transparent summative assessment of the academic achievements of students of all levels of education, as well as students defended their bachelor's and master's theses online. To implement the assessment, Google Meet and Webex Meetings were recommended for online communication and e-learning system for competency tasks or tests.

Researchers of IT Lab in Education by the decision of the university administration developed recommendations in the form of step-by-step instructions and video instructions (in Ukrainian). We present the main components of the recommendations for the fragment that reflects the possibility of students taking the test, being in direct contact with the teacher, and then taking the interview (survey, demonstration of practical skills, etc.).

The recommended form of the exam for the final year students' attestation at BGKU is a combined (testing and examination/interview/demonstration of practical skills), for exams during the credit-examination session (for students of all courses and study forms), taking the specifics of the discipline, can be the chosen testing or testing + interview or interview. It is mandatory to record the examination procedure.

One option for online combined exam conducting is to use Webex Meetings. Technical features of this exam: the presence of a webcam, access from a computer or laptop. Login is by personal corporate account. Once the students have gathered, we give them a brief instruction that they will be testing in an e-learning. In the test parameters, it is important to set access times, including time, restrictions on trying and opening the test in a separate pop-up window (with JavaScript protection) so that students cannot open additional tabs, and work on the test.

All students must have video cameras and microphones turned on during the test. In parallel with the students' performance of the test, the teacher can monitor the progress of the test in viewing the attempts in the test. At the end of the test, all students close the ELC and focus on the exam room, where the teacher voices the test scores and conducts a short interview with the students. At the end of the interview, we announce the interview scores and the general exam scores to the students in any chosen scenario. During this time, it is recommended that you display a screen that displays the ELC scorecard with the exam scores entered.

After completing the exam and receiving a link to the record of the exam, it is necessary to place the record in the ELC so that it is available to all students in the group who took the exam.

Thus, BGKU academics staff perform objective and transparent summative assessment of students' academic achievements during the exam, while the use of e-learning systems and video recording of the exam in the course mobilizes students to prepare better, which will increase the level of mastery of academic disciplines.

CONCLUSION

According to the analysis, the priority of urgency in addressing the issue of qualified, professional organization of distance learning through e-learning using modern technologies is confirmed. It is proved that university teachers, including humanities, are able to master digital tools at a fairly high level, as at the end of the academic year 98% of disciplines are provided by ELC, which were developed by teachers during the pandemic. The quality of ELC and, accordingly, the quality of the educational services' quality has increased significantly, which is confirmed by an increase of 42% in the number of ELCs prepared and submitted for certification. Traditional student assessment of teachers' activities in using e-learning during a pandemic demonstrates an improvement in the quality of prepared and presented teaching materials and the educational services 'quality in general.

Given the above, universities can use the experience of BGKU in organizing e-learning, which is provided by high-quality ELC. Another useful example is the development of an ELC structure, a certification procedure to ensure the quality of education, implementation of transparent and objective assessment of students' academic achievements in the form of a comprehensive exam.

Thus, the experience of BGKU teachers confirms that e-learning fosters the objectivity and transparency of the educational process and the quality of educational services provided to higher education students.

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GAMIFICATION AS SUCCESSFUL FOREIGN LANGUAGES E-LEARNING FOR SPECIFIC PURPOSES

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Abstract: *The article analyses gamification as one of the modern technological trends in distance foreign language teaching, presents various approaches to defining this concept and considers various classifications. The role of game methods for teaching foreign languages for professional purposes is studied; these methods provide an effective way of encouraging students to achieve success. Using mobile applications, various types of exercises for teaching Russian as a foreign language to students specialising in medicine and law are presented: games for matching images of objects with their names, games for memorising the meaning of lexical units, play-based communicative tasks, etc. Through a focused questionnaire, the authors demonstrate the high efficiency of the gamification technology in professionally oriented teaching of the Russian language to foreign specialists. The questionnaire consisted of three units: conceptual, organisational-methodological and psychological. The resources presented in this article provide a modern teacher with a wide range of tools to convert the routine types of academic work into an interesting game form, simulate real professional communicative situations, and compensate for the lack or absence of a language environment when teaching a foreign language for professional purposes.*

Keywords: gamification; e-learning for specific purposes; the effectiveness of digital gamification; medical communication.

INTRODUCTION

Nowadays, professionally oriented language learning is becoming more technology-intensive. Modern university students, for the most part, seem to 'live' on the

Internet and prefer to perceive educational information using various modern teaching technologies that successfully allow them to develop the necessary competences and skills in using a foreign language for professional purposes.

The use of game elements and game design techniques is one of the most modern technological trends in teaching professionally oriented foreign languages. On the one hand, this develops students' motivation, encourages them to think outside the box and exercise self-control. On the other hand, this reduces students' anxiety and fear of speaking a foreign language in front of others (Arnold, 2014). Moreover, scientists note that the game is an effective means of assimilating the reality itself, the simultaneous and complex "emotional, intellectual and moral development of the student's personality, which occurs not under duress, not out of necessity, but at the request of students themselves (Azimov, 2009).

1. GAMIFICATION IN DISTANCE PROFESSIONALLY ORIENTED FOREIGN LANGUAGE LEARNING

1.1. On the Definition of Gamification

In the beginning of the 21st century, after the publication of the well-known monographs of Pelling, Prensky and Kapp a special direction was developed in didactics, which received a special terminological name – 'gamification' (Pelling 2012, Prensky 2006, Kapp 2009). It is believed that this term was introduced into scientific circulation by Nick Pelling in 2002. In the modern scientific literature, two main approaches to the interpretation of this concept can be distinguished: wide and narrow ones. According to the first approach, gamification is any use of gaming technologies, methods, tools or game designs in training. From this perspective, gamification was also interpreted by one of the founders of this direction, Karl Kapp, the author of the book *Gamification of Learning and Instruction*. This scientist defines the essence of gamification as "the introduction of gaming technology into non-gaming processes" (Kapp, 2009, p. 10), while he considers educational games as "using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" (Kapp, 2009, p. 15). Proponents of the second approach narrow the scope of the concept of gamification, delimiting it from such 'game practices' as role-playing game, simulation, 'ordinary game', etc. (Titova, 2019, p. 136). As a basis for the delimitation, it is indicated that gamification involves game settings that are correlated with reality. An analysis of the literature on this issue shows that most scientists still adhere to the first point of view regarding the essence of this concept.

It is customary to distinguish between two main types of gamification: structural and conceptual (Titova, 2019; Kapp, 2010). Structural gamification is the use of game techniques and elements in the educational process, while conceptual gamification involves the educational interaction in the game format and design, the organisation of the learning process within the framework of the game scenario.

In terms of the strategic approach, structural gamification is described in (Werbach, 2012). Werbach and Hunter presented it as six 'steps' that form *the 6 D Strategy* (Werbach, 2012, 85):

Step 1. *Define – define* the goals and objectives of the use of gaming technologies in the educational process.
Step 2. *Delineate – delineate, outline* the expected learning outcome.
Step 3. *Describe – describe* 'one's own players', i.e. compile profiles of the main categories of students – potential participants in the game. Let us consider this 'step' in more detail. In the process of compiling the profiles of participants, it is advisable to take into account the psychotypes of the players identified by Professor R. A. Bartle (University of Essex). This typology is widely recognised by educational game developers. In identifying these psychotypes, Bartle took into account two scales: (1) action – interaction; and (2) players – the world. The scientist called the zone of intersection of the scales 'a plane of interests'. Having tested more than 200,000 people, Bartle identified the following four main psychotypes:

1. Achievers – aimed at achieving the highest possible result, at the accumulation of funds, artefacts, resources and benefits provided by the game;
2. Killers – whose main goal is to achieve superiority over other players; such people head for victory at all rates, using all means available to them;
3. Explorers – who are interested in studying gaming reality; and
4. Socialisers (social workers or partygoers) – who are first of all attracted by the possibility of social interaction and communication with other people in the game.

Step 4. *Devise – devise, develop* cycles of game learning activities: (1) engagement loops and (2) progressive stairs. The first cycle integrates the actions of students and the responses of the system to these actions, i.e. feedback, which is expressed in points, scores, awards, or in the form of reaching a new level, gaining access to hidden content, etc. The second cycle is the participants' progressing along the educational game path, the 'micro perspective' of their game journey.
Step 5. *Don't forget – not to forget* that this is still a game: about entertaining game aspects.
Step 6. *Deploy – deploy, introduce* the game into action, in educational practice.
In professionally oriented language teaching, gamification performs several functions, the main of which are as follows:

- *Learning function*, i.e. learning in a game form facts and phenomena of language and speech, developing communication skills;
- *Adaptive-integrating function*: during the game, students learn the norms, rules, strategies of professional and communicative interaction, "try on" social and professional roles, which ultimately contributes to their successful adaptation and integration into the professional community;
- *Control and diagnostic function* – establishing the level of the development of skills, abilities and competencies, and determining the zones of the nearest and further communicative-verbal development;
- *Communicative function* – creating the necessary conditions for enhancing educational communication in the target language;
- *Corrective function* – correcting inaccuracies in the formation and use of words as well as 'false automatisms' in the process of an educational game;

- *Play therapy function* – assisting by means of the game in correcting personal qualities that impede free communication with other people, effective communication, including in the target language;
- *Relaxing function* – relieving emotional stress, fatigue, introducing diversity into monotonous training activities, etc.;
- *Entertaining function* that underlies the interest, motivation to learn, actively involving students in activities to learn a new language and thereby contributes to the integration of gamification as the main component in the linguistic and methodical direction, called 'edutainment' (Bartle, 2004).

The main didactic advantages of gamification in teaching a foreign language as a means of professional communication include:

- increasing interest and internal motivation of students;
- involving students in the educational process; and
- overcoming the fear of making mistakes.

In professionally oriented foreign language teaching, it is recommended to use this game technique in relation to the future specialities of students. Of course, there are professional-communicative games that are structured and meaningfully built as competitions, for example, games for future lawyers – "Advocate" or "Court Session", – during which the parties compete in the art of persuasion and argumentation and only one of the participants becomes the winner – the one who belongs either to the defence or to the prosecution. An element of competition can be introduced into other professional-communicative games, for example, developed using the web-quest technology (which of the participants will select the largest number of necessary materials, the most significant, detailed information on a given problem, etc.) or case technology (who makes the most accurate diagnosis, selects a convincing legislative framework, etc.).

1.2. Digital Gamification

In modern linguodidactics, gamification based on the use of computers is the most interesting and promising direction. Currently, teachers have a large arsenal of educational mobile applications, computer games, software shells for developing their own game learning products, applications with elements of augmented reality, applications with 3D communication using avatars. For example, Second Life, an online virtual world, developed and owned by the San Francisco-based firm Linden Lab and launched on June 23, 2003, has gained great popularity among game creators. Using this application, it is possible to provide conditions for educational communication in 3D format. Second Life users, also called 'residents', create virtual representations of themselves, called avatars, and are able to interact with places, objects and other avatars. In addition, the application provides opportunity for both dialogic and polylogic communication that accompanies a variety of social activities (building, shopping and trading virtual property and services with one another). Second Life also has its own virtual currency, the Linden Dollar, which is exchangeable with real world currency. It should be noted, that in accordance with the policy of the developer company, participants in games created using this application can be people aged 16 and over. There are other popular mobile applications based on the principles of structured gamification, for example, LearningApps, Quizlet, Classtools, etc.

1.3. Digital Gamification

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2. GAME RESOURCES FOR TEACHING RUSSIAN AS A FOREIGN LANGUAGE

As an example, we shall consider the game resources that we have developed for different categories of foreign specialists based on the LearningApps shell (https://learningapps.org/index.php?overview &s=&category=0&tool=). This is a convenient free mobile Web 2.0 application, using which one can develop game training and control tasks as well as tests in a variety of subject areas:

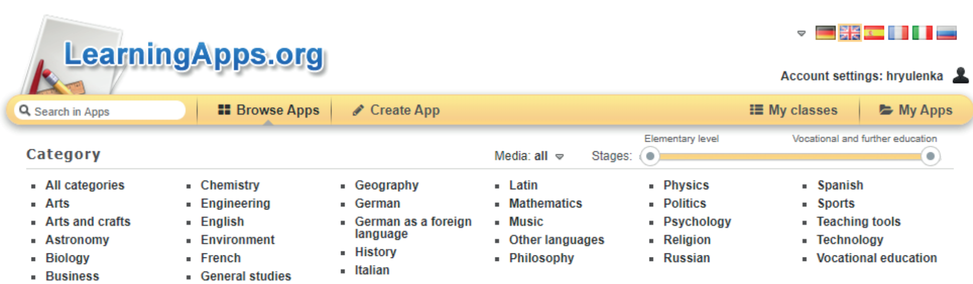


Figure 1. Game-based application for training

Source: https://learningapps.org/index.php?overview&s=&category=0&tool=

The developers define the main goals of this resource as providing support for training and learning different subjects "through interactive modules". At the same time, the teacher can use the modules developed by LearningApps specialists, correct and change them, or quickly create new ones according to the available templates: the application includes 20 task templates and 5 organisational tools. The most interesting game tasks are: 'Horse racing', 'Puzzle', 'Couples' and 'Who wants to be a millionaire?'. The latter is based on the scenario of the popular game in which participants need to choose the correct answer from each of the four proposed for each question. The most interesting tools are the Interactive Notepad and Message Board. The Notepad can be used in the chat function to communicate with the participants. In it, users can exchange information in video and text format as well as using pictures. The Message Board contains important educational and organisational information. In general, this resource can be assessed as one of the most interesting, technologically equipped, easy-to-work: teachers without special knowledge in computer science can easily and quickly create the required amount of game learning resources.

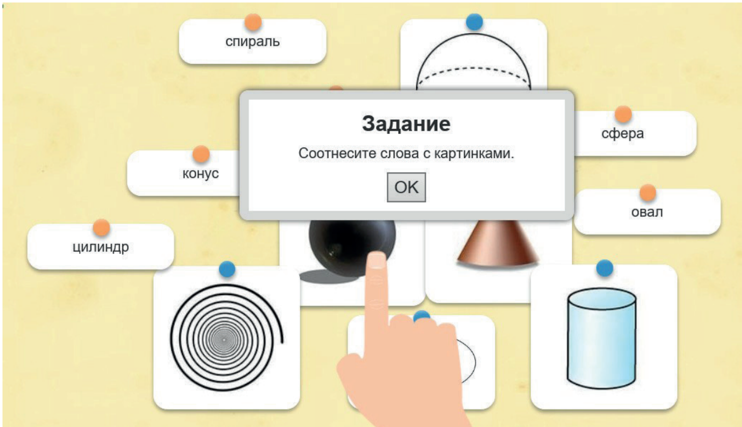
It should also be noted that, in the process of creating games, we used the most authentic, most frequent and 'communicatively demanded' linguistic and speech material, selected the most interesting and relevant topics as well as problems that encourage students to actively participate in dialogic and polylogic communication. An important distinguishing feature of educational games is the simulation of situations of natural communication between representatives of the professional community – native speakers of the Russian language. These factors, in our opinion, contribute to the formation of the motivational base necessary for acquiring the skills of professional and business communication, and also make it possible to solve the problems of preparing students for the conditions of real communication and their adaptation in a professional and business environment, which in general significantly increases the effectiveness of training and gives great savings of time.

The game application intended to teach foreign medical students to communicate in the educational and professional field. This application includes several units of tasks. The first unit contains language games aimed at students' learning terminological vocabulary, developing lexical and grammatical skills. To consolidate the terminological nominations of objects, the meaning of terms, we used various types of games. Let us consider the main ones.

2.1. Games for Medical Students

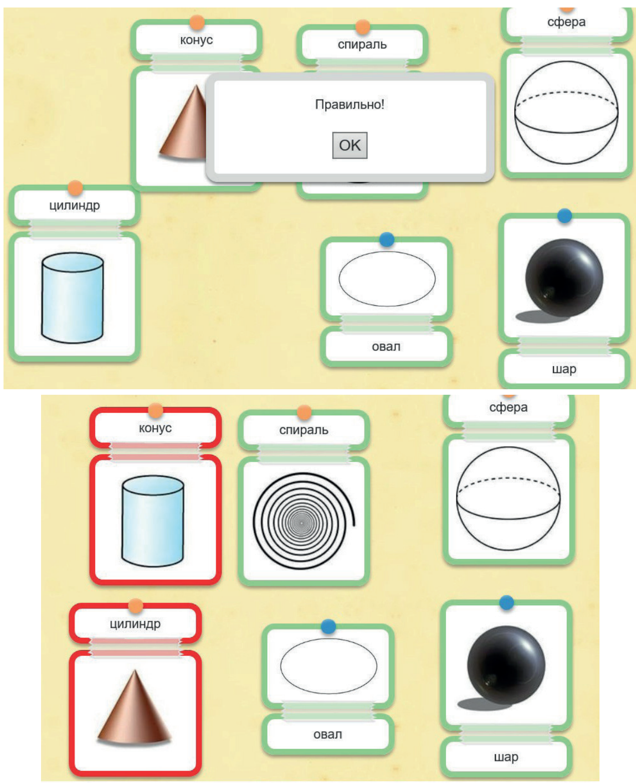
2.1.1. Games for matching images of objects with their names (games with pictures)

Let us see an example of such a task, which is performed in the course of learning the lexical-semantic group (LSG) 'the form of an object (cell, organ, organoid, etc.)':



F i g u r e 2. The example of learning lexical-semantic group
S o u r c e: https://learningapps.org/display?v=pvjfin64k20.

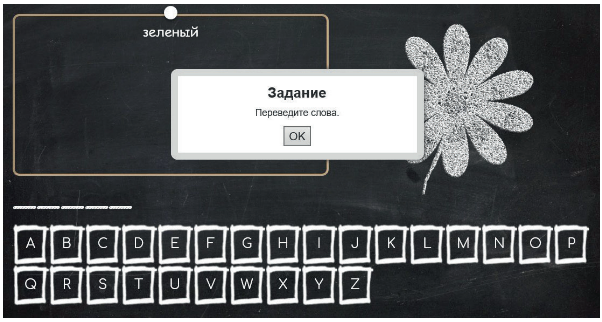
The system immediately evaluates the quality of the completed task and indicates the errors made:



F i g u r e 3. The evaluation of the task
S o u r c e: https://learningapps.org/display?v=pvjfin64k20.

2.1.2. Games for memorising the meaning of lexical units

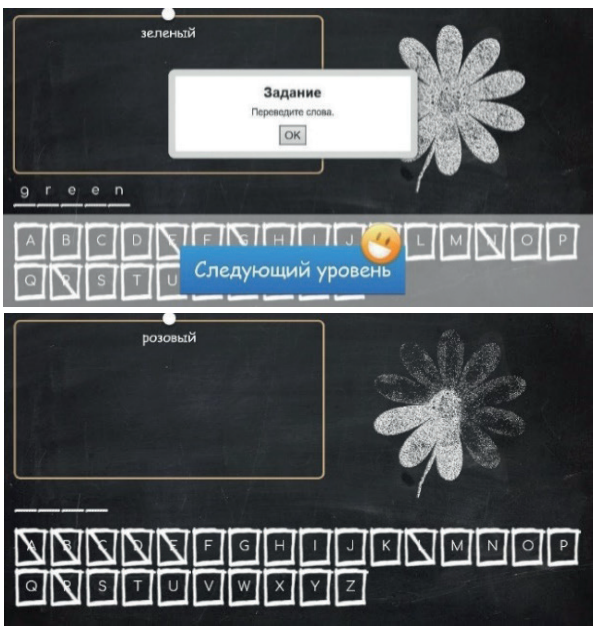
One of the most important, but perhaps the least interesting, tasks is memorising the meanings of new words. LearningApps provides the teacher with all the necessary tools to make this process effective and exciting. For example, in the process of studying the lexical-semantic group "colour of an object" we offered the students this game:



F i g u r e 4. The example of the game to train the colours

S o u r c e: https://learningapps.org/display?v=p84m2swva20.

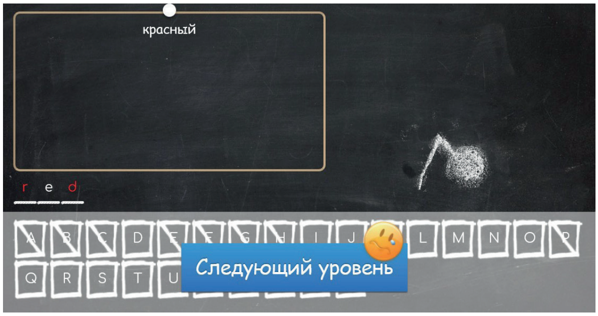
In accordance with the assignment, students must type the correct colour name in their native language. Their answers are evaluated by the system: in case of an error, they cannot proceed to the next question, and the number of mistakes made can be counted by the number of 'lost' flower petals:



F i g u r e 5. The stages of the game

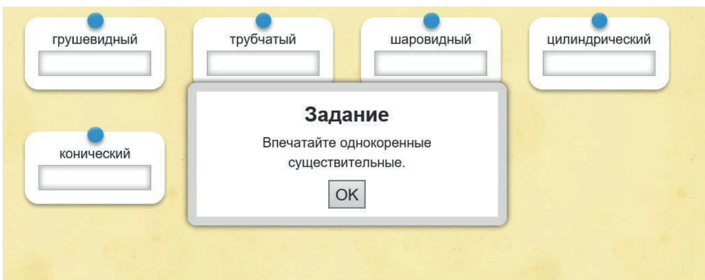
S o u r c e: https://learningapps.org/display?v=p84m2swva20.

If the students still fail to give the correct answer, the system gives a hint (the correct option), 'signals' the failure (the image of a withered flower appears on the screen) and skips the students to the next task:



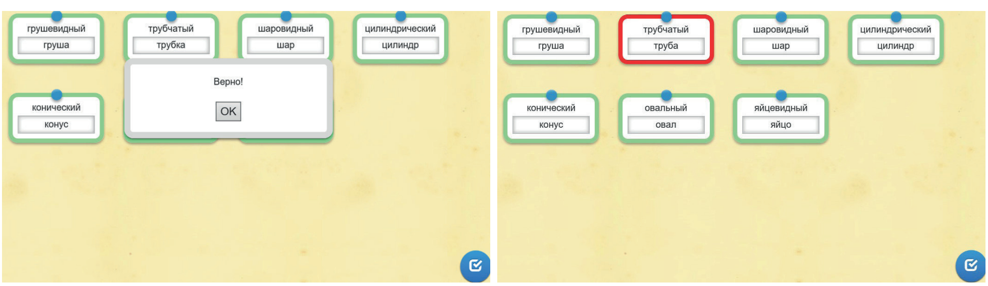
F i g u r e 6. The example of incorrectly completed task
S o u r c e: https://learningapps.org/display?v=p84m2swva20.

This unit also includes game tasks for studying the paradigmatic connections of words:



F i g u r e 7. The game for studying the paradigmatic connections of words
S o u r c e https://learningapps.org/display?v=p3wp9mdqn20.

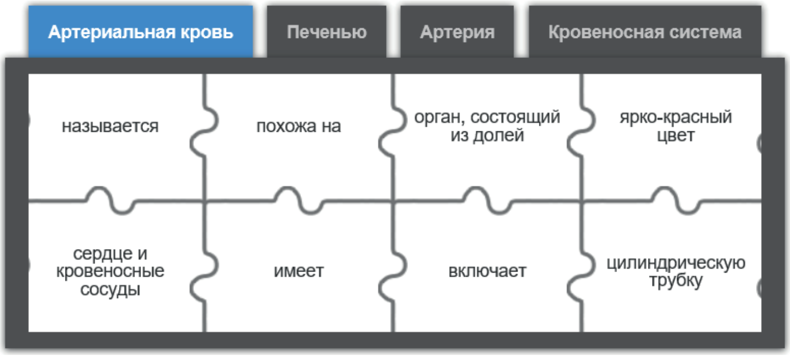
These tasks are also immediately checked by the system, errors are noted, and if the students can correct them on their own, the system evaluates the answer positively and offers the following task for this group:



F i g u r e 8. The example of correctly and incorrectly completed task
S o u r c e https://learningapps.org/display?v=p3wp9mdqn20.

2.1.3. 'Puzzle'

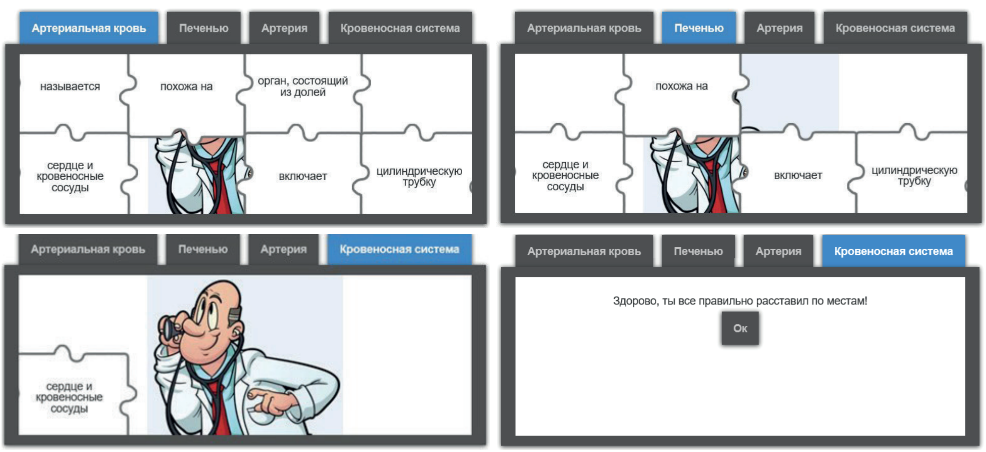
This is one of the most interesting game tasks that we used in teaching the construction of communicative units of the sentence-statement level:



F i g u r e 9. The game for constructing the communicative units of the sentence-statement level

S o u r c e https://learningapps.org/display?v=pzkjvy07a20.

In this task, the following response evaluation system is proposed: students sequentially select the components of each sentence, which, in their opinion, are correct. If their choice is correct, a hidden picture gradually opens on the screen and an overall assessment of their actions appears:



F i g u r e 10. The example of correctly and incorrectly completed task

S o u r c e https://learningapps.org/display?v=pzkjvy07a20.

2.1.4. Unit of game communicative tasks

We developed this unit using case technology. We selected the most relevant situations of professional medical communication – interviewing patients with diseases of various organs and systems. Students are invited to familiarise themselves with an extract from the medical card, which indicates the patient's passport data, brief information about the family history, a description of the symptoms, etc. Further, they are supposed to conduct an interview: to formulate questions for the patient in accordance with the data presented in the medical record. If the question is formulated correctly, the patient's answer appears on the screen.

3. METHODS

In order to check the effectiveness of the use of gamification technology in teaching a foreign language, a survey of students was conducted. 30 medical students took part in the survey distantly. They were sent the online links to make the necessary exercises and the results were checked online as well by the teachers.
The students' satisfaction was assessed through questioning. It was necessary to identify the level of satisfaction of the students with the proposed technology. All the respondents were asked to rate the proposed learning technology on a satisfaction scale from one to five.

Table 1

Satisfaction scale

Number of points	Assessment description
5 points	Excellent. You are very satisfied with the proposed technology.
4 points	Good. You are generally satisfied, but it could be better.
3 points	Satisfactory. Your assessment is neutral.
2 points	You are not satisfied with the support provided.
1 point	You are absolutely dissatisfied with the support provided.

The questionnaire included questions on the following thematic units: conceptual (compliance of the material with the needs of students), organisational-methodological (comfort of performing exercises using gamification technology), psychological (general satisfaction with the proposed technology).

4. RESULTS

Data processing was carried out for each subject separately, and then the average arithmetic score was calculated for the units presented (expressed as a percentage). The level of students' satisfaction was established for the above aspects, which can be correlated with the following intervals: the low level: from 0 to 30%; the middle level: from 31 to 75%; and the high level: from 75 to 100%.
The results of the questionnaire survey are shown in the table below.

Table 2

Assessment of satisfaction with the use of gamification technology (questionnaire survey results)

Subjects	Units		
	Conceptual aspect (%)	**Organisational-methodological aspect (%)**	**Psychological aspect (%)**
Students	83%	90%	99%

The processed questionnaire survey data showed a rather high level of the respondents' satisfaction with the conceptual, organisational-methodological and psychological aspects, which together make it possible to positively evaluate the use of the proposed technology in teaching a foreign language.

In general, the students' satisfaction with the use of the proposed technology was 90.6%. Thus, the results of the questionnaire survey allow us to conclude about the effectiveness of using gamification technology in teaching a foreign language.

CONCLUSION

In conclusion, it should be noted that our experience and the conducted questionnaire survey confirm the high efficiency of gamification technology in professionally oriented teaching of the Russian language to foreign specialists. Computational linguodidactics provides a modern teacher with a wide range of tools to convert the routine types of academic work into an interesting game form, simulate real professional communicative situations, and compensate for the lack or absence of a language environment when teaching a foreign language for professional purposes. All this makes it possible to increase the motivation for learning the Russian language, to make memorisation more durable and to develop professional communication skills and abilities more effectively.

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THE COMPILATION OF A MULTILINGUAL TERMINOLOGICAL DICTIONARY AS A MEANS OF STUDENTS' PROFESSIONAL AND LEXICAL COMPETENCE DEVELOPMENT

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Abstract: *In the era of digitalization, globalization as well as scientific and technical progress it seems greatly significant to investigate characteristic features of e-learning means to develop professional and language competence of the students who do a course in Applied Linguistics. Therefore, the article deals with the peculiarities of electronic multilingual terminological dictionary compiling and its use in students' language acquisition, lexical competence development in particular. Electronic multilingual terminological dictionary is viewed as any reference material presented in an electronic form that provides thorough and relevant information about spelling, pronunciation, meaning and use of words. Such characteristics make it popular among, and indispensable for, the users. The research reviews the results of the study conducted within the national scientific research work № 52 "Electronic Multilingual Terminological Dictionary Compiling" at the Department of Theoretical and Applied Linguistics of Zhytomyr Polytechnic State University (Ukraine). It is a collaborative university project involving specialists in the field as well as undergraduate students. The compilation of an electronic multilingual terminological dictionary requires the knowledge of data collection, translation capability, sufficient language wording, data transport, software identification, etc. It involves five stages that include data collection and input; database creation and software identification; evaluation of its accuracy and suitability, and the necessary improvements.*

All in all, electronic multilingual terminological dictionary has a multi-aspect educational value. Its compilation contributes to language and IT skills development and greatly facilitates the professional growth of the students with a major in Applied

Linguistics. What is more, it makes international scientific cooperation possible and thus leads to constant scientific and technical development.

Keywords: lexical competence; e-learning; electronic dictionary; dictionary compiling; electronic multilingual terminological dictionary.

INTRODUCTION

Nowadays people live in an extremely fast-paced society where, despite constant technical and scientific progress, the gap between the unskilled and skilled is widening. One of the major keys to a successful and promising career is mastering the 21st century skills, such as critical thinking, problem solving, collaboration, communication, creativity and many others. Undoubtedly, the 21st century skills are greatly interrelated with language, which is one of the most significant tools in the life of all human beings. Learning and mastering languages contributes to effective modes of communication between different communities and cultures. It creates openness to changes, responsibility and integration and makes cooperation and teamwork possible. Therefore, it satisfies a growing demand for employees' professionalism, which presupposes beneficial co-existence, trust-building respect to personality, constructive dialogue and mutual creative activity (Alijevs 2005, p. 57). All in all, it leads to productive professional cooperation and thus contributes to scientific and technical development of modern society.

Therefore, we absolutely agree that the process of acquiring knowledge should be student-centered and first and foremost oriented towards holistic acquisition of the specialization (Luka, 2008). Undoubtedly, developing language competence in a knowledge society is one of the most important objectives. Therefore, it is significant to reconsider the language-learning model. It is a common known fact that proficiency comes out of cognitive and practical activity (Vigotskis, 2002; Čehlova, 2002). Thus language skills should be developed in action as experience and abilities that constitute competence require practice (Luka, 2008). Hence, it means that educators should use a great variety of techniques to invoke students' motivation, imagination and creativity. It presupposes organizing pair work, group work, and team work when students can switch on their critical thinking, assess and evaluate their peers' work, highlight strong points and provide constructive criticism and in such a way mutually help each other. On the one hand, it leads to strengthening of learners' independence and teaches them to use interdisciplinary knowledge in their constant professional development. On the other hand, it contributes to team work skills development, which is a great basis for further professional integration.

Moreover, learners have their own attitudes, motives and learning strategies that influence their learning. The sooner we make students find them out and use, the better for their skills development. Having their own experience students are able to further direct their own learning. Consequently, it contributes to the formation of productive learning environment which is based on partnership and cooperation and is full of mutual trust and respect (Blūma, 2004).

Electronic Multilingual Terminological Dictionary (EMTD) compiling is exactly the case when learners need to learn languages from inside working in both modes, individually and as a team. Teachers facilitate the process by setting tasks, giving guidelines and letting students complete the task the way they see that. It creates opportunities for students to construct professional as well as language knowledge themselves. Learners become active participants in the process and thus learning by rote (which is absolutely inappropriate in the digital age) shifts to learning by doing which helps students to quickly acquire hands on skills and become proficient in the field of study. Moreover, teachers' advice is not any more taken as an intrusion but as facilitation. As a result, students and teachers mutually enrich from such cooperation.

1. THEORETICAL BACKGROUND

The peculiarities of IT use in education have been greatly investigated by the outstanding scholars worldwide V. Bykov, O. Glazunova, M. Zhaldak, S. Lytvynova, S. Semerikov, O. Spirin, A. Striuk, Yu. Tryus, M. Shyshkina, Chao Lee, G. Chen, C. Dineva, V. Nedeva, C. Dzikite, D. Hanson-Baldauf, H.S. Hughes, F. Jian, J. Amor, Y. Juan, Yi-Xiang, K. Lepi, A. Masud, J. Yong, X. Huang, M. Jalgaonkar, A. Kanojia, P. Mell, T. Grance, M. Mircea, Al. Andreascu, K.Palanivel, S. Kuppusvami, J. Reich, Th. Daccord, A. November, B. Silky, S. Sawtantar, K. Amit, M. Simonson, S. Smaldino, M. Albright, S. Zvasek, E. Tuncay, D. Weaver and others. Thus, significant attention has been given to studying the impact of IT on teaching-learning process and finding out the ways to improve it (Hussain, 2008; Bhakta & Dutta, 2016). Moreover, the question of teachers' role, interaction mechanisms, and classroom organization has been markedly disputed (Sangra& González-Sanmamed, 2010). In addition, teachers' practices in technology-enhanced classrooms have been considerably highlighted (Al-Abdullatif&Alsaeed, 2019). What is more, mapping students' and teachers' perception on technology use has been to a great extent researched (Choy & Ng, 2015). Although, learning by doing implying IT requires more detailed study. Therefore, the article is aimed at the analysis of professional and lexical competences development through EMTD compiling.

According to the Law of Ukraine "On Higher Education", competence is interpreted as a dynamic combination of knowledge, skills, ways of thinking, professional, ideological and civic qualities, moral and ethical values, which determine a person's ability to carry out professional and further educational activities and is the result of training at a certain level of higher education. As stated in the National Qualifications Framework, competence is a person's ability to perform a certain type of activity which is expressed through knowledge, understanding, skills, values, and other personal qualities.

The main objective of professional training is to teach students to obtain, process and store information and use it effectively in professional activities. It presupposes that students get a teacher-guided practice in computer laboratories with free Internet access using cutting-edge IT as well as industry-focused practical training (Ivanchenko, 2009). At the same time, lexical competence development implies knowledge of sufficient language stock and is greatly significant in professional advancement.

Professional competence implies a sufficient skill set of academic, communication and language mastery (Blūma, 2001). Therefore, lexical competence is also viewed as a part of professional competence in terms of teaching the students who do a course in Applied Linguistics.

Computer-assisted vocabulary learning has been studied extensively by the outstanding methodologists and scientists such as R. Ellis, J. Decarrico, M. Lewis, J. Li, A. Oberg, D. Wilkins and others. However, most of the studies focus on the peculiarities of lexical competence development with access to computer-mediated dictionaries (Lin, Chan, & Hsiao, 2011). On the contrary, our idea is to improve lexical competence by means of the creation of computer-mediated dictionary, EMTD in particular.

Nowadays, the importance of EMTD is undisputable. This quick and astonishingly flexible lexical database greatly contributes to intercultural communication as well as any linguistic research. Due to constant technical and scientific progress as well as increasing globalization, EMTD has already become a universal tool for establishing professional network and facilitating both scientific and economic cooperation. The use of EMTD significantly contributes to better cross-cultural communication. It enables professional communication of outstanding scholars worldwide thus contributing to world science growth. Consequently, incorporating EMTD in educational process has become one of the main priorities of language acquisition.

There is no common understanding of what EMTD is. EMTD is also viewed as a computer database of entries specifically coded to facilitate quick word search with regard to morphological forms and with the possibility of searching word combinations and changing translation direction (Zavarueva, 2007). Hence, it is a special lexico-graphic source characterized by non-linear textual structure (mix of text and hypertext), inside and outside search (within dictionary itself and in other Internet resources), the combination of phonetic, semantic, grammatical, stylistic and encyclopedic information etc. in one entry; and availability of verbal and non-verbal means of lexical unit description (Kuprijanov, 2014).

EMTD is a universal tool for any specialist in the field. It facilitates the process of getting detailed information about the search word. It minimizes the time needed for that. EMTD is user-friendly and has various options for data processing. It is of great help for any user, a student or a teacher, an engineer or a linguist, a doctor or a translator etc. EMTD provides the list of the most frequently used terminological items in different knowledge areas. Consequently, anyone interested can get acquainted with it. It helps to get a general idea of the term searched as well as acquire in-depth knowledge how to use it in context. What is more, EMTD compilation requires knowledge of data collection, translation capability, sufficient language wording, data transport, software identification etc. Thus, the students with a major in Applied Linguistics will also develop their IT skills which are greatly beneficial for their future profession. Therefore, EMTD has tremendous potential and greatly assists learners in understanding as well as enlightening their language skills and IT competence.

2. RESULTS AND DISCUSSION

2.1. Methodology

The paper introduces the results of the study conducted within the national scientific research work № 52 "Electronic Multilingual Terminological Dictionary Compiling" at the Department of Theoretical and Applied Linguistics of Zhytomyr Polytechnic State University (Ukraine). It shows the ways to organize a student-centered pedagogical process that greatly contributes to students' language and professional competence development and thus leads to students' ability to compete in the labour market. Moreover, learners become more motivated and goal-oriented as they learn by doing. Therefore, they get used to live and learn that makes them continuously develop themselves.

The research started in January 2020. The sample group includes 105 undergraduate students that form 88% of all the participants and 21 teachers (12% correspondingly). All students are divided into 7 groups according to their study fields: Applied Linguistics, IT, Economics, Law, Ecology, Finance and Accounting, and Engineering. Their task is to deal with the corpus of terms in the field of students' study. The students start taking part in EMTD compilation project during their 3-week workshop practice. The most interested and motivated learners continue their research and become equal participants of the project. Each group is guided by 3 teachers who are the specialists in the field. The teachers give recommendations, practical advice and provide the students with all assistance needed. The students and the teachers are equal partners in the project and share equal responsibilities. Therefore, their cooperation is based on the principles of equality partnership, mutual respect and cooperative learning.

The students who do a course in Applied Linguistics form the most numerous group (34% of all students) as their task is to investigate linguistic peculiarities of EMTD and to create the register (see Figure 1). Such tasks are rather time-consuming and require philological background. Moreover, the students have to deal with several languages (Ukrainian, Russian, English, French, German and Chinese) searching for appropriate terminological equivalents. The second place goes to IT students (16%), who are responsible for database creation, data transport, software identification as well as technical support.

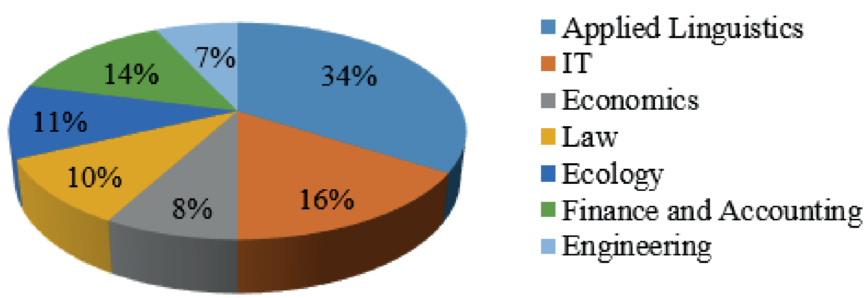


Figure 1. Study Fields in the Sample Group

Source: own work.

The students of the other groups (Economics (8%), Law (10%), Ecology (11%), Finance and Accounting (14%), Engineering (7%)) are responsible for providing reliable data in the field of study. Working on EMTD compiling gives the students an opportunity to significantly improve their professional skills and get the necessary experience which is undoubtedly beneficial for their future career. What is more, it has a great interdisciplinary value as students share their experience in different knowledge areas. Furthermore, they acquire the necessary life skills which make them be ready for an adult life.

Our study undergoes several stages. Each stage requires particular attention and is significant in its own way. The stages align with the stages of EMTD compiling and include the analysis of dictionaries available; data collection and input; database creation and software identification; evaluation of its accuracy and suitability, and the necessary improvements (see Figure 2). To successfully complete the stages the researchers have to work conscientiously and be very attentive to the details. The succession of the stages should be followed closely.

EMTD Compilation Stages

dictionaries analysis → data collection and input → database creation and software identification → accuracy and suitability evaluation → improvements

F i g u r e 2. The Stages of EMTD Compiling

S o u r c e: own work.

To conduct our research within the stages we have used a great variety of methods, such as: − theoretical method that presupposes study of theoretical literature and sources on EMTD distinctive features, as well as peculiarities of its compiling; − empirical method which implies observing students work on EMTD compilation to find out difficulties that may occur and thus come out with possible solutions; − data obtaining method that includes students and teachers interviews, students assessment and self-assessment tests etc.; − qualitative and quantitative data processing methods to assess the results and interpret the conclusions.

All five stages of EMTD compiling require meticulous efforts to deliver. That is the process that needs great attention, perseverance and dedication. The peculiarities of the stages completion will be highlighted further.

2.2. Dictionaries Analysis

The first stage corresponds to dictionary analysis. It is one of the most essential stages. It presupposes a thorough investigation of all printed as well as electronic dictionaries available. The dictionaries are chosen according to their popularity among the users which is frequently rated by the international edition "The Guardian" (section "Culture") and Amazon Publishing. These statistics are available for any user free of charge. The stage is aimed at finding out dictionary advantages and disadvantages and coming out with the distinctive features of a model EMTD. To perform the tasks stated the students are asked to conduct the research and fill in the table (see Table 1).

To complete the stage the students are to analyze dictionaries in terms of forms and functions. They investigate different types of dictionaries, deep into their translation capability, reflect on the significance of thesaurus, try various language-learning web-applications, look through encyclopedic reference material and consider other added features.

Table 1

Dictionary Parametrical Analysis

Dictionary	Parameters																	
	Issue Date	Dictionary Type	Dictionary Volume	Dictionary Arrangement	Dictionary Entry Size	Language Variant	Chronology	Definition	Word Frequency	Etymology	Spelling	Pronunciation	Word Morphology	Part of Speech	Grammatical Categories	Stylistic Aspect	Graphic	Pictorial Means

Source: own work.

On the basis of this research the students are able to single out the most important characteristic features of EMTD. They try all the dictionary options, consider which ones are necessary and assess their functionality. Such a critical analysis enables the learners to get a big picture of EMTD peculiarities and motivates them to create their own EMTD prototype.

2.3. Data Collection and Input

One of the major tasks and a significant part of the educator's craft is teaching vocabulary. Lexical competence is considered as the most significant part of communicative competence (Decarrico, 2001). Its development presupposes that the students can use sufficient language stock both in its direct and indirect communication. It is the ability to determine word contextual meaning, the structure of meaning as well as compare the volume of meanings in several languages (Jumanazarov, 2018). Working on EMTD compiling, data collection and input in particular, helps the students to significantly develop their lexical competence as they are provided with authentic texts from which they choose terminological units and improve their awareness of terms by analyzing their morphological characteristics, investigating syntactic and semantic properties. It creates constructive attitude to the task and greatly contributes to getting a good command of the target lexicon. What is more, the learners acquire the necessary skills in hands-on linguistic and textual analysis in computerized learning environments which definitely leads to their future career success.

It is important to mention that the students work only with authentic materials, aimed at fulfilling social purpose in the language community (Little, Devitt& Singleton, 1989). These materials include scientific articles, journals, encyclopedias, manuals, specialized quality newspapers, and official statistics etc. which are reliable and trustworthy. Moreover, all students are provided with the necessary criteria to search the data needed. The criteria imply the following:

- authentic language (written in the author's mother tongue);
- sufficient academic degree of the author (Doctor of Philosophy (PhD), Associate Professor, Professor);
- issue date (less than 10 years).

In addition, the students are informed about scientific articles databases, such as eLIFE, GetCITED, CiteSeer^x, PLOS ONE, Science and TechnologyofAdvancedMaterials, ScienceDirect, iJRDO journal, Directory of Open Access Journals, Microsoft Academic Research, Google Scholar and many others. By referring to them learners can easily find the necessary material for further investigation. Moreover, the students' work is mentored by the specialists in the field who have the necessary scientific degrees. The specialists guide the students and provide them with all necessary assistance. One of the specialists' primary tasks is to consider the list of terminological units the students are working on. All terms are checked as for their frequency using British National Corpus (BNC). The project on EMTD compiling has just started, although the students and the teachers have already processed up to 300 terminological units. Such a result proves that all participants are fully engaged in the process of dictionary creation and greatly motivated to achieve the objective.

Furthermore, significance is given to the creation of dictionary entries. Special attention is given to the principle that a sufficient definition of a term should facilitate its understanding as well as distinguish the related terms. Consequently, the students with the help of the specialists are to make sure that: a definition is given in the most possible comprehensive way; a definition is clear and concise; a definition has no logical contradictions; a term does not appear openly or implicitly; a term is neither overdefined nor underdefined (Devel&Kovalchuk 2016).

Sticking to the following rules guarantees accuracy in dictionary entry creation which is our main objective. What is more, the students indicate morphological and syntactic features of terminological lexemes thus giving thorough analysis of their use in context. They analyze the words in terms of spelling, pronunciation, etymology, stylistic properties; consider derivatives, semantically related words etc. In addition, quick interaction between the learners and the specialists of various fields makes it possible to provide encyclopedic references. As a result, the students study words in depth. They become aware of their meanings as well as the peculiarities of their usage. All in all, it is a common known fact that the best way to introduce new lexical units is to get learners to read texts so that they see those words in action (Harmer 2015). In that way new language input comes naturally and gradually transforms into skills. It really gives students positive motivation towards vocabulary learning.

2.4. Database Creation and Software Identification

The third stage is dedicated to database creation and software identification. It presupposes the work with electronic dictionaries publishing systems, dictionary writing systems, natural language processing systems, and software etc. It aims at providing the necessary functionality in EMTD software to satisfy the needs of EMTD users. Therefore, it should significantly contribute to automatization of usual lexicographic chores, managing the entries structures, automatic renumbering of entry elements, automatic cross-reference update, filtering features to retrieve data quickly. Moreover, it includes the work on EMTD interface, toolbar, and additional features. The peculiarities of the stage will be highlighted in the next articles.

2.5. Accuracy and Suitability Evaluation. Making Improvements

The last two stages refer to the evaluation of accuracy and suitability as well as working out the kinks. It presupposes editing and checking EMTD for compliance with the requirements. It creates final terminological product that requires high accuracy in solving linguistic ambiguity problems as well as professional issues. This stage requires meticulous efforts to secure EMTD functionality to enable effective communication of specialists in different fields. That is the final stage of the project consequently it will be discussed in the due time.

2.6. Students' and Teachers' Feedback.

Each EMTD compiling stage is followed by an online or offline meeting. At the meeting, the students and teachers discuss the results, deal with problematic issues, reconsider the tasks and objectives, and come out with solutions. Moreover, all the participants fill in the questionnaire form (see Table 2) which is aimed at students' self-assessment as well as students' progress assessment done by the teachers.

Students' feedback proves that most of the learners enjoy the process of EMTD compiling (see Figure 3). It creates productive learning environment and motivates them to study.

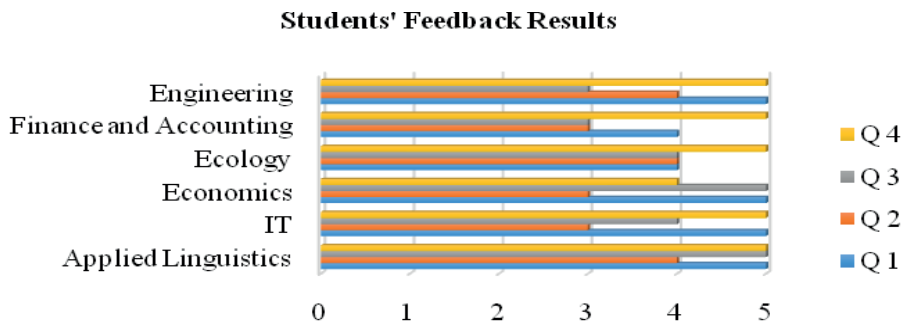
Table 2

Progress Assessment Form

Questions	**Satisfaction Score Mark the square with '+'**				
	1	**2**	**3**	**4**	**5**
Q1. EMTD compilation is interesting and useful.					
Q2. It is useful to work with authentic material.					
Q3. Wordanalysis contributes toits correct use.					
Q4. EMTD compilation facilitates vocabulary skills development.					

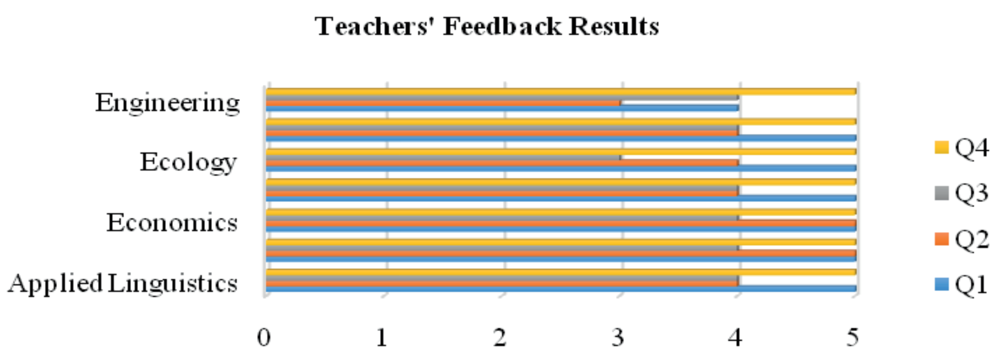
Source: own work.

Moreover, the learners state that learning by doing is much more satisfying as they know the objective and become interested in the result. In addition, collaboration with the groupmates and the teachers boosts their team spirit and has a positive feedback on their interpersonal skills. However, some students (IT, Economics, Finance and Accounting) find it rather difficult to work with authentic material and constantly need teachers' advice. Words analysis turns out to be an enjoying and tiring activity. To analyse lexical units properly the students have to revise theoretical material, which takes additional time and efforts. Nevertheless, it contributes to students' professional competence development, which is beneficial for the learners.



F i g u r e 3. Students' Feedback Results
S o u r c e: own work.

Teachers' feedback results prove that the students enjoy the process of EMTD creation, despite the difficulties that they have to overcome (see Figure 4).
The educators agree that the students find it problematic to work with authentic material. Scientific style is sometimes difficult for understanding. However, thanks to teachers' assistance the learners get used to it rather quickly. Words analysis seems to be one more challenge for the students. Some students find it tiring and time-consuming. Nonetheless, despite the difficulties students' vocabulary skills are gradually improving. Therefore, we may conclude that EMTD compiling contributes to lexical competence development as well as the students' professional advancement.



F i g u r e 4. Teachers' Feedback Results
S o u r c e: own work.

CONCLUSION

Scientific and technical progress requires effective cooperation of specialists in different fields. Therefore, in modern marketing conditions there is even a greater demand for creative, decisive, well-educated and competitive specialists who can speak professional foreign language fluently observing the peculiarities of different countries' traditions and values. Sufficient knowledge of foreign languages greatly contributes to the development of excellent cooperation skills. It maximizes the chances for professional advancement and thus creates opportunities for beneficial cooperation. EMTD compiling has proven to be one of the most productive ways to develop students' lexical competence as well as master their professional skills. The process of EMTD creation undergoes five stages during which the learners have an opportunity to advance their understanding of terminological units use and acquire practical skills in their analysis. Moreover, collaboration with peers and teachers facilitates students' 21st century skills development and makes students more competitive on the labour market. The prospects for further research are seen in the analysis of the peculiarities of database creation and software identification.

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THE POSSIBILITY OF USING LINGUISTIC ANALYSIS TO FUNNEL STUDENT TRANSLATORS' POST-ONLINE-EXCHANGE REFLECTIONS TOWARDS THE METACOGNITIVE ELEMENTS OF TRANSLATOR COMPETENCE

Mariusz Marczak

Abstract: *The use of collaboration and teamwork is being advocated as a means of developing translator competence in translation education courses at university level. The most optimal telecollaborative work mode facilitating the development of a wide range translator competences seem to be team translation projects, another are Online Intercultural Exchange (OIEs), aimed primarily at developing students' intercultural communication competence. However, they can also be used to further the metacognitive components of translator competence. This paper demonstrates how that can be achieved by analysing linguistically excerpts of students' online communication in an OIE with a view to investigating to what extent this kind of analysis, when performed by students themselves, can potentially foster metacognitive competence.*

Keywords: virtual exchange; translator education; translator competence; intercultural competence.

INTRODUCTION

OIEs, which involve teacher-guided online intercultural interaction between geographically distant groups of students (O'Dowd, 2017), have been implemented in educational contexts for nearly three decades, and by many, e.g. Lewis and O'Dowd (2016), they are now recognised as the mainstream of foreign language instruction. However, in the course of their proliferation, they have also successfully entered other areas of education, including translator training (cf. Marczak, 2019). The relevance of OIEs for translator education stems from the fact that they do not only foster translation students' intercultural competence, but also other vital components of translator competence, as the present papers demonstrates.

1. METACOGNITIVE COMPONENTS OF TRANSLATOR COMPETENCE AMENABLE TO DEVELOPMENT VIA ONLINE INTERCULTURAL EXCHANGES

1.1. The Importance of Metacognitive Competences in Translation Courses

Competences indispensable to translators have been thoroughly discussed in the professional literature, e.g. by Alves and Gonçalves (2007), Risku, Dickinson and Pircher (2010) or Gouadec (2007). However, in order to design the translator education process, it is most desirable to look towards models which were proposed with pedagogical intent in mind. The frequently cited and implemented pedagogical models are the PACTE model (PACTE, 2003), and the EMT models (EMT, 2009; 2017), compiled by the EMT Expert Group. It is the EMT model, however, that can be viewed as seminal in that it has moulded translator education at university level across Europe, informing 84 (EMT, 2020) MA programmes in Translation Studies delivered by tertiary-level institutions networked under the auspices of the EMT quality label. All of these models emphasise the importance of knowledge, both declarative, procedural and instrumental, which – in a more or less direct manner – brings to the fore the indispensability of self-learning and life-long learning skills for translation students and translation professionals.

The PACTE (2003) model comprises six major constituent competences, known as sub-competences. The central element of the model is (i) strategic sub-competence, which covers the ability to plan and evaluate the translation process, activate relevant sub-competencies, compensate for deficiencies, identify translation problems and apply adequate solutions with view to ensuring efficiency, and the remaining components which are subordinate to it. The remaining components are: (ii) bilingual sub-competence, including pragmatic, socio-linguistic, textual and lexical-grammatical knowledge in the languages between which the translator operates; (iii) extra-linguistic sub-competence, which embraces encyclopaedic, thematic and bicultural knowledge; (iv) translation knowledge sub-competence, which entails the knowledge of translation processes, translation methods, procedures and the profession per sé; (v) instrumental sub-competence, covering knowledge about the use of documentation sources and translation technologies in the translation process; and (vi) psychophysiological factors affecting the translation process, such as memory, attention span and perseverance, as well as psychomotor mechanisms.

Both the older EMT model (EMT, 2009) and its updated version (EMT, 2017), delineate a similar set of competences, including: (a) language and culture competence, including communication skills, as well as transcultural and sociolinguistic awareness; (b) translation competence, covering strategic, methodological and thematic competence; (c) technology competence, entailing skills pertaining to translation technologies; and (d) service provision competence. Yet, it is noteworthy that the latest model singles out (vi) personal and interpersonal competence, including self-learning, self-assessment, and collaborative learning skills, as a separate component.

Thus, it corroborates the propositions of Gile (2009) and Coban (2015), who underline the vitality of: (i) life-long learning and continuous self-development; as well as (ii) self-regulated learning, including planning, self-monitoring, and self-reflection, respectively.

1.2. Developing Metacognitive Competences via OIEs

Since the EMT model can be treated as the overarching list of competences to be developed in translation courses, it is reasonable to analyse which of its metacognitive constituents – as delineated by the EMT Expert Group (EMT, 2017) – could be developed through OIEs. The results of such an analysis are summarised in Table 1.

Table 1

Developing metacognitive competence via OIEs

EMT Competence	Constituents possible to develop via OIEs	Constituents difficult to develop via OIEs
Personal/interpersonal	Planning, time management Complying with deadlines, instructions Using social media, Self-reflection, self-learning skills	_____

Source: Own work.

As it can be seen, the major competence which appears to be particularly fit to development via OIEs covers a set of metacognitive skills (Personal and interpersonal competence).

In online exchanges, students can improve their personal and interpersonal skills, including the ability to plan actions, do time management, meet deadlines, follow instructions, use social media responsibly and telecollaborate with project partners. At the same time, they can also reflect on their project experience, interaction with partners and the learning process, which – as Byram (2008) underlines – are all essential for effective intercultural education.

2. LINGUISTIC ANALYSIS AS A MEANS OF DEVELOPING SPECIFIC COMPONENTS OF TRANSLATOR COMPETENCE

Interactions in OIEs can be subjected to various types of analyses, which can foster post-experience reflections, and thus enhance intercultural development. Such analyses can examine the affective, cognitive, behavioural (verbal and non-verbal) and meta-cognitive elements of intercultural awareness, fostering the development of students' knowledge, skills, and awareness. An example of linguistic analysis that can be used to examine online communication, and thus foster intercultural learning, has been discussed by Wise and Chiu (2011). Another idea comes from Chiu (2000), who demonstrates how the interactive actions of individuals collaborating within a team can be analysed in terms of their properties and contribution to problem-solving.

The present paper focuses on the applicability of linguistic analysis to the development of the EMT competence which comprises metacognitive skills, i.e. Interpersonal and personal competence, particularly with regard to self-learning and self-assessment.

An example of linguistic analysis which can be used to develop the above-cited skills and which directly relates to the research conducted by the present author comes from Ryshina-Pankova (2018), who demonstrates how abstract aspects of intercultural communication competence, as proposed by Byram (1997), can be operationalised and assessed with the use of a method based on Eggins and Slade's (1997) systemic-functional linguistic analysis. She examined the interactions of a group of American university-level learners of German and German university students within a telecollaboration project in which the partners used synchronous written online chat as a means of communication in order to demonstrate the discursive moves used by the students and the language resources through which those moves were realised.

The type of interactional moves which Ryshina-Pankova (2018) analysed fell into four groups: initiating moves, responding moves, continuing moves and rejoinder moves, as they had been discussed by Eggins and Slade (2011). The initiating moves did not relate to previous moves in the discourse under analysis, they aimed at directing the chat discussion towards a particular issue and were operationalised as commands, statements as facts, statements as opinions, as well as open and closed questions as facts and opinions.

The responding moves involved the chat participants' reactions to their interlocutors' interactional moves and included three sub-categories: (i) interaction-supporting moves, e.g. respond-answer, respond-agree, respond-register, and respond-acknowledge moves; (ii) interaction-developing moves, including respond-elaborate, respond-extend and respond-enhance moves; and (iii) confronting moves, which covered: respond-contradict, respond-withhold moves.

The continuing moves were those which particular interlocutors made in order to build up their previous moves, through continue-elaborate, continue-extend and continue-enhance moves, while rejoinder moves comprised moves which were made in order to "(…) deepen the conversation even further through alignment and disalignment strategies" (Ryshina-Pankova, 2018, p. 223). The alignment moves were attempts to elicit more information (rejoinder-clarify), verify information (rejoinder-confirm), provide more information for confirmation (rejoinder-probe) or provide clarifications (rejoinder-resolve). The disalignment moves were realised through rejoinder-challenge moves, which would question the interlocutors' right to voice their opinion, rejoinder-rebound moves, which would question the legitimacy or relevance of a previous move, rejoinder-refute moves, which would contradict a challenge, or rejoinder-rechallenge moves, which would carry an alternative position. Another two moves (respond-evaluate and continue-evaluate) were also introduced by Ryshina-Pankova (2018) to cover the interlocutors' evaluative comments.

Additionally, Ryshina-Pankova (2018) identified the mood types, as discussed by Halliday (1994), through which the above-cited moves were realised. The moods comprised the use of declaratives, WH-interrogatives, and polar interrogatives.

The analyses conducted by Ryshina-Pankova (2018) permit the examination of the discursive moves which the students used while chatting online and how specific moves were realised, but also the extent to which the moves revealed the students' attitude of openness and curiosity, discovery skills and the ability to change perspectives, which are all elements of Byram's model of intercultural communication competence. The former two can be evidenced by the balance between the initiating and responding moves performed by both parties in an interaction and the degree of elaboration in which they involved. The latter can be traced through the production of rejoinder-disalignment moves, which are likely to contribute to a shift in students' perspectives.

In the light of the above, linguistic analysis seems to be a tool with which to examine students' interactions in OIEs with a view to stimulating metacognition (self-reflection and self-assessment), which in turn fosters the development of language and culture as well as personal and interpersonal competences.

3. FOSTERING BEHAVIOURAL, COGNITIVE AND METACOGNITIVE COMPETENCES IN THE GPE PROJECT: STREAMLINING STUDENTS' POST-EXPERIENCE REFLECTIONS THROUGH THE ANALYSIS OF DISCOURSE SEMANTIC MOVES

3.1. Research context, aims, sampling and procedures

3.1.1. Context and research questions

What follows is a recount of research which aimed to investigate how the linguistic analysis of students' discourse moves in an OIE could be used to develop their metacognitive (self-learning) skills.

The research was based on data elicited from students' written interactions automatically recorded by the synchronous chat application IceChat, which was used in the course of tandem work performed as part of the 10th edition of the Global Understanding project – an intercultural online exchange organised by the Global Partners in Education (thegpe.net). The project aimed to develop the participants' online communication skills and involved in-class and out-of-class work. The in-class work involved six days of live online links between the partner institutions: East Carolina University, USA (ECU) and Jagiellonian University in Kraków, Poland (UJ) on which the participants worked in small sub-groups on each side alternating between two work modes: videoconferencing and email tandems, and discussed five project topics: (i) College Life; (ii) Family and Cultural Traditions; (iii) Meaning of Life and Religion; (iv) Stereotypes and Prejudices; and (v) Free Topic. The out-of-class work consisted in the performance of the Telecollaborative Project, where pairs of students from the partner institutions jointly prepared PPT presentations about selected aspects of each other's cultures.

The research was motivated by three research questions:

- RQ1: Which discourse moves did the randomly selected GPE project participants use in online chat exchanges?
- RQ2: What can be inferred from the discourse patterns and their realisations?
- RQ3: How can the results of the linguistic analysis, as worded in RQ1 and RQ2, be potentially useful for developing the metacognitive components of translator competence?

3.1.2. Sampling and procedure

Research data have been collected on a convenience basis from 6 teams which participated in the Global Understanding project (14 students in total). However, since the present paper aims to only illustrate how the linguistic analysis of students' communicative performance in an OIE could be used to foster the development of metacognitive competence, the data selected for discussion here come from 3 students who happen to have worked in Team 2, all in their early twenties: 2 ECU students (both females, henceforth referred to as S1 and S2) and 1 UJ student (male, henceforth referred to as S3). The UJ student was majoring in Translation Studies, while his USA partners' major was health and natural sciences. The Polish student's documented competence in English was at the level of C1, according to the Common European Framework of Reference for Languages (CoE, 2001).

The data selected for analysis were records of the students' fifty-minute long written online chat exchange in which they participated on a linking day in the classroom. To obtain data with which to answer RQ1, their conversations were analysed and coded for discourse moves in R's RQDA – the statistical program's plugin for qualitative data analysis. Subsequently, the distribution of specific discourse moves, which were discussed in section 2 of the present paper, was computed for each student within the two teams and bar charts were generated in MS Excel. The research data were subjected to further qualitative analysis, this time with a view to answering RQ2. The research results are presented below.

3.2. Results and discussion

3.2.1. Interaction in Team 2

As Figure 1 shows, the students produced the following discourse moves: S1 produced 4 initiating moves (IMs), 16 responding moves (RMs), 9 continuing moves (CMs) and 9 rejoinder moves (RejMs) at all. S2 produced 3 initiating (IMs), 13 RMs, 5 continuing moves (CMs) and 2 rejoinder moves (RejMs), while S3 produced 19 initiating (IMs), 24 responding moves (RMs), 10 continuing moves (CMs) and 8 rejoinder moves (RejMs).

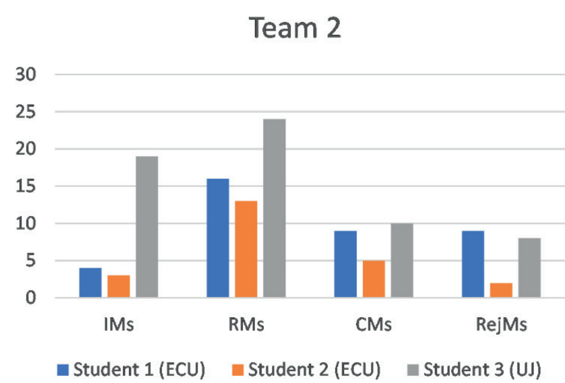
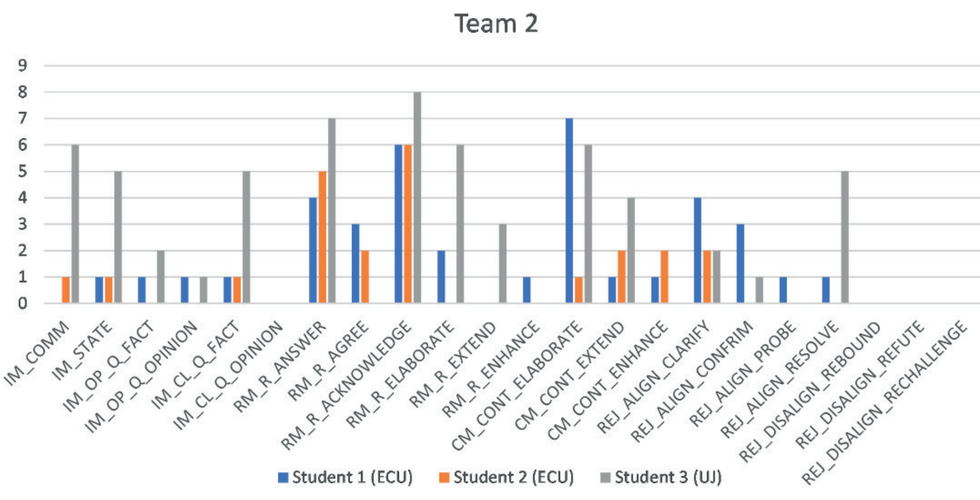


Figure 1. Numerical Distribution of Discourse Semantic Moves in Team 2

Source: Own work.

What strikes is the students' apparent intensive involvement in the conversation. First of all, all the students in Team 2 used the full range of the discourse moves under examination. S1 made 4 initiating moves (IMs), S2 made 3 such moves, while S3 produced 19 IMs. Even though S3 was the only representative of the Polish university in the conversation, he initiated the conversation more than both of his American partners, perhaps in an attempt to compensate for the disparity in representation. It might, however, also indicate their active involvement in the conversation at large, which finds substantiation in the relatively larger number of responding (24 RMs), continuing (10 CMs) and rejoinder moves (8 RejMs) which they produced in contrast to the number of these moves made by the other two partners: S1 and S2 (16 RMs and 13 RMs, 9 CMs and 5 CMs, and 9 and 2 CMs, respectively). It seems that S3 led the discussion by initiating most of its threads, while both ECU students and the UJ student contributed to topic development; the latter is corroborated by the aggregated numbers of RMs (29), CMs (14) and RejMs (11), which both ECU students produced, and which even slightly exceed the numbers of these moves made by S3. It demonstrates that the ECU students kept alternating their communication turns in response to the fact that they outnumbered S3 in the conversation and perhaps intentionally, they attempted to share the floor equally with S3. S1 one was more active in those attempts and produced more moves of each type than S2, but in total, there was a perfect balance between the number of moves made by the representatives of both international partners: ECU (61) and UJ (61). The actual realisations of particular discourse moves used by Team 2 members are presented graphically in Figure 2.



F i g u r e 2. Distribution of Particular Types of Discourse Moves in Team 2

S o u r c e: Own work.

Figure 2 demonstrates that students in Team 2 realised 18 different types of discourse moves. The moves which prevailed were answers to questions (S1=4, S2=5, S3=7) and instances of acknowledgement as responding moves (S1=6, S2=6, S3=8), as well as attempts to elaborate (S1=7, S2=1, S3=6) as continuing moves. What strikes is S3's active involvement in the discussion, which manifested itself in the 6 initiating comments, 5 statements, 2 open and 5 closed questions about facts which were made by S3. They all by far exceeded the number of initiating comments (S1=0, S2=1), initiating statements (S1=1, S2=1), open questions about facts (S1=1, S2=0) and opinions (S1=0, S2=1), and closed questions about facts (S1=1, S2=1) and opinions (S1=0, S2=0) performed by the other two partners. In Team 2's exchange, a range of rejoinder moves were also used in order to elicit clarification (S1=4, S2=2, S3=2), receive confirmation (S1=3, S2=0, S3=1), volunteer further information for confirmation (S1=1, S2=0, S3=0) or provide clarifications (S1=1, S2=0, S3=5), which seems to corroborate the idea that Team 2 members were quite engaged in the conversation. Again, one needs to allow for the fact that in Team 2, one UJ student interacted with two ECU students, the two ECU students needed to share the floor with each other and their partner; hence the smaller number of some moves, e.g. initiation moves, on their part. At the same time, the aggregated number of their other moves, e.g. respond-answer and respond-acknowledge moves, exceed the number of these moves made by S3. In conclusion, it may be stated that the conversation was generally relatively balanced, which finds reflection in the number of words the students used (S1=307 words, S2=339 words and S3=683). Given that S1 and S2 shared the floor, they produced a smaller number of words each, but when the word counts for both of them are accumulated, the sum (646) is nearly as large as that computed for S3.

What merits notice is that in neither of the teams the interlocutors used any disalignment moves, the use of which might – in Ryshina-Pankova's (2018) opinion – imply students' attempts to shift their cultural perspectives. Even if such shifts do not occur, attempts to disalign create opportunities for questioning cultural phenomena and exploring them in greater depth, by dint of which intercultural learning is facilitated. Thus, the students should be encouraged to use disalignment moves in future exchanges.

The analysis of moods realised through the questions asked by Team 2 members revealed that S1 and S3 asked 1 WH question and 2 polar questions each, while S2 asked 2 questions of each type (Table 2), which suggests that each of them at least at one point in the conversation tried to elicit more details from their interlocutor. At the same time, it is noticeable that each of the students used polar questions, which potentially limited the scope of intercultural exploration, as such questions narrow the response options to those which are already contained in the question.

Table 2

Numerical distribution of types of initiating moves in Team 2

Mood types	**Student 1 (ECU)**	**Student 2 (ECU)**	**Student 3 (UJ)**
WH questions	1	2	1
Polar questions	2	2	2
Total no. of words used in the exchange	**307**	**339**	**683**

Source: Own work.

It is time now to answer RQ3 and consider how the data presented above can foster the development of the metacognitive components of translator competence. The contribution of the kind of linguistic analysis discussed above to the development of students' metacognitive skills and awareness is impossible to overlook. By reflecting on their own and their OIE partners' communicative performance students learn not only how to systematise reflection on a communicative experience and what criteria to utilise for self-assessment of language performance, but also how to interpret the results of their findings. They can subject their own performance to both qualitative and quantitative scrutiny. However, it must be underlined that students' linguistic analysis needs to be performed cautiously and take into account the numerous factors which can potentially affect the findings. After all, communicative behaviour can be influenced by e.g. the level of one's language competence, of which students must be aware.

Therefore, it seems reasonable that prior to the linguistic analysis, students are introduced to the notion of communication moves and their possible realisations, so that that their analysis is conducted in an informed manner. In the long run, they might use the analysis to identify their interactional strengths and weaknesses, plan and monitor their learning process and set personal learning goals, which would help them to orientate learning towards improvement in the most relevant areas.

In this way, they will learn how to operationalise particular target competences, collect evidence of progress, and make informed decisions about remedial action. By doing so, they will be able to develop personal competence, while also equipping themselves for effective self-reflection and self-learning.

CONCLUSION

As it has been demonstrated, the metacognitive constituents of translator competence can be potentially developed by means of post-experience reflections, stimulated by the linguistic analysis of students' interactions in OIEs. What is more, the kind of analysis discussed above, can be easily extended, e.g. in order to cover cognitive and behavioural aspects of interaction, which would not only increase the scope of linguistic analysis, but also enrich the students' learning experience and ultimately, contribute to proliferating the learning outcomes.

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DISTANCE TECHNOLOGIES IN THE TRADITIONAL MODEL OF HIGHER EDUCATION

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Abstract: *The paper discusses some aspects of the organisation of higher education based on distance technologies. It shows the advantages and disadvantages of distance form of higher education versus traditional full-time and part-time forms. It also considers the role of e-learning and m-learning technologies; the essence and features of blended (mixed, hybrid, combined) learning. The authors describe the experience of managing the educational process at a typical institution of higher education in the conditions of forced transition to distance learning. They allocate the main problems and possible solutions, proceeding from the conditions of efficiency and methodical expediency of certain forms and means. The conducted analysis allowed designing an adaptive fulltime-distance model of training, with the traditional model of higher education remaining unchanged. The proposed approach derives from the focus on the complete transfer of students' independent work to a distance mode for theoretical material and to a combination of full-time and distance modes for other types of work in a ratio determined by the specific situation. Besides, all preparatory issues are tackled at the beginning of the semester in order to train students to learn according to the proposed scheme.*

Keywords: higher education, distance learning technologies; blended learning; adaptive scheme.

INTRODUCTION

The COVID-19 pandemic has dramatically affected all spheres of society, including education. The educational process in Ukraine was forcefully transferred to distance mode in the middle of the school year (semester), without prior training. Consequently, both learners and teachers faced new challenges. Most participants in the learning process were not prepared for full transition to distance learning. Teachers mainly tried to use elements of remote technologies relying on provided electronic

versions of teaching materials as well as various ways of communicating with students (e-mail, messengers such as Viber, Telegram, etc.). In some cases, video conferencing was used via tools such as MS Teams, ZOOM, Google Meet, Skype, and specialised environments such as Classtime or Google Classroom.
The experience gained has drawn increased attention to the problems of distance education. Opinions of the participants of this forced experiment were divided: from calls to urgently redesign the entire educational process into remote format to a full denial of the feasibility of such a step. The arguments in both cases are quite strong, which determines the relevance of further research aimed at analysing the problems of education using distance technology.

1. DISTANCE LEARNING AND ITS RELATION TO OTHER FORMS OF HIGHER EDUCATION IN UKRAINE

The nature of discussions about the feasibility, advantages and disadvantages of distance learning is largely determined by certain inconsistency of the terminology used. For example, when determining distance learning a number of researchers pay attention, above all, to the physical distance between the participants in the learning process. Thus, there appear claims that this form of education was born at least 150 years ago and its equals the correspondence form of education. Other researchers, focusing on the defining nature of modern information and communication technologies, identify the concept of distance learning through the concepts of e-learning (e-learning) or m-learning (mobile learning).
We consider it appropriate to use the terminology of regulations currently in force in Ukraine. According to the Law of Ukraine «On Higher Education», the main forms of higher education are «… institutional (full-time (day and evening modes), part-time, distance, network forms); dual» (Zakon Ukraïni, article 49, paragraph 1). The network and dual forms of education will not be considered further due to their specificity.
Full-time and part-time forms can be considered traditional, the difference between them is in the ratio of students' in-class and independent work. The Law cited above provides for full-time classes and practical training for at least 30 weeks during the school year. For part-time form, the duration of the period between short sessions for training classes and assessment activities is fixed as no less than one month.
The distance form of higher education has shaped relatively recently. The Law of Ukraine On Higher Education defines it as «… individualised process of obtaining education, which occurs mainly through the indirect interaction of distant participants in the educational process in a specialised environment that operates on the basis of modern psychological-pedagogical and information and communication technologies» (Zakon Ukraïni, article 49, paragraph 4). As we can see, the distance between the participants in the learning process is common to both distance and distance forms of education. At the same time, the correspondence form of education designates short-term sessions for presence training sessions and assessment activities, and the distance form allows complete absence of face-to-face interaction of participants in the educational process. The fundamental specificity of distance form is a clear focus on the use of modern information and communication technologies. The reference to mod-

ern psychological and pedagogical technologies only reinforces this feature and emphasises the need to take into account the specifics of distance learning.

The main normative document regulating distance learning should be considered the Regulation on distance learning, approved by the order of the Ministry of Education and Science of Ukraine № 466 of 25.04.2013 (Položennja pro distancijne navčannja). The provision allows the possibility of using asynchronous and synchronous training modes. The first mode involves the interaction of distance learning participants with a delay in time, using e-mail, forums, social networks etc.. Synchronous mode is defined as «… interaction between the subjects of distance learning, during which all participants are simultaneously in the web environment of distance learning» (ibid., p. 1.6). The main types of classes for higher education (lectures, consultations, practical classes) can be conducted in asynchronous or synchronous modes (ibid., p. 3.3, 3.5).

Importantly, the focus on certain information and communication technologies at the current level of society development is typical for any form of learning. This is evidenced by the widespread use of such concepts as *e-learning* (electronic learning) and *m-learning* (mobile learning). E-learning can be considered as the broadest concept among the two. Semerikov, Striuk, Moiseenko claim that in Ukraine «the following interpretation is widespread: e-learning is the presentation of educational materials and management of the learning process using new information and telecommunications technologies» (Semerikov et al., 2012, p. 197). It is clear that this approach can be used in any form of higher education.

Further development of the use of information and communication technologies in education is connected with the emergence of mobile devices (mobile phones, tablets, devices for reading e-books, etc.). As a result, we observe how *e-learning* gave birth to *m-learning*. This technology is characterised by high portability (including the ability to access wireless Internet), individual adaptation to a person, intuitive interface. As a result, the potential and opportunities for personalised learning are significantly expanded, in particular, the limitation not only to time but also by the place of study disappears. It is possible to organise professor-to-student interaction in real time, including the diagnosis of educational achievements (Rekomendacii JUNESKO po politike…).

Based on the regulations of Ukraine (1,2) e-learning and m-learning cannot be considered as independent forms of higher education. Present authors believe that it is more correct to differentiate between full-time, part-time and distance forms of educa-

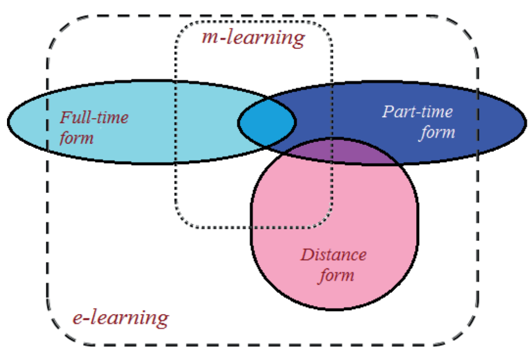


Figure 1. The relationship between forms of higher education in Ukraine

Source: own work.

tion, which actively (albeit to different degrees) use e-learning and m-learning technologies (Fig. 1).

1.1. Research methodology

In order to specify the content and features of various forms of higher education the authors used historical-logical and systematic approaches as well as the method of theoretical literature review. The theoretical background of the study relies on basic principles and provisions in the field of higher education, legislative and normative acts on higher education, monographic studies by Ukrainian and foreign scientists.
Methods of observation and generalisation were applied when discussing the experience of using elements of distance learning in off-nominal mode; methods of system analysis and synthesis were employed to design the scheme of adaptive distance learning.

2. ADVANTAGES AND DISADVANTAGES OF DISTANCE LEARNING: BLENDED LEARNING

Distance learning has its own characteristics which determine its advantages and disadvantages compared to traditional full-time and part-time forms of higher education. There is significant literature on the topic (Semerikov et al., 2012; Bikov et al., 2015; Rams'kij et al., 2008; Smirnova-Tribul'skaja, 2007; Trius, 2012). A summary of the most significant features, as well as affordances and risks are presented in Table 1. Obviously, all the positive points are accompanied by quite significant challenges.
Particularly noteworthy was the problem of minimising or lack of face-to-face interaction between a professor and a student. After all, it is the pedagogical skill of the professor, his or her ability to engage the audience, to form and maintain the creative nature of learning that largely determine the effectiveness of the entire educational process.
The desire to combine the advantages of traditional forms of higher education (full-time and part-time) and distance learning gave birth to so-called blended learning. In essence, *blended learning* is actually a combination of full-time (part-time) form with distance learning, and the ratio of each of them can vary widely. In Ukraine, blended learning is often interpreted as hybrid (Smirnova-Tribul'skaja, 2007) or combined (Trius, 2012) learning. Such interpretations seem to reflect the features of blended learning as a pedagogical technology more accurately.
The interpretation of term *blended learning* by Yu.V. Trius is indicative. He defines it as "a purposeful process of acquiring knowledge, skills and abilities, mastering the ways of cognitive activity by the subject of learning and development of their creative abilities based on comprehensive and systematic use of traditional, innovative pedagogical technologies and information and communication technologies of teaching based on the principles of mutual complementarity with the aim of improving the quality of education" (Trius, 2012, p. 304). As we can see, the concept of *distance learning* is completely absent in this definition. In fact, we are talking about supplementing the traditional full-time and part-time forms of higher education with elements of *e-learning and m-learning* technologies, which already takes place in practice (see Fig. 1). But the reference to *innovative pedagogical technologies* directs

professors' focus towards the need of detailed elaboration of methodological issues of combining traditional forms of learning with new technologies of presentation (acquisition) of knowledge.

T a b l e 1

The main features of distance learning

Feature	Advantages	Challenges
Lack of strict regulation of the learning process in terms of time and location	The students has opportunity to: • independently determine comfortable learning conditions, including time, place and pace of learning material; • combine the learning process with other regular activities (work, other learning, etc.)	Comfortable conditions often lead to loss of focus. High motivation and self-discipline of applicant, their ability to self-control are required.
Shift away from group classroom work, individualisation of training	The student is no longer a hostage of the teacher's focus on *average* student; they get an opportunity to form learning trajectory independently	Lack of sharing experience with other students, the desire for leadership emotionally impoverishes learning
Online – communication of students with teachers and other participants	The use of modern means of communication, efficiency, similarity to everyday life patterns	The negative consequences of electronic communication remain due to the psychological characteristics of participants
Online assessment of students	Eliminating risks of subjective assessment, convenience for students and professors	Problematic identification of students and checking the independence of testing
Availability of high-quality educational materials	Abundance of educational literature, the opportunity to attend lectures of leading experts etc.	Perception of material presented at a high level requires previously accumulated knowledge of the appropriate level

S o u r c e: own work.

3. FORCED LEARNING IN DISTANCE MODE

One of the positive features of distance learning is the ability to use appropriate technologies in situations where traditional classes become impossible for reasons beyond the will of the participants in learning process. Until recently, the main reason was the imposed quarantine in a separate educational institution or its unit. The COVID-19 pandemic has led to a strict quarantine in March–April 2020 in most parts of the world. Full-time classes in educational institutions of Ukraine were initially suspended and later the educational process was transferred to distance mode (Pro organizacijni zahodi…). The education system has gained a unique experience of unprepared mass transition to distance learning.

The recommendations of Ministry of Education and Science of Ukraine regarding work in quarantine conditions were mainly reduced to a reference to the Regulation (Položennja pro distancijne…). This regulation is intended for use in an institution with distance learning as a separate form of education. The Ministry of Education and Science of Ukraine suggested that educational institutions determine the procedure for the use of distance learning technology for students of other (except the distance one) forms of education by themselves. The above-mentioned Regulation «… can be used as a guide» (Informacijnij portal Dniprovs'kogo…). Thus, educational institutions as a whole and individual professors were given ample opportunities to find the optimal organisation of the educational process in conditions of forced transition to distance mode.
The analysis of preparedness of higher education institutions (HEIs) to operate in new conditions gives grounds to divide them into three groups. The first group includes those HEIs where the distance learning has already been used, i.e. the ones where certain elements of distance technologies were already implemented. The second group consists of HEIs, in which elements of e-learning and m-learning technologies were used sporadically in teaching particular disciplines. Dniprovsky State Technical University (DSTU) can serve as an example of the second group. Below we discuss the university's experience as to individual units and trained personnel below. The third (most numerous) group comprises those HEIs where distance learning as a special form of obtaining higher education was not used, but some aspects of the organisation of education were actively implemented for full-time education in the conditions of forced transition to distance learning.
First, it should be pointed out that DSTU was almost ready to use the asynchronous distance learning mode. According to the above-mentioned regulation, such a mode provides for the interaction of participants in the educational process with the time delay, using e-mail, forums, social networks, etc. In due time at DSTU the Information Portal (Rekomendacії ŝodo organizacії …) was launched, where one can find information for each discipline of the curriculum, namely syllabus, programme of study, synopsis of lectures, methodological guidelines for practical (laboratory) classes and independent work of students as well as other material. The only remaining thing to be implemented in the transition to distance learning was to inform the students about the calendar planning of the educational process and communication channels with professors.
To address this issue the enthusiast professor O. Shumeiko developed "Student-Professor Distance Exchange Information System" (SPDEIS) in the DSTU website. With its help the professors were able to inform students about all the nuances of the educational process as well as to send the necessary materials. The students were given the opportunity to contact the professors if they needed extra help with particular theoretical material or algorithm of carrying out practical tasks; to send a report on the completed practical assignment, etc. The introduction of authorised access provided personal service and certain level of confidentiality of communication. E-mail and messengers (Viber, Telegram, etc.) have become backup communication channels.
Synchronous mode is defined as "… interaction between the subjects of distance learning during which all the participants are simultaneously logged on the web environ-

ment of distance learning" (Položennja pro distancijne navčannja, p. 1.6). Typically, synchronous mode is implemented by using video conferences with the help of such tools as MS Teams, ZOOM, Google Meet, Skype and others. The use of synchronous mode in the transition to distance learning at DSTU has caused some difficulties as it turned out that not all professors and students were familiar enough with communication technologies. As a result, the difficulties of using the tools of interaction in many cases have become dominant in the organisation of educational process, and the study of a particular discipline of the curriculum has lost attention. The same applies to attempts of using specialised environments such as Classtime or Google Classroom.

Knowledge assessment of students appeared a significant problem of distance learning (see table 1). The Ministry of Education and Science of Ukraine formulated special recommendations in this regard, making a warning: "The recommendations complement, but do not replace the best practices and solutions that the educational institutions have already developed and implemented under quarantine restrictions" (Rekomendaciï ŝodo organizaciï). With this in view, we used the algorithm of holding examinations which was based on the above-mentioned information system.

According to the schedule on the exam day the student must log in to the system at a specified time. After authorisation each student is sent information about the procedure of the exam through the same system and there opens a test to assess student's knowledge of theoretical material. The time to complete the test is limited and the evaluation is performed automatically. After closing access to the test, the system SPDEIS sends each student individual set of practical exercises. Files with the answers are sent to the professor again through the SPDEIS no later than the deadline. The time to complete the exercises is also limited. Taking into account the results of practical exercises and assessment of the test, the professor sets the final grade for the test and informs the student about it.

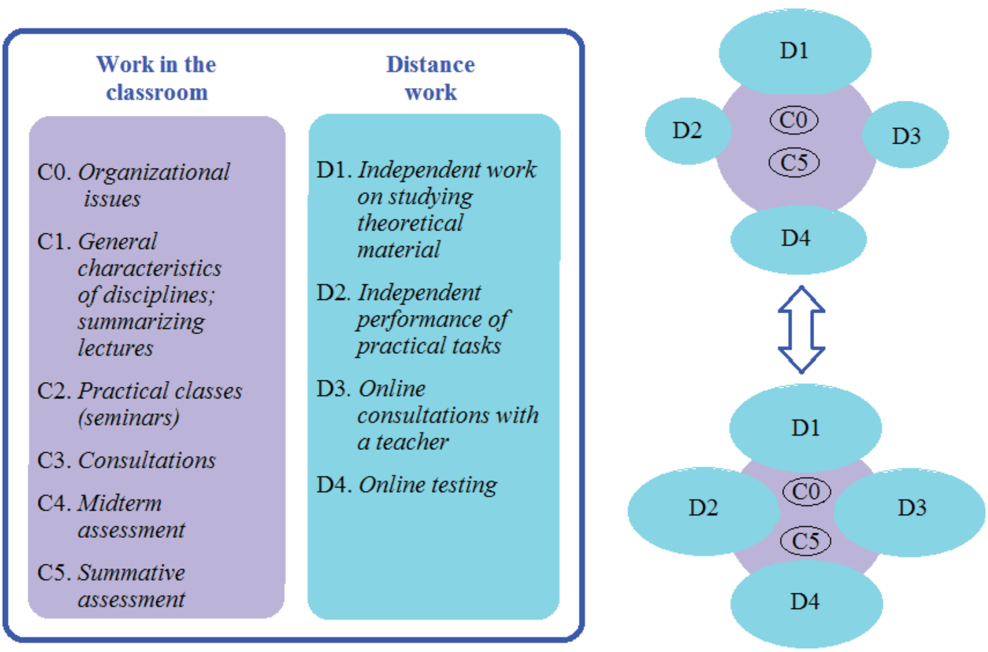
Using the approach described above, professors and students generally coped with the situation despite the problems that arose. The main issues were technical, psychological and methodological. Among the technical problems the most common ones were the unequal opportunities of students due to the presence or absence of appropriate gadgets (PCs, laptops, tablets, smartphones, etc.) and the quality of Internet access. Psychological problems are primarily related to the unwillingness of many students for active independent work, including time management, adherence to the proposed schedules of training work, development of new learning environments and means of communication. Despite the comfortable working conditions at home, lack of constant support by the teacher led to a fall in focus and procrastination.

In truth, many students lacked live communication with professors and student colleagues. Methodological problems have arisen because distance learning requires other approaches. In particular, this applies to the planning of the educational process, the distribution of the student's time budget for lectures, practical classes, consultations and independent work. It turned out that the student spends much more time on practical classes and independent work than in the traditional model of higher education; thus the need for professor advice, including in individual mode, is growing significantly.

4. ADAPTIVE FULL-TIME AND DISTANCE LEARNING MODE

Evidently, the transition to distance learning technologies, as circumstances may require, will be much easier if elements of distance technologies are used systematically in the traditional model of higher education. For this reason, we propose to apply the *Adaptive full-time and distance learning scheme (AFDLS)* while maintaining the traditional model of higher education on the whole (cf. Figure 2 for details).

When using AFDLS, from the beginning of every semester the participants of the educational process should be prepared to combine classroom and distance work, and the proportions of such a combination may be changed during the training, depending on the specific situation. The components C0 and C5 remain unchanged, which, in any case, provide face-to-face communication between professors and students, as well as component D1, which is fully realised in distance learning mode. We would like to emphasise that the focus is on studying theoretical material only in the part that is under the syllabus precisely aimed at independent work. Components D2, D3 and D4 can be changed if necessary due to components C1–C4 (cf. Figure 2). Before the beginning of training it is necessary to fix the scope of the specified components at a level which is sufficient for skill formation related to using corresponding technologies and means.



F i g u r e 2. Adaptive full-time and distance learning scheme in the traditional model of higher education

S o u r c e: own work.

The effectiveness of the aforementioned learning scheme significantly depends on the elaborate organisational issues (component C0) and the rational distribution of academic work between components C1 and D1, C2 and D2. In class the teacher must outline the problems and focus on the most important or difficult matters, all the rest is transferred to distance learning mode and is based on e-learning and m-learning technologies.

CONCLUSIONS

Of all the forms of higher education provided by the Regulations of Ukraine, the main ones today are traditional full-time and part-time forms of education. Distance learning is actively developing, but it is too early to consider it one of the leading forms. The advantages of distance learning are connected with systematic use of e-learning and m-learning technologies, and the disadvantages are related to the lack of face-to-face communication between students and professors.

Blended learning is a progressive trend of higher education; its essence is a combination of full-time (part-time) form of education with distance learning and it is based on sound pedagogical grounds and methodological support.

The experience of forced transition of higher education institutions to distance learning mode indicates the need and possibility of such design of the educational process which will not be disrupted by emergencies of various kinds. The use of the adaptive full-time and distance learning scheme, with varying proportions of classroom and distance work during the semester, provides a smooth transition to distance learning in the case of off-nominal situations.

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USE OF SPECIALIZED SOFTWARE FOR THE DEVELOPMENT OF VISUAL THINKING OF STUDENTS AND PUPILS

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Abstract: *The article reveals the essence and defining characteristics of visual thinking: visual productivity and activity of putting forward visual hypotheses, constructive activity, strategic-semantic flexibility, and visual originality. The ways of using specialized software for the development of visual thinking are revealed: the organization of visual search through the tasks visualized in the virtual environment, the use of tasks aimed at the developing the ability to put forward visual hypotheses, the use of tasks aimed at identifying visual originality in solving them, the use of cognitive-visual graphics, the use of tasks with incomplete conditions and tasks with redundant data, and the use of inverse tasks. According to the results of the expert assessment, two most effective ways in which to influence the development of visual thinking have been identified: the organization of visual search through the tasks of visualized in the virtual environment and the use of cognitive-visual graphics. It is established that for the implementation of these ways it is advisable to use specialized software, namely programs of dynamic mathematics, Smart-objects from the package of office programs, tools for creating infographics, and graphic editors. The results of a pedagogical experiment on the development of visual thinking of young people through visualized tasks in a virtual environment and the use of cognitive-visual graphics are presented.*

Keywords: visual thinking; specialized software; e-learning; programs of dynamic mathematics.

INTRODUCTION

Modern education faces some challenges. Among them are active and constant use of information devices (smartphones, tablets, netbooks) by young people; they need to be online all the time and perceive information content more visually than linearly and others. At the same time, educational material in educational institutions, due to the peculiarities of its presentation in textbooks (mostly in the text form), is usually not interesting enough to hold attention for a long time and effectively influence the development of the younger generation thinking. This highlights the problem of strengthening the cognitive activity of young people by changing the ways of presenting the material in terms of its visualization in order to develop visual thinking as a basis for the creativity of young people. And if the shift of emphasis toward visualization is traced today, the problem of the development of visual thinking and the means of doing it are insufficiently studied.

1. ANALYSIS OF CURRENT RESEARCH

The works of Arnheim, Ware, Moeller, and others are devoted to the study of the peculiarities of visual thinking (Arnheim, 1994; Ware, 2004; Moeller, 2013). Thus, scientists have substantiated: cognitive-visual methods of teaching mathematics, in a basis of which accents are shifted from illustrative function of clarity to its cognitive function, which has a positive influence on the development of visual thinking of pupils (Dalinger, 2006); the possibility of forming the skills of visual search activities in mathematics lessons through visual thinking (Reznik, 1997); psychological features of visual thinking, in particular, perception and reflection of connections and relations of objective reality through various forms of visual coding, namely models, graphics, schemes, maps, etc. (Symonenko, 2005). Certain theoretical and methodological principles of the development of visual thinking by using digital technologies are presented in the works of Andersoninman, Horney; Abdullah, Halim, Zakaria; MonesHattal, Mandes and others (Andersoninman, Horney, 1996; Abdullah, Halim, Zakaria, 2014; MonesHattal, Mandes, 1995).

At the same time, the analysis of scientific research shows the fragmentary nature of the work on clarifying the ways in which to develop visual thinking through the use of specialized software.

The aim of the study is to identify ways of using specialized software to develop the visual thinking of students and pupils.

The aim led to the need to do the following: 1) clarify the essence of the phenomenon of "visual thinking"; 2) describe possible ways to use specialized software for the development of visual thinking; and 3) based on statistical analysis, determine the most effective ways to use specialized software for the development of visual thinking.

2. MATERIALS AND METHODS

2.1. Research base

The study was conducted based on Sumy State Pedagogical University named after A.S. Makarenko. The pedagogical experiment was attended by 104 students of 3–4 courses of specialties “014 Secondary Education” (specializations – mathematics, computer science) and high school pupils of the Kyiv, Donetsk, and Sumy regions, with a total of 98 people.

2.2. Stages of research

The study took place in four stages: the first stage is theoretical, aimed to clarify the concept of visual thinking, its components, and its characteristics. The second stage is practical, provided for the identification of possible ways to use specialized software to develop visual thinking of young people. In the third stage, an expert assessment of the identified ways was carried out to select the most effective ones using the Kendall concordance criterion. The fourth stage involved a pedagogical experiment: during 5 sessions, two of the most effective ways to use specialized software to develop visual thinking selected by experts were proposed. At the beginning and end of the fourth stage, by means of the method of “Raven’s Progressive Matrices” (Raven’s test), the dynamics of the development of visual thinking of your people were determined and tested statistically by the comparison of students’ mean scores.

3. MAIN RESULTS

3.1. The essence and defining characteristics of visual thinking

Dalinger explains the term “visual thinking” as thinking which is oriented on the reproduction of concrete, but previously unknown images, and which is relevant to the field of object transformation methods. When mastering mathematical content, the specificity of visual thinking lies in the activity of creating mathematical images, filling them with semantic load, operating on them, etc. (Dalinger, 2006).

Symonenko identifies the following visual-mental operations: “visual comparison; ability to visually differentiate and integrate structural elements; ability to highlight significant elements of visual structure; establishing of visual analogies; visual regrouping; visual synthesis; visual analysis; the ability to generalize “the vision” of the entire transformed structure at once – a visual generalization; visual abstraction” (Symonenko, 2005).

The *operational mechanism of visual thinking* includes the ability to visually differentiate the elements of the structure, the establishment of visual analogies, visual synthesis, visual analysis, the ability to generalize the “vision” of the entire transformed structure.

This gives reason to talk about the importance of mastering visual-mental operations, that develop visual thinking.

3.2. Ways to use specialized software for the development of visual thinking

To determine the ways in which to use specialized software for the development of visual thinking of young people we took into account the opinion of O. Ivanyuta, who states that "one of the defining characteristics of developed visual thinking is the ability to create new images and operate them, which is realized in the production of visual hypothesis, based on given stimulus material. The solution to the problem in images is carried out mainly based on visual material" (Ivanyuta, 2003). Therefore, below we will focus on possible ways in which to use specialized software for the development of visual thinking.

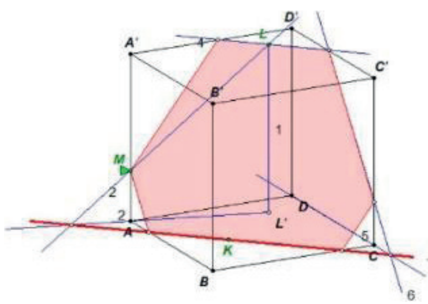
3.2.1. Organization of visual search through tasks visualized in a virtual environment

By the visualized problem we mean a problem "in which the image is explicitly or implicitly involved in the condition/answer, sets the method of solving the problem, creates resistance to each stage of solving the problem or explicitly, or implicitly accompanies at certain stages of its solution" (Knyazeva, 2003).

The use of visualized tasks allows us to quickly learn certain fragments of the theory, to formulate and disseminate a generalized algorithm of practical actions, to focus on the key points of the problem-solving process. Note that visualized problems are a tool for implementing a cognitive-visual approach to teaching mathematics and are a means of developing visual search skills.

The use of visualized tasks and mastery of visual search affects, in particular, at the development of strategic and semantic flexibility of visual thinking.

For example, when constructing sections of polyhedral passing through given points, in the program *The Geometer's SketchPad* it is possible to construct a section and to investigate the form of a section depending on an arrangement of the setpoints and conditions under which the section, in general, cannot be constructed (Figure 1).



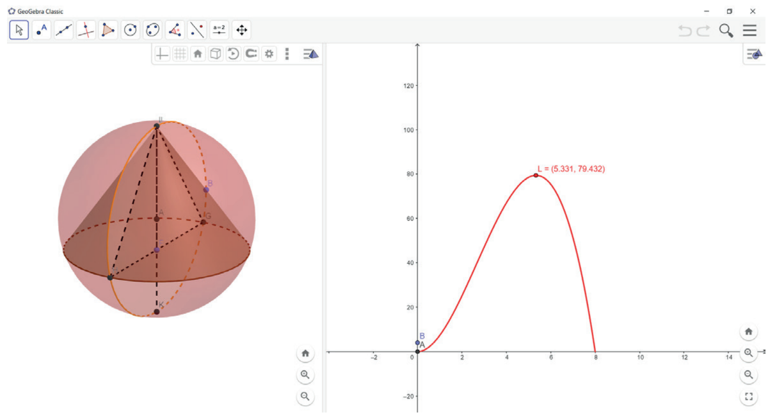
F i g u r e 1. Building a section of a cube in the program The Geometer's SketchPad (the section is a hexagon)

S o u r c e: http://aleshko.ucoz.kz/load/interaktivnye_stereochertezhi_v_srede_quotzhivaja_matematikaquot/24-1-2.

Programs of dynamic mathematics are suitable for organizing a visual search. This is emphasized by the authors of the article Semenikhnina (Semenikhina, 2019) and Proshkin (Astafieva, Bodnenko, Proshkin, 2019).

3.2.2. The use of tasks aimed at developing the ability to make a visual hypothesis

Visual productivity or the activity of making visual hypotheses is associated with the search for new methods of solving problems. For example, the use of a constructive method for solving geometric problems to the extremum (Figure 2).

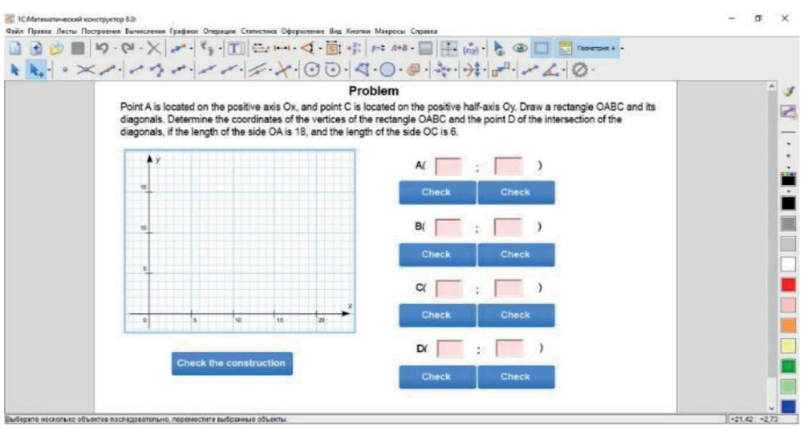


F i g u r e 2. A constructive method for solving geometric problems to the extremum

S o u r c e: Own work.

3.2.3. The use of tasks aimed at identifying visual originality in their solution

Visual originality is shown, in particular, at the use of non-standard computer tools at the solving of problems (for example, use of parametric color at the solving of a problem on GMT), in non-standard applications of computer visualization in the educational process (for example, as a means of visualized control of knowledge, shown in Figure 3), as a means of visual repetition of theoretical material, as visualized tips for solving problems).



F i g u r e 3. Tasks for visualized control of knowledge

S o u r c e: Own work.

3.2.4. The use of cognitive-visual graphics

Educational visualization is used not only for illustration but also as an independent source of knowledge. Therefore, it is often realized through infographics – cognitive-visual models of presentation of educational material in the form of images, that "explain". The infographic is based on the theory of the "consolidation" of educational information (Klepko, 1998).

The use of cognitive-visual graphics affects the development of the constructive activity of visual thinking, resulting in the formation of skills of the selection of educational content, skills of processing, integration, and generation of educational information with a demonstration of deep connections between objects; the ability to systematize and analyze information; the ability to present a compact material with a focus on key information; visual translation skills; and programming skills.

An example of cognitive-visual graphics is given in Figure 4. The creation of such models is possible in a package of office programs (Smart-objective), in programs for the construction of smart card (X-Mind, Free-Mind, Mind-Meister, Spiderscribe, Mindomo, Mindmap, etc), graphic editors (Adobe Photoshop, Paint.NET, Photoscape, Photo Instrument, Movavi Photo Editor, The GIMP, etc).

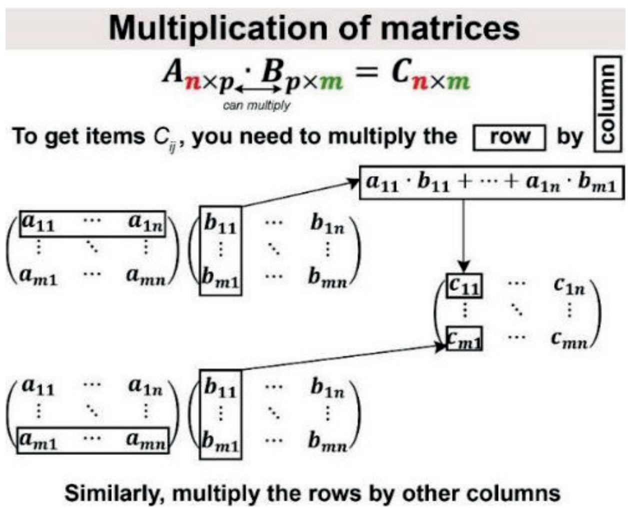
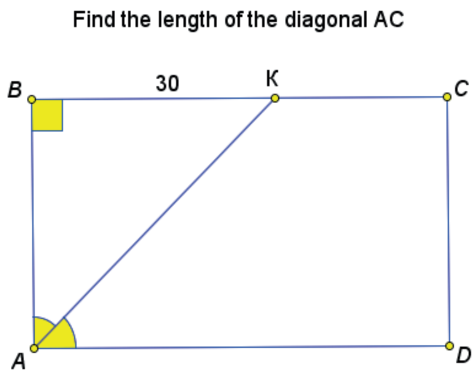


Figure 4. Cognitive-visual graphics "Matrix Multiplication"

Source: Own work.

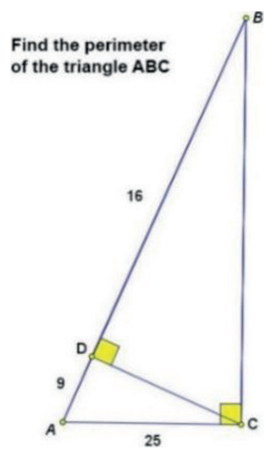
3.2.5. Use of tasks with incomplete conditions and tasks with redundant data

In problems with incomplete conditions (Figure 5) some data are missing, so it is impossible to give an accurate answer to the problem (Krutetskyi, 1968). But if you enter the required data, the exact answer can be found. When solving this type of task, you need to "grab" the formal structure of the problem condition and identify incomplete data. Additional quantitative or qualitative characteristics, that are irrelevant, incorrect, or that in some ways mask the data needed to solve are presented in problems with redundant data (Figure 6). When solving, it is necessary to select from the set of given quantities exactly those that constitute the essence of the problem and are necessary and sufficient for its solution. It also needs to be explained why the rest of the data is redundant.



F i g u r e 5. Problem with incomplete condition
S o u r c e: Own work.

Solving this type of problem contributes to the formation of skills to compare and visually determine the inconsistency of given conditions, the ability to adjust the input data to quickly solve the problem, and the ability to see different options for solving problems with different input data, etc.

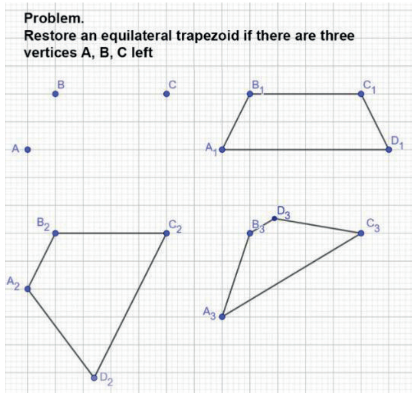


F i g u r e 6. Problem with redundant data
S o u r c e: Own work.

Visual support of such tasks if possible in programs of dynamic mathematics.

3.2.6. Using inverse tasks

We will call inverse tasks for which one of the first two elements of a chain "initial data – a method of the decision – result" is passed, that is the known method of the decision and result, but it is necessary to establish initial data (Figure 7).



F i g u r e 7. The problem of restoring the original conditions

S o u r c e: Own work.

The process of solving inverse problems consists of three stages: research (one needs to find out whether it is possible for those elements that are left, to restore the elements that are missing, or they are clearly defined), construction, proof (one needs to prove that by these constructions received exactly the right shape).

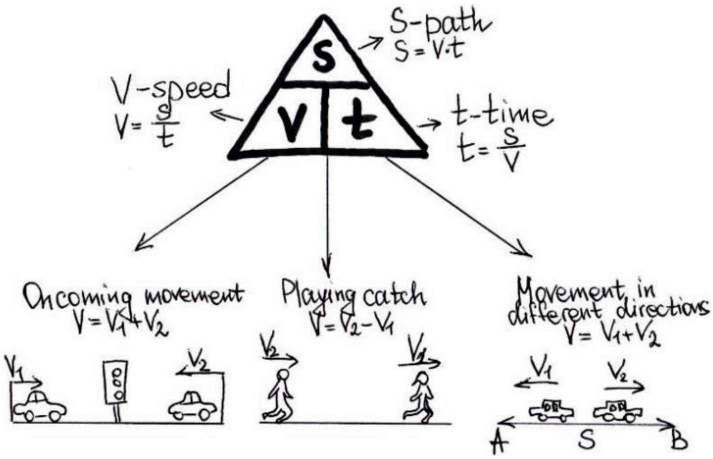
Solving such tasks not only activates educational and cognitive activities but also promotes the development of thinking flexibility, originality of thinking, develops intelligence, the ability to predict, and teaches ways in which to check results. Visual support of such tasks is possible in programs of dynamic mathematics.

3.2.7. The use of scribes

In a general sense, scribing (from the Eng. "scribe" meaning "drive a pen") – is a technology of presenting information, the essence of which is the simultaneous accompaniment of oral presentation of educational material with drawings (felt-tip pen on a whiteboard or a sheet of paper). Scribing involves a specific type of such accompaniment – illustration "on the fly", which gives a special emotionality and the ability to focus the listener on the main semantic objects. Many programs (VideoScribe, Moovly, Plotagon, Obyasnyashki) and online services (PowToon, GoAnimate, Wideo) have been developed today to create scribing presentations.

As a result of the use of scribing technology, the skills of visual interpretation, visual comparison, integration, evaluation, creation, and application of educational material presented visually are formed; the skills of visual communication, skills of transmission, perception, and understanding of education content using scribe technology are formed (Figure 8).

Thus, we have identified seven different ways to use specialized software to develop visual thinking: 1) organization of visual search through tasks visualized in the virtual environment; 2) use of tasks aimed at developing the ability to put forward visual hypotheses; 3) use of tasks aimed at identifying visual originality in solving them; 4) usage of cognitive-visual graphics; 5) use of tasks with incomplete conditions and tasks with redundant data; 6) usage of inverse tasks; and 7) use of scribing. These ways were subjected to expert evaluation in order to determine the most effective of them.



F i g u r e 8. Scribe «Tasks on the move»

S o u r c e: Own work.

3.3. The results of the experiment

According to the results of expert assessment, the two most effective ways of influencing the development of visual thinking were identified: the organization of visual search through the tasks visualized in the virtual environment, and the use of cognitive-visual graphics.

This is confirmed by the results of statistical evaluation based on Kendal's concordance coefficient (Table 1).

T a b l e 1

Expert ratings

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Total rating
Way 1	1	3	2	1	1	2	**10**
Way 2	3	4	4	4	6	4	25
Way 3	5	5	6	7	7	7	37
Way 4	2	1	3	3	2	1	**12**
Way 5	7	7	5	6	5	6	36
Way 6	4	6	7	5	4	5	31
Way 7	6	2	1	2	3	3	17

S o u r c e: Own work.

The concordance coefficient was estimated at 0.75, which indicates the consistency of experts' opinions. The statistical analysis of the obtained data also confirms a statistically significant conclusion about the consistency of expert opinion $\chi^2_{emp} = 26.86 > 11.07 = \chi^2_{critical}$.

Thus, the pedagogical experiment was built using two ways: 1) the organization of visual search through the tasks visualized in the virtual environment; and 2) the use of cognitive-visual graphics.

The experimental training took place during September–November 2019 among 3rd- and 4th-year students, as well as high school students. The training of 104 students in total took place within the special courses “The use of computer in the study of mathematics” and “Computer-oriented systems of teaching mathematics and computer science”. The training of 98 high school took place within the extracurricular activities conducted by undergraduate students during internship. The result of Raven’s test at the beginning and end of the experiment are presented in Table 2.

Table 2

The results of diagnostic sections in the experimental groups at the beginning and end of the experiment (in %)

	Students, before	Students, after	Pupils, before	Pupils, after
Total number	104	104	98	98
Low (71–90)	16	7	42	29
Medium (91–110)	71	76	49	48
High (111–130)	17	21	7	21
Average	100.9	103.2	93.9	98.6

Source: Own work.

Table 3

Statistical evaluation of average at the beginning and end of the experiment

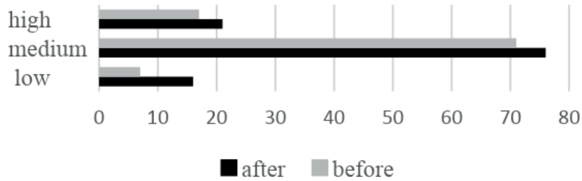
Students	Before	After	Pupils	Before	After
Average	100.9	103.2	Average	93.9	98.6
Number	104	104	Number	98	98
Hypothesis H_0:			Hypothesis H_0:		
Averages the same	0.0		Averages the same	0.0	
t-empirical	–3.75		t-empirical	–5.85	
t critical	1.98		t critical	1.98	

Source: Own work.

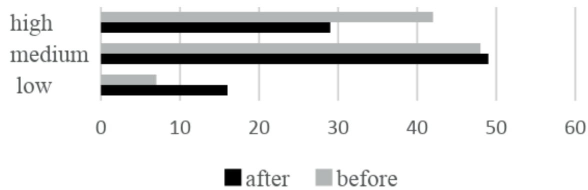
The statistical analysis of averages in groups of students and pupils by Student’s t-test gives grounds to reject the null hypothesis and to accept an alternative statistical difference between the averages at the beginning and end of the experiment (calculations were performed using the tools of the analysis package of MS Excel at the significance level of 0.05).

At the same time, the analysis of the dynamics of averages (+2.3 in students against +4.7 in pupils) shows better results of changes for pupils, which is explained by more flexible cognitive skills in adolescence (see Figure 9, 10).

At the beginning of the experiment, the indicators for a group of students is mainly at high and medium levels. We explain this by high initial values, as the same consisted of students majoring in “Secondary Education (Mathematics)” and “Secondary Education (Computer Science)” in which the level of development of visual thinking, spatial thinking, logical thinking is a priori above average.



F i g u r e 9. Diagrams of levels of development of visual thinking of students
S o u r c e: Own work.



F i g u r e 10. Diagrams of levels of development of visual thinking of pupils
S o u r c e: Own work.

Note, that despite the not very high dynamics of changes, we show that the researchers with high performance at the end of the experiment offer original hypotheses about non-traditional ways of using cognitive-visual models in the educational process.

CONCLUSION

Among the possible ways to use specialized software for the development of visual thinking are the organization of visual search through tasks visualized in a virtual environment; use of tasks aimed at developing the ability to put forward visual hypotheses; use of tasks aimed at identifying visual originality in solving them; use of cognitive-visual graphics; use of tasks with incomplete conditions and tasks with redundant data; and use of inverse tasks.
For the realization of the specified ways, it is expedient to use the specialized software, namely programs of dynamic mathematics, Smart-objects from a package of office programs, means of creation of infographics, graphic editors.
Expert assessment of these ways and the statistical analysis of the results of the pedagogical experiment confirmed the feasibility of the development of visual thinking in young people; the organization of visual search through visualized tasks in the virtual environment and the use of cognitive-visual graphics, and better dynamics were observed in pupils (+2.3 in students against +4.7 in pupils), which indicates the feasibility of using these ways in general secondary education.

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CLOUD TECHNOLOGIES FOR TRAINING UNIVERSITY STUDENTS OF SOCIO-HUMANITARIAN SPECIALTIES AND PUBLIC ADMINISTRATION

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Abstract: *The article discusses the current state of cloud technologies and examines their in training students on socio-humanitarian and public administration courses. The research deals with the essence, features and functions of «cloud», «cloud computing» and «cloud technologies». It outlines the structure of university cloud-oriented educational environment by defining its components, subjects and objects of architecture. Discussed are the specificity and ways in which to employ cloud technologies to improve the efficiency of training students on socio-humanitarian specialties and public administration. Relying on the analysis of their sociological research and secondary data, the present authors outline the most popular cloud services used in times of forced transition to distance learning mode. The article analyses the existing software products based on the cloud computing system, as well as the advantages and affordances of each of them when applied in the training of students of socio-humanitarian specialties and public administration at universities. The research pinpoints the challenges in university functioning which can be quickly overcome by virtue of cloud technologies.*

Keywords: cloud technologies, online services, teaching, distance learning, university, sociology, public administration.

INTRODUCTION

2020 will go down in world history as a year dividing the lives of modern humanity into *before* and *after* the global pandemic, which has significantly changed all aspects of public life. In terms of education, this year saw professors and students fully, or even exclusively using information and communication technologies in organising and managing all classes remotely. In contrast to recent years, when a large number of teachers and students used the Internet only to find the necessary information to prepare for classes, the Internet has currently become a full-fledged communication tool. Distance learning systems in Ukrainian universities until 2020 were more an exception rather than the rule, because this form of education required full licensing and accreditation, and most universities focused more on traditional presence classes. But under the conditions of quarantine restrictions, the situation changed dramatically: some universities developed their own systems of remote data exchange between professors and students, while others have been using the specialised services of the world's leading IT companies, in particular Google and Microsoft, namely cloud technologies.

1. PREVIOUS RESEARCH ON THE USE OF CLOUD TECHNOLOGY IN THE EDUCATIONAL PROCESS AT UNIVERSITY

While characterising modern Ukrainian scientific discourse on the use of cloud technologies in the educational process, its fragmentary nature and certain one-sidedness should be noted, as most scientists focus on general issues of ICT implementation and distance learning at universities: there are only a few works on the use of cloud services at universities. Thus, Morze and Kuzminska (2011) singled out the pedagogical aspects of cloud computing in the functioning of universities; Husiev and Usherenko (2016) considered the aspect of managing the formation of competencies of higher education seekers through the use of cloud services, Shelestova (2018) explored online services as promising and alternative means of teaching students in Ukrainian universities. The authors of this article published a series of papers on various aspects of optimising the educational process in higher education based on the introduction of modern ICT and cloud technologies, namely social networks, the use of media, thematic websites, e-books, official websites of universities, electronic literature repositories, information portals, personal pages of teachers (Shelomovska et al., 2019; Shelomovska et al., 2018; Shelomovska et al., 2017; Shelomovska, Sorokina, & Romaniukha, 2017; Shelomovska, Sorokina, Romaniukha, & Bohomaz, 2017). However, these works do not reveal all the extremely diverse educational potential of cloud technologies. The scientific discourse lacks publications discussing opportunities of cloud technology in the training of students on socio-behavioral courses and public administration course at universities, hence the choice of topic for the present study.

1.1. Research Methodology

The present research was possible with a number of methods. The method of theoretical literature review was employed with an objective to study the general trends in the use of cloud tools in education, their essence, structure and functions.

In order to study the experience of students and professors using cloud tools in education there was designed an anonymous questionnaire, which was carried out remotely via e-mail and messengers. The purpose of the study was to identify the scope of use of cloud tools by professors and students of socio-humanitarian specialties and public administration in conditions of forced transition to distance learning mode. The collection of primary sociological information among professors and students of DSTU coincided with the start of the global Covid-19 pandemic in April 2020. The main stages of the study included: the development of the questionnaire and accompanying tools, questioning, quality control of the work performed, input and verification of data for logical errors, and preparation of the final data set.

Elements of qualitative and quantitative methods of data processing were employed to discuss the results of sociological survey and deliver conclusions.

2. PRESENTATION OF RESEARCH RESULTS

Surprisingly, cloud technologies were known to the academic community, but it is only recently that they gained such popularity. Now in a global pandemic came the paradigm of so-called *cloud thinking*. Experts say that over the next few years, about 80% of all organisations and businesses will totally depend on cloud computing.

In modern scientific discourse, the term *cloud is understood* as the latest innovative way of organising information and telecommunications infrastructure, which consists in the deployment of hardware and software on remote (cloud) providers' sites. In fact, the cloud is one huge virtual server. In turn, *cloud (scattered) computing* or cloud, scattered data processing is a way of processing data in which computer resources and capacity are provided to the user as an Internet service (Rudenko, 2015; Nazarenko, 2016). Pihariev, Lozhkovskyi, & Mamatova (2017) expressed the view that these are service models that provide consumers with universal and convenient network access to a common pool of computing resources, e.g. data networks, servers, repositories, applications, services, etc., which are configured and form a *cloud*. *The key function of cloud tools* is to provide users with remote data processing. Cloud technology involves a computer / web application hosted on remote servers through a user-friendly interface or application format. Cloud technologies in education *allow communication between an unlimited number of professors and students through messenger and e-mail; teamwork collaboration* to achieve common educational goals as well as the creation and maintenance of personal and shared file repositories; *cooperation* via collaboration, interconnectedness through their activities (Odainyk, 2016; Zhornytska & Ivasiuk, 2017).

Based on this, *three components* of the cloud-based learning environment can be identified: spatial-semantic, content-methodological and communication-organisational. *The subjects of the cloud-based learning environment* are professors, students, university management and administrators. Importantly, cloud technologies allow carrying out both individual educational activities on subjects, and group ones in teacher↔student format, which is the one-on-one mode of work, as well as in the teachers↔ students format based on group interaction.

The objects of architecture behind cloud-based learning environment include: e-mail, planning system, e-notebook, address book, calendar, structured repository of teaching materials available to all users, online surveys and testing, software, website designer, video conferencing system, user management system and corporate network (Makarenko, 2015). In his professional activity, the teacher can use any of the types depending on the purpose of the service, and combining them into a single system allows you to build a *cloud over the university* that can replace the local network without the need for a server. *Cloud resources allow* storing educational information in a shared information environment of the educational community.

Morze and Kuzminska (2011) state that the use of cloud computing at universities makes sense for all the staff, in particular professors and students can benefit from the cloud's personal set of software depending on specialization, course, etc., it allows keeping personal data of significant volume. At the same time, cloud computing provides personal environment for the students throughout the study period, with access to it from anywhere at any time, allows mobility and session saving functionalities, as well as automatic distribution of software packages, according to curricula, scientific needs etc.

Significant *advantages of cloud computing* which indicate the possibility and necessity of their use in the training of students of socio-behavioral specialties and public administration at universities are the following:

1. Accessibility and mobility – clouds are available to everyone from any location where there is an Internet connection, from any device with a browser. The comfort and convenience of using cloud computing is provided by the appropriate customization or individualization and versatility of the connected devices. Given this, the teacher with the help of cloud technology can not only use traditional forms and teaching methods, but also create conditions for learning everywhere. Generally speaking, the interface is quite intelligible.

2. Economy – since cloud technologies do not require additional software and most of them are absolutely free, as they do not involve the university's financial costs necessary to develop custom-made software and hire a local IT-technician.

3. High manufacturability and flexibility. The user has a large computing power to use for storage, analysis and data processing. Unlimited computing resources, e.g. disk space, memory, processing power, are achieved through the use of virtualisation systems (Hladkova, 2017). All the necessary resources are supplied by the provider automatically, and all information in the cloud storage is always kept up to date.

4. Reliability. According to many experts, the reliability provided by modern cloud computing is much higher than the reliability of local resources, as only few universities are capable of acquiring and incorporating a full-fledged data center.

Cloud services provide the following *opportunities for the training of specialists in socio-humanitarian specialties and public administration*:

1. A platform for cooperation and a forum for the exchange of ideas, as they enable multiple users to work simultaneously, create group projects and optimize plans for cooperation of participants in the educational process. It develops students‘ critical thinking, promotes deeper study and awareness of educational material.

2. Keeping unlimited amount of educational information without external storage. The teacher gives all students access to the necessary study material. Discussion of materials and media reports helps not only to increase students' interest and motivation in learning, but also to keep abreast of current events in various spheres of public life, accumulate social and political material, get acquainted with innovations and form their own worldview and identity (Shelomovska, Sorokina, Romaniukha, Sorokina, & Machulina, 2019).

3. Expanding the content of educational material, which is extremely needed for sociologists, political scientists, public administration, whose work depends on their ability to navigate the surrounding events and provide a reasoned opinion. Cloud tools help the teacher to create and upload teaching materials in a variety of formats.

4. Fast updatability. Cloud technologies allow the professor to make adjustments to the material and take into account students' work, such as their presentations, audio and video in teaching future students of the same course. They can increase the quality of training due to dynamic update of curricula and allow joint access to educational materials.

5. The openness of educational environment and student-centered approach. Students see each other's work, comments and instructions of teachers, take into account their own and potential comments in their work. Consequently, student group work becomes more informed, and the teacher interactively manages the activities, leaving comments and showing students control points.

The quality of learning with cloud technologies increases due to the faster adaptation of students to the educational material, strong account of their capabilities and abilities, selection of a more appropriate method of mastering the subject; regulation of training intensity at different stages of the educational process; self-control, and figurative visual form of presentation of the studied material.

Among *the disadvantages* of using cloud technologies in the educational process one can often hear technical issues: the need for permanent Internet connection, the dependence of the educational process on the quality of the Internet channel (Shelestova, 2018), the inability to maintain intermediate stages of information processing, and security issues, such as the risk of transferring control over intellectual property products to third-party providers and servers, the vulnerability of clouds in terms of information security and the inability to transfer all data to the cloud environment due to a limited set of tools, as well as the emergence of huge amounts of uncontrolled information. Also, Viter and Zasadna (2014) assume that in the long run, the cloud model may become more expensive than hosting a local server.

The greatest success of applying cloud tools in Ukraine so far is the creation of *Unified state electronic database on education at the governmental level which is working on hybrid cloud technology*, encompassing *public cloud*, where the provider offers relevant IT resources for wide Internet audience and *community cloud*, shared by several universities with related computing resources and tasks. The Unified State Electronic Database on Education (USEDE) is an automated system for collecting, processing, storing and protecting information on students and subjects of educational activity. Its main purpose is to provide public authorities, local administration, individuals and legal entities with information in the field of education on educational institutions, documents on education and scientific degrees, the results of external independent evaluation, the course of the admission campaign to educational institutions, student ID sample, other information in the field of education (Pro YeDEBO). According to a survey among students and academic staff conducted by the State Education Quality Service of Ukraine in April–May 2020 universities demonstrate quite a systematic use of distance learning technologies. Thus, academic staff shows a fairly high degree of readiness for new working conditions, particularly among professors of the humanities (15%), pedagogy (11.5%), management and administration (10%), information technology (8%), social and behavioral sciences (6.5%) and law (6%) (Informatsiino-analitychna dovidka, 2020).

The survey on the share of respondents using distance learning technologies to provide feedback, transfer or obtain information found that asynchronous learning tools dominate in distance learning for students, namely, messengers: Viber, Messenger, Telegram, WhatsApp with a share of 69.7 %. At the same time, most teachers – 69.4% – showed that they manage distance learning and communicate with students through virtual educational environments like Moodle, Google Classroom, etc., and use messengers a little less – 67.7%. The share of students who were trained through virtual educational environments during quarantine was 56.6%. Among teachers, the third place in the use of ICT in the educational process during the pandemic was taken by communication technologies – Zoom, Skype, Meet, Hangouts – with a share of 59.5%, and among students they were used by only 43%. E-mail was used by every second respondent in both categories, and e-cabinets on the websites of institutions – every fifth respondent in both groups.

Only 48.3% of the surveyed professors assessed their experience with *virtual educational environments* as positive. At the same time, 80% believe that this distance learning technology is the most effective in organising remote education. However, among the respondents who have positive experience of working with virtual educational environments, one in four does not use them to develop their own educational content and only one in three provides advisory guidelines for laboratory, practical, seminar classes with their use. Simultaneously, when trying to determine the ranking of distance technology tools by efficiency, virtual educational environments are found the most effective – 70.1%of professors and 50.1% of students believe so. The effectiveness of video communication is stressed by 69.7% of professors and 46.8% of students; messengers – 41.3% of professors and 51.5% of students; e-mail – 33.4% of professors and 30.7% of students. Messengers remain the most effective distance learning tools for students.

The present authors believe that modern universities should rely on specific cloud technologies in the training of students of socio-humanitarian specialties and public administration, especially in periods of restrictions: web-applications, e-journals, online services for learning, tools for live communication, testing, distance learning systems, libraries, media collections, file repositories, shared access, collaboration resources, video conferencing tools, Google Apps and Microsoft cloud platforms, cloud file repositories, e.g. Dropbox, SkyDrive, GoogleDocs, etc.

Currently, in the Ukrainian segment of Internet there is a strong preference among educators and public administration students towards cloud computing services by Microsoft and Google, available in the public domain. In education, Google provides *Google Apps for Education* cloud applications for distance learning, and *Google Apps for Government* for public administration. Microsoft corporation offers to educational institutions cloud options of the package *Office 365 for education* (Windows Azure in education). Generally speaking, the educational services available today within the cloud can be divided into *three broad categories*: storage, data processing, and collaboration.

To study the aspects of use of cloud tools in the educational process in Dniprovsky State Technical University (DSTU) there was conducted a sociological survey involving 250 full-time students (80.2% undergraduate and 19.8% master students). Random sampling by the method of simple probabilistic selection, representative by the course of study and the educational program was used. The survey addressed 75 research and teaching staff as well. Random sampling by the method of simple probabilistic selection, representative by sex, age and profession was used.

Table 1.

The experience of students and professors of DSTU using cloud services in education, in %. According to the authors' sociological survey

Cloud services	Professors		Students	
	Familiar	Used	Familiar	Used
Google translate	93.4	78.9	92.3	84.9
E-mail	91.5	72.1	89.1	61.4
Google Disc (Drive)	81.2	47.8	59.4	32.1
Videoconferences (ZOOM, Skype, Google Talk)	75.4	57.2	83.4	52.4
Google Docs	75,1	52.3	48.3	24.8
Google Classroom	72.1	43.5	51.2	38.4
Google Forms	71.3	42.1	65.8	17.3
Cloud technologies for testing	68.2	51.3	72.4	35.3
Google Presentations	64.2	46.3	35.1	12.3
Google Tables	52.8	25.4	27.4	5.1
Cloud data storages Dropbox, SkyDrive	52.1	15.8	67.2	34.2
Google Calendar	42.1	14.3	42.6	7.8
Office 365 for education/ Windows Azure in education	36.5	4.5	25.8	12.3
Google Groups	34.5	15.7	24.3	2.6
Microsoft Live@Edu	31.2	5.7	11.4	0.5
Google Hangouts	27.0	5.2	14.5	1.2
Google Keep	8.1	1.8	5.2	–

Source: own work.

Table 1 represents the trends in the use of cloud tools. When it comes to implementing a number of educational tasks the largest proportion of students use such cloud services as e-mail and online translator. More than half of both professors and students employ cloud tools for collaboration, such as ZOOM, Skype, Google Talk. In contrast to that, when it comes to tools for knowledge management and assessment, for instance, such group of tools as Google Docs, Google Classroom and Google Forms, professors demonstrate stronger awareness of the environments than students, who were evidently receiving the tasks from professors in these formats. Interestingly, the survey revealed poor use of such time-management tool as Google Calendar by both professors and students.

Importantly, it is not only professors and full-time students who enjoyed the efficiency of cloud tools, but also part-time students. For them, cloud services can almost completely solve the problem of interaction with professors and access to learning environment in-between sessions.

Microsoft Office 365 allows users to stay in touch with other people via instant messaging and video chat; store documents in the cloud and share them with other users via OneDrive; hold multi-user meetings through conferencing which includes enhanced sharing, notetaking and commenting. Microsoft Office Web Apps offers advantages of existing Microsoft Office functions through a web browser. *Office 365 Education* is a set of services that allow one to collaborate on teaching materials. The product contains: Office Online, Word, PowerPoint, Excel and OneNote, 1D OneDrive storage, Yammer and SharePoint sites, as well as e-mail, calendar, web conferencing; virtual board; designer of creating and maintaining websites, schedule of classes and activities, allows video files, online meetings, joint processing of documents, creating, editing, storing teaching materials and their use. For high school distance learning, Microsoft proposes to optimize distance learning with *Microsoft Teams*, which provides an online classroom with virtual one-on-one communication, tasks, files, and conversations as a single solution available on many devices (Perekhid na dystantsiine navchannia).

Google Apps come with a free basic and a professional package. For educational purposes, there is Google Apps Education Edition – a free package for schools which includes all the features of the professional package. Google Apps Education Edition – Web-application based on cloud computing, providing students and teachers with tools necessary for effective communication and collaboration. *Google programs for education* are free, and for educational institutions with 24/7 support free of charge. The service allows you to create and share files in real time, automatically store information in the cloud, access it from any device. The service includes: Gmail e-mail; *Google Calendar* web conferences; virtual board; website builder and supporter. The service provides an opportunity to create, edit documents *on Google Drive*, where one has space for creating, editing and storing files and set access rights to them. Since 2012, GoogleDrive allows users to store data in the cloud, synchronize files across multiple devices and share files. GoogleDrive includes the Google Docs office suite, Google Spreadsheets, and Presentations, as well as document editing, spreadsheets, presentations, drawings, and forms. *Google Docs* is an online office for creating and storing text documents, spreadsheets, PDFs, and presentations, as well as collaborating on them. At each stage of designing assessment surveys or independent work of students one can use a special form within *Google Forms* which also allows you to create sociological questionnaires and get results in graphic mode. *Google Talk* enables professors to organise online-consultations with students, both in writing and as a video conference. *Google Calendar* is a web tool for managing and planning the educational process, lets set tasks for a thesis project, offers to share calendars to create and view schedules of classes and consultations. *Google Hangouts* software is used for instant messaging and video conferencing. Chat histories are stored on Google servers, allowing you to sync them on a number of devices. Photos that participants share during the conference are automatically uploaded to private Google+ albums (*Google products for Education*).

Google Classroom environment enables professors to easily provide information to students: texts and/or presentations of lectures, literature for self-study, assignments for independent work, thematic online discussions, grades and announcements. One of the benefits of Google Class is its integration with other Google services. Thus, the teacher can upload information to Google Class in almost any format: text, PowerPoint presentations, images, videos, audio and other kinds. Naturally, these features of the Google Class will contribute to effective learning only if the teacher has a well-designed course, as well as texts and/or presentations of lectures, and a set of practical tasks that contribute to the assimilation of theoretical material. Tasks and work performed by students are stored, organised as structured folders and documents on Google Drive.

It can be argued that the GoogleApps cloud services in distance learning will be best used to organise the practical work of students of socio-behavioral specialties, including sociologists when planning and conducting their own sociological research. According to the educational program for bachelors and masters in Sociology in most free educational institutions of Ukraine during their studies at the university, applicants must develop such competencies as the ability to use modern software and computer technology for processing sociological data; the ability to analyse data for the preparation of analytical decisions, expert opinions and recommendations; the ability to use basic theoretical knowledge, practical skills and abilities to participate in scientific and applied research, analytical and consulting activities; ability to analyse, present and interpret numerical and non-numerical social data. Google‘s cloud services can be used to form specific skills:

- planning and conducting surveys using Google Drive, Calendar, Group, Email, Google Hangouts, Google Keep, Google Talk. At this stage, it is also worth using online services, social networks, thematic forums, scientific communities and electronic libraries to identify research issues, determine their relevance and conduct pilot activities;
- gathering information – Google Drive, Forms and Email, Google Groups, Google Hangouts;
- analysing and processing of the necessary information – Forms and Google Drive, Google Keep;
- presenting information as text, presentations, electronic tables, etc. – Google Presentations, Google Spreadsheets, Google Docs, Google Talk.

Public administration students found cloud technologies more convenient and motivating for study, especially in a global pandemic. This doesn’t come as a surprise, since distance learning relying on various cloud services increases the share of independent involvement with the material and this in turn gradually ensures the development of such qualities as independence, responsibility, organisation and the ability to realistically assess one's strengths and make informed decisions, which is very important for a successful career as a public servant. In particular, in the training of public servants at the Dnipropetrovsk Regional Institute of Public Administration of the National Academy of Public Administration under the President of Ukraine web-applications from Google Apps are widely used as communication and educational technologies. The convenience and efficiency of using Google Apps tools was appreciated not only by teachers of the academy and full-time students, but also by those who study by correspondence. Google Apps allows part-time students to solve the problem of interaction with the teaching staff and learning environment almost completely. A flexible system of knowledge assessment in combination with individual and group work formats and tests enables students to acquire any amount of knowledge. The distance education of public servants, enhanced by cloud technologies, allows professors to implement all tasks and improve practical skills related to work processes, while simultaneously reducing the costs.

CONCLUSION

Cloud technologies should become the key element of the educational process, especially in a global pandemic, which challenges the work of universities in the coming years. They help create shared communication environment, new forms of work in the classroom, free exchange of documents for classes, general contextual environment for creative tasks. Cloud technologies should be especially useful for professors when teaching students of socio-behavioral specialties and public administration with whom communication should not be limited to asynchronous tools such as e-mail and messengers, but must contain the tools to develop in them the skills of expressing their own opinion, analyzing the surrounding socio-political situation, reflecting on all latent phenomena. It is also necessary to engage students in extra work in order to expand their knowledge by providing them with access to educational materials that are allocated to independent work. The latter requires from students a great deal of self-discipline, since in most cases, the material submitted to students for self-study is neglected. Cloud technologies can fix this situation via the tools that manage and motivate independent student activity.

The use of cloud technologies in the training of students of socio-behavioral specialties and public administration, on the one hand, requires from professors of humanities cutting-edge ICT-skills, and on the other – promotes the solutions to one of the most pressing tasks of the country and society – digitalization and informatization of all spheres of public life, which can only be achieved by improving the ICT competence of both students and professors.

With cloud technologies it is possible to organise the process of interactive online communication between teachers and students, and is indispensable for distance education during global quarantine restrictions. However, even after their relaxing, cloud technologies should be incorporated in the universities' activities to prepare students of socio-behavioral specialties and public administration as a supplement to the classic forms of full-time education. However, cloud technology will never replace the process of direct *live* communication between professors and students, because it is here that you can move away from one-size-fits-all approach.

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DISTANCE LEARNING: ON THE WAY TO DEVELOPING A NEW DIDACTIC MODEL OF UNIVERSITY EDUCATION

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Abstract: *The article considers the problem of developing a modern didactic model of university education, which is competency-oriented, designed for a reasonable combination of pedagogical management with its own initiative, independence, and activity of students. It is noted that a significant role in this belongs to distance learning resources. It is proved that when developing a modern didactic model of professional training, the following should be taken into account: distance learning allows creating the same conditions for all students; it is necessary to constantly increase lecturers' digital competence as a basis for the introduction of distance learning; electronic systems for monitoring and measuring the effectiveness of training, etc need to be improved. It is proved that the most optimal format for the organization of the educational process in higher school is a harmonious combination of distance and classroom learning.*

Keywords: distance learning; e-learning tools; university education; didactic model; professional training of students.

INTRODUCTION

The quality and efficiency of education have always been the main problem of pedagogical science. It has gained special importance recently, in the conditions of new information and communication reality – the dominance of information and communication technologies. It is with pedagogy that scientists hope to create concepts for combining the humanistic and technological components of the educational process (Bykov, Zhaldak, 2017).

Today, the leading influence in education is actively occupied by distance learning, the use of various educational resources, the creation of a virtual environment of educational and practical activities, etc. Modern learning is becoming more electronic, computer, Internet-dependent, mobile. This expands opportunities for communication, stimulates the development of mobile thinking, personal awareness. Therefore, it becomes obvious and at the same time necessary from the standpoint of the realities of the information society to develop a new didactic model of training specialists in higher education, taking into account the impact on this process of information and communication technologies, distance learning.

In the modern didactic model, the essence of learning is not reduced to the transfer of ready-made knowledge, it is competency-oriented, and designed for a reasonable combination of pedagogical management and students' own initiative, independence, and activity. A significant role in this didactic model belongs to distance learning resources, which helps deliver information in an interactive mode through the use of Information and Communication Technologies (ICT) from those who teach (lecturers) to those who study (students).

Given the above, the modern didactic model of university education as a certain system must have certain features:

- be based on the following conceptual methodological approaches: personal, axiological activity, competence, communication, interactive, information technology, which allows individuals to self-realize in their own development and profession on the basis of common human values and culture;
- create of various technological spheres of professional and personal development of personality: intellectual-cognitive, communicative-behavioral, emotional-value, digital, reflexive-evaluative;
- provide learners with systematic and at the same time operational knowledge, stimulating cognitive interest and motivation of students to search in the information space for new information and the ability to self-development;
- combine cognitive and practical strategies in the process of professional training of future specialists due to the creation of virtual environments of educational and practical activities; use of electronic simulators; computer simulation tools, etc.;
- build an information and educational environment that allows future professionals to be formed in the conditions of redundancy of options for solving personal and professional problems and more.

1. ANALYSIS OF CURRENT RESEARCH

Theoretical and practical aspects of distance learning have been the subject of research by a number of scientists. Thus, Zormanová's comparative study presents a comparison of the main trends, forms, and directions of the development of distance education in European countries (Zormanová, 2016). In research of Zalewska, and Ślósarz revealed the democratic potential of distance learning, it is proved that it, in contrast to the traditional more qualitatively affects the process of professional training of students of generation Z (Zalewska, 2015; Ślósarz, 2019). Fojtík outlined the methodical, partnership, advisory, and mentoring role of the teacher in the organization of distance learning of students (Fojtík, 2018).

Of particular interest to us are those studies that reveal the priority areas of transformation of the higher education system in terms of distance learning. Smyrnova-Trybulska proved that changes in the university information and educational space are caused by the modernization of educational technologies, content, resources based on the strategy of development of the electronic environment of the university (Smyrnova-Trybulska, 2018).

At the same time, the analysis of available scientific sources has shown that modern scientists consider mainly methodical or organizational issues of realization of distance learning of students. Currently, there is a significant need for both lecturers and students to rethink and lead the development of higher education in distant learning.

The purpose of the article is to investigate the attitude of lecturers and students to the use of distance learning and its various resources; assess their satisfaction with the educational process and its effectiveness, which will serve as an analytical basis for further development and implementation of a new didactic model of training specialists in the higher education system.

2. MATERIALS AND METHODS

Achieving the goal of the study contributed to the use of a set of appropriate methods: the analysis of the scientific literature to establish the state of development of the problem implementation of distance learning in higher education, the definition of categorical-conceptual apparatus of research; synthesis, generalization, systematization for theoretical substantiation of the basic tendencies of development and realization of a new didactic model of training specialists in the conditions of intensification of distance learning; empirical: diagnostic (conversation, testing); statistical (Mann-Whitney U-criteria, Fisher‘s test φ^*) for quantitative and qualitative interpretation of the results of the attitude of lecturers and students to the impact of distance learning. To implement the criteria, statistical hypotheses were formulated: null hypothesis H_0: – students and lecturers have the same attitude to research problems; alternative hypothesis H_1: – students and lecturers have different attitudes to research problems. The “presence of effect” position was characterized by those respondents who assessed the distance learning issues positively, i.e. at 5 and 4, and the “lack of effect” was characterized by respondents who rated such issues at 3, 2, and 1.

The experimental base of research – Borys Grinchenko Kyiv University (Ukraine). A total of 53 lecturers and 120 students from various faculties and institutes of the university took part in the study. The survey of lecturers and students was conducted during 06/26 – 07/03/2020.

3. MAIN RESULTS

Given that the question of building a new didactic model of university education that we see in the development of distance learning of students, first of all, it is necessary

to clarify the interpretation of the term "distance education" (Distance education). Modern understanding of the concept of distance education allows its consideration from two main perspectives:
1) purposeful and methodically organized management of educational and cognitive activities of persons at a distance from the educational center, which is held by electronic and traditional means of communication; 2) the process of acquiring knowledge and skills through a specialized educational environment, which is based on the use of IT, which provides the exchange of educational information at a distance and implements a system of support and administration of the educational process (Dictionary, 2019).
We share the scientific position of Bykov that the successful use of digital technologies is the task of education of the 21st century, it is associated with learning, development, building a successful life trajectory. An important area of educational policy today is the process of informatization of education (Bykov, Spirin, Pinchuk, 2019). However, it should be noted that at the beginning of 2020, we all witnessed a certain intensification of distance learning. The forced mass transition to e-learning during the quarantine period has become a kind of global challenge for the entire educational environment, for higher education, in particular.
It is clear that in such a situation it was the lecturer of higher education who was given increased responsibility for the process and results of professional training of students. Therefore, it is important to find out how lecturers evaluate the quality of distance learning for the period of quarantine, as well as to compare their views with the views of students (see Figures 1a, 1b).

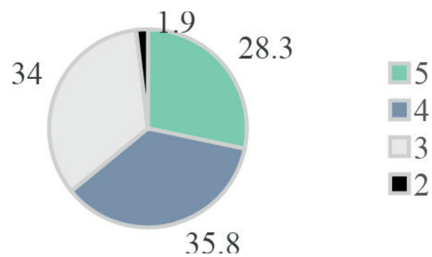


Figure 1a. Lecturers' assessment of the quality of distance learning (%)
Source: Own work.

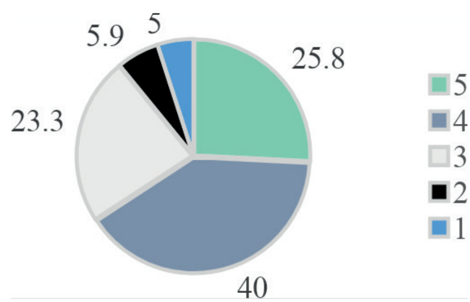


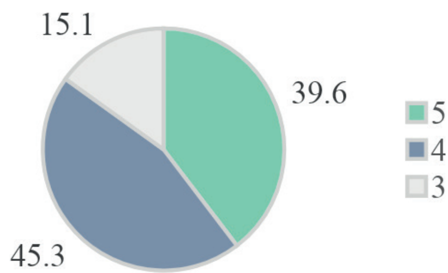
Figure 1b. Students' assessment of the quality of distance learning (%)
Source: Own work.

According to the results of the study, lecturers and students evaluate the quality of distance learning approximately equally, which was confirmed by Fisher's test φ^*. Received, $\varphi^*_{emp} = 0.247$, $\varphi^*_{cr} = \{1.64, p \leq 0{,}05\ 2.31, p \leq 0{,}01$, hence we accept hypothesis H_0. However, every tenth student evaluates the quality of distance learning very negatively (2 and 1 points). Only 1.9% of lecturers rate the quality of distance learning as unacceptably low (2 points).

It is clear that in order to develop and implement a new didactic model of university education, it is necessary to investigate the level of digital competence of lecturers and students as a significant guarantee of distance learning.

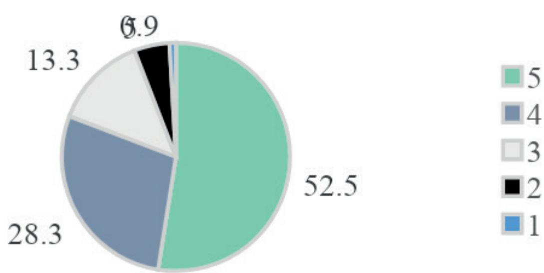
To date, there are a number of approaches to the definition of "digital competence". The approach described by Bykov in the "Dictionary of information and communication technologies in education" is a reference point for us. According to the scientist, digital competence is the ability of an individual to confidently and thoroughly use the means of digital technology in such areas as professional activities and employment, education, leisure, community activities, which are vital for participation in everyday socio-economic life (Dictionary, 2019).

In Figures 2a, 2b presents a self-assessment of the level of formation of the digital competence of lecturers and students.



F i g u r e 2a. Assessment of the level of lecturers' digital competence (%)

S o u r c e: Own work.



F i g u r e 2b. Assessment of the level of students' digital competence (%)

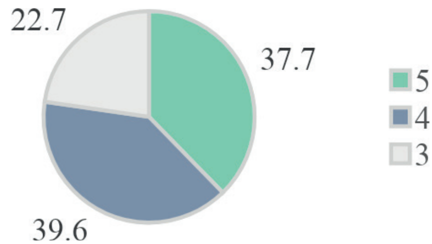
S o u r c e: Own work.

According to Fisher's criterion φ^*, $\varphi^*_{emp} = 0.771$, $\varphi^*_{cr} = \{1.64, p \leq 0{,}05\ 2.31, p \leq 0{,}01$, therefore we accept the hypothesis H_0, which states that students and lecturers equally assess the level of development of their own digital competencies. As we can see, both students (80.8%) and lecturers (84.9%) believe that the level of their digital competence is sufficient to ensure the educational process. Besides, more than half of students (52.5%) say that they have the highest level of development of digital competencies for the implementation of the tasks of the educational process. Lecturers, unlike students, are less confident in their own digital abilities – only 39.6% of respondents rate the level of their own digital competencies with the highest score. At the same time, 5.9% of students believe that their level of development of digital competencies does not allow them to solve the problems of the educational process. In this context, it is also necessary to draw parallels with the previous study of the authors, based on the results of the international project № 21720008 Visegrad Fund "Competences of higher education teachers in the days of change", which was aimed at diagnosing a number of competencies of higher education lecturers in Ukraine and Poland. The results of the study also showed that not all lecturers have a high level of digital competence. The study also proved that such competencies include the ability to something new, which is realized through the use of ICT technologies in the process of training and creating new information resources (Khoruzha, Proshkin, Kotenko, Smyrnova-Trybulska, 2019).

The problem of the formation of lecturers at an insufficiently high level of digital competence was manifested in the conditions of social distancing (during the quarantine period), when all professors, even opponents of e-learning, turned en masse to digital technologies. However, as a practice has shown, for most of them the ability to use digital technologies is extremely limited. Typically, lecturers during the quarantine period used the free open learning management system Moodle, as well as various programs for video conferencing (Hangouts Meet, Skype, Webex, Google Classroom, Zoom). Additionally, in the course of the survey, it was found that the most popular programs among both students and professors are Hangouts Meet and Zoom. In our opinion, this is due to the advantages of such programs, among them the most important:

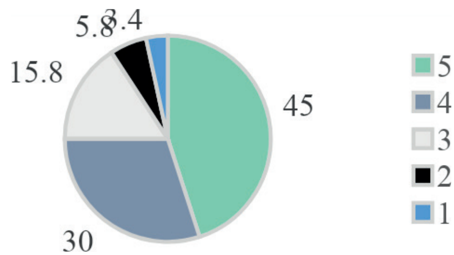
- a significant number of participants in the free package (up to 250 people);
- available choice of platforms (Android, iOS, Chrome, Mozilla, Firefox, Apple, Safari, Microsoft Internet Explorer, Microsoft Edge browsers);
- wide possibilities for joining (via browser, mobile application, Google Calendar, via URL or meeting code, etc.);
- the ability to record video calls, show documents and program windows, view high-resolution content, support scaling in the mobile application, etc.

It is clear that the quality of distance education determines not only the level of digital competence of lecturers and students but also the available technical opportunities (Internet access, availability of equipment, computer programs, etc.) that allow you to qualitatively implement the educational process. We obtained the following results (Figures 3a, 3b).



F i g u r e 3a. Lecturers' assessment of the technical feasibility of quality implementation of the educational process (%)

S o u r c e: Own work.



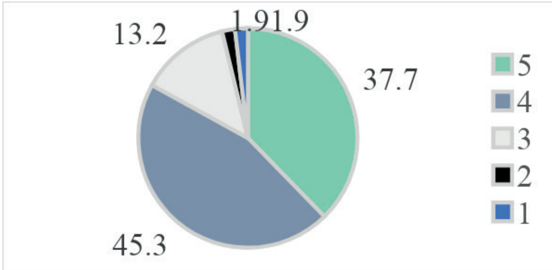
F i g u r e 3b. Students' assessment of the technical feasibility of quality implementation of the educational process (%)

S o u r c e: Own work.

With the help of Fisher's criterion φ^* received, that φ^*_{emp}, therefore we accept the hypothesis H_0, which states that students and lecturers equally evaluate the technical capabilities (Internet access, availability of equipment, computer programs, etc.) for the quality implementation of the educational process. At the same time, every fourth student (25.0%) and every fifth professor (22.7%) do not have the necessary technical capabilities for the quality implementation of the educational process. In addition, 9.2% of students assess their own technical capabilities as extremely unsatisfactory.

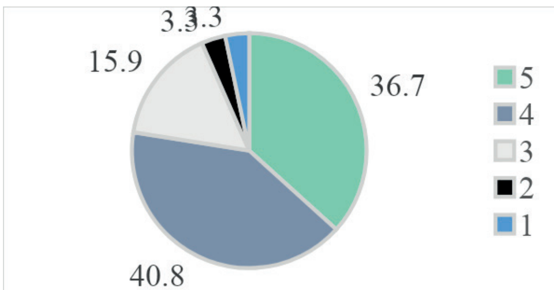
It should be noted that e-learning courses are of special importance for the implementation of distance learning. According to Morse, ETC – a set of teaching materials and educational services designed to organize individual and group learning using distance learning technologies implemented by ICT, in which educational material is presented in a structured form (Morse, Glazunov, Mokriev, 2016). As a result of conversations with lecturers, we have summarized the main advantages of using ETC, in particular: expanding access to different categories of participants in the educational process to educational content; ensuring the individualization of the educational process; improving the quality of the educational process; implementation of monitoring the quality of education.

Considering that ETCs have become in fact the most important means of implementing distance learning during 2020, we asked lecturers and students to assess the quality of ETCs (Figures 4a, 4b).



F i g u r e 4a. Lecturers' assessment of ETC quality (%)

S o u r c e: Own work.



F i g u r e . 4b. Students' assessment of ETC quality (%)

S o u r c e: Own work.

Using Fishers test φ^* is was found that φ^*_{emp} so we accept hypothesis H_0, which states that students and lecturers in general equally evaluate the quality of ETC. At the same time, 17.0% of professors consider the quality of ETC to be quite low. In addition, every fifth student (22.5%) is extremely dissatisfied with the quality of the ETC. Critical attitude to the quality of ETC prompts us to pay attention to the general problems of distance learning. To do this, lecturers and students are asked to make a ranking existing problems according to the following principle: 1 – is the most serious problem, 5 – is the least serious problem (see Table 1).

T a b l e 1

The attitude of lecturers and students to the problems of distance learning

Problems	Lecturers	Students
Lack of practical skills	1	2
Interpersonal communication	2	4
Task overload	3	1
Weak consideration of the level of available knowledge of students in the discipline	4	3
Late verification of completed tasks and their evaluation	5	5

S o u r c e: Own work.

According to the *U* – criterion of Mann-Whitney is obtained U_{emp} = 12.5, U_{cr} = {4, $p \leq 0,05$ 1, $p \leq 0,01$, so we accept hypothesis H_0, which states that students and lecturers in general equally evaluate the problems of distance learning. Together with him, we outline certain trends:

- For both lecturers and students, the problem of the weak possibility of distance learning for the formation of practical skills is relevant.
- Students and professors are equally convinced that the lateness of the tasks and their evaluation is not the most important problem of distance learning.
- Lecturers consider interpersonal communication as a guarantee of quality learning. According to the mobile „computerized" young generation, weak interpersonal communication in the implementation of distance learning is not a significant problem.
- Distance learning outlined another important problem – the excessive overload of students with tasks. As practice has shown, lecturers do not always take into account the available opportunities for students to master the material: time for self-study of the material and do tasks, different levels of preparedness of students (including psychological), etc.

It was also interesting to explore the benefits of distance learning (Table 2).

Table 2

The attitude of lecturers and students to the benefits of distance learning

Benefits	Lecturers	Students
Objectivity and impartiality	1	4
Creating conditions for the implementation of independent work of students	2	1
Self-management of educational (professional) activities	3	3
Variability of educational resources	4	5
Equal conditions for all	5	2

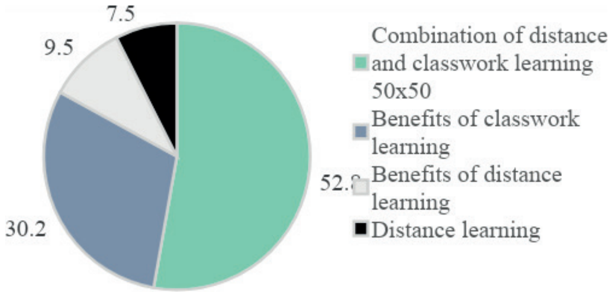
Source: Own work.

As in the analysis of the previous question using *U* – criterion of Mann-Whitney obtained U_{emp} = 12.5, we accept the hypothesis H_0, which states that students and lecturers in general equally evaluate the benefits of distance learning. However, there are certain patterns:

- Both lecturers and students believe that distance learning provides opportunities for independent learning of students.
- Respondents equally treat such an advantage of distance learning as self-management of educational (professional activity).
- Professors and students agree that the variability of educational resources is not the most important factor in the quality of the educational process.
- Lecturers pay more attention to objectivity and impartiality.
- The implementation of learning on the basis of equal conditions for all is most important for students.

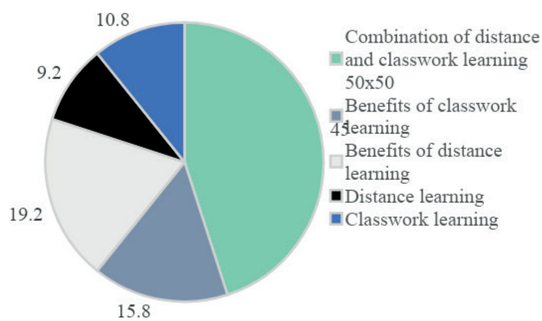
It is clear that the further development of a new didactic model of university education will depend on the format of the educational process. Rethinking the importance of informatization of education can be a guarantee of the implementation of new teaching methods, which are already being successfully implemented in universities in different countries, but have not yet become widespread in Ukrainian higher education. The most important of them, as described by Morse and other Researchers, are: blended learning, inverted learning, research learning, problem-based learning (PBL-Problem Based Learning), and IBL-Inquiry Based Learning, etc. (Dzyabenko, Morse, Vasylenko, Varchenko-Trotsenko, Wember, Boyko, Vorotnikov, Smirnova-Tribulska, 2020).

Therefore, it is important to predict such a format and highlight its main trends. Figures 5a, 5b show the results of the relevant survey.



F i g u r e 5a. The optimal format of the educational process according to lecturers (%)

S o u r c e: Own work.



F i g u r e 5b. The optimal format of the educational process according to students (%)

S o u r c e: Own work.

So, let us outline certain trends:

- Lecturers have a more conservative spirit – in the second place, in terms of importance, they put the traditional format of learning – the advantage of classroom learning over distance learning, students are more flexible and mobile in

this matter. For them, the most convenient format is the advantage of distance learning over the classroom.
- Both lecturers and students believe that purely distance learning is not effective (professors – 7.5%, students – 9.2%).
- None of the lecturers mentioned that training should be implemented only in the classroom. 10.8% of students spoke about the implementation of purely classroom training.

CONCLUSION

- An important feature of the modern didactic model of professional training of a specialist is its openness, which applies not only to the content but also to new learning technologies, among which the distance learning plays a leading role.
- When developing such a model should be taken into account that:
- Distance-learning makes it possible to create equal conditions for all students;
- It is necessary to constantly increase the digital competence of lecturers as a basis for the introduction of distance learning;
- Needs to improve electronic systems for monitoring and measuring the effectiveness of training;
- Distance learning resources should be diversified in terms of their competence orientation. Not to be limited to the educational content of ETC, but to provide students with the opportunity to participate in virtual environments of educational and practical activities; use of electronic simulators; to develop computer means of simulation modeling, etc.;
- The most optimal format for organizing the educational process in higher education is a harmonious combination of distance and classroom learning.

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ICT TOOLS AND PRACTICES FOR FINAL QUALIFICATION ASSESSMENT IN THE FRAMEWORK OF COVID-19 LOCKDOWN

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Abstract: *The global pandemic and the subsequent quarantine measures and restrictions have posed an array of challenges to the structure and procedure of university summative assessment process. Qualification assessment for major programmes in Foreign Languages in particular is a strictly regulated procedure that involves different stages (oral and written exams, final project viva, internal and external review). This study seeks to analyse the practices of Borys Grinchenko Kyiv University digital qualification assessment for students of European (French, Italian, Spanish, English, German) and Asian (Mandarin, Japanese) Languages major programmes, employed in the year 2020 due to quarantine measures. The survey and analysis of different ICT tools is used to translate real life qualification assessment practices into an online blended format. The investigation also seeks to identify various groups of applied digital skills and collaboration skills, utilized through qualification assessment process by all parties (students, faculty and referees).*

Keywords: ICT Tools and Practices; Final Qualification Assessment; digital literacy; blended learning.

INTRODUCTION

The global pandemic and subsequent quarantine measures and restrictions have posed an array of challenges to the structure and procedure of university summative assessment process. Qualification assessment for major programmes in Foreign Languages is a strictly regulated procedure that involves different stages (oral and written exams, final project viva, internal and external review).

This study *objective* is to critically review the applied case and best practices of Borys Grinchenko Kyiv University Digital Final Qualification Assessment for students enrolled on European (French, Italian, Spanish, English, German) and Oriental (Mandarin Chinese, Japanese) Languages major programmes, employed in the year 2020 due to quarantine measures. The survey and analysis of different ICT tools is used to translate real life qualification assessment practices into online blended format. The investigation also *seeks to identify* various groups of applied digital skills and collaboration skills, utilized through qualification assessment process by all parties: students, faculty and referees.

The global pandemic COVID-19 emerged as *a kind of black swan scenario* for various spheres of social and economic life. The black swan theory is a metaphor that describes an event that comes as a surprise, has a major effect on society, and is often inappropriately rationalised after the fact with the benefit of hindsight (Taleb, 2010). In the educational sphere, according to our estimations, the result of the COVID-19 pandemic development was the need to take quick action in order to achieve such desirable results: a) Adapt the existent educational scenarios to digital, remote and blended formats; b) To upgrade ICT competence and digital literacy of all participants of the educational process.

The higher education technology landscape of 2020 (Encoura, 2020) was prognosticated to include the following components: college-wide IT infrastructure; admissions and enrolment management, advancement tools, student distinction tools.

The study premise included the identification and elaboration of ICT competency principles, derivative of 21st century skills (Abbot 2013; Dos Reis 2016; Morze, Makhachashvili, Smyrnova-Trybulska, 2016) for university staff members (according to various ICT competency frameworks for educators) and projected digital literacy requirements:

1) UNESCO ICT Competency Framework (UNESCO, 2018) emphasizes that it is not enough for educators to have ICT competencies and be able to teach them to their students. Educators need to be able to help the students become collaborative, problem solving, creative learners through using ICT so they will be effective citizens and members of the workforce. The Framework therefore addresses such aspects of education: Understanding ICT in education, Curriculum and assessment, Pedagogy, ICT, Organization and administration, Teacher professional learning.

2) Liberal Arts (Digital Humanities) ICT proficiency profile sampling elaboration, according to the European e-competence framework guideline (European Commission, 2020) was conducted. ICT Liberal Arts/Digital Humanities Educator sample profile includes the following components:

- Trains ICT professionals and practitioners to reach predefined standards of ICT technical /business competence.
- Provides the knowledge and skills required to ensure that students are able to effectively perform tasks in the workplace.
- Defines and implements the ICT training policy to address organisational skill needs and gaps; structures, organises and schedules training programmes and

evaluates training quality through a feedback process and implements continuous improvement; and adapts training plans to address changing demand.
- Organises the identification of training needs; collates organisation requirements, identifies, selects and prepares schedule of training interventions.
- Acts creatively to analyse skills gaps; elaborates specific requirements and identifies potential sources for training; and has specialist knowledge of the training market and establishes a feedback mechanism to assess the added value of alternative training programmes.
- Monitors and addressees the development needs of individuals and teams.

3) A unified framework of correspondence between the crucial communicative competence (Hymes, 1972) and various aspects of ICT competence in Liberal Arts/Digital Humanities, utilized in the educational process, devised for the purposes of this study (Table 1):

Table 1

Correspondence between the crucial communicative competence and various aspects of ICT competence in Liberal Arts/Digital Humanities

Communicative competence components	ICT competence components correspondence in Liberal Arts/Digital Humanities
Linguistic competence	Participation in group ICT initiatives of regional and national levels
Sociolinguistic competence	Creating e-learning courses/tasks
Discourse competence	System using of ICT
Strategic competence	Presentation to the community the results of their own research activities through the use of ICT

Source: Own research.

The following study seeks to identify, among other parameters, challenges for actual and underdeveloped skills (hard, technical and soft), that all participants of the educational process encountered through Final Qualification Assessment.

1. FINAL QUALIFICATION ASSESSMENT: ACTIVITY PROFILE

Qualification assessment for Foreign Languages major programmes in particular is a strict regimen process that involves different stages (oral and written exams, final project viva, internal and external review).

According to the Law of Ukraine „On Higher Education" (Laws, 2019), qualification assessment is the establishment of learning outcomes (scientific or creative work) for higher education students in compliance with the requirements of the educational (scientific, educational and creative) programme and / or the single state qualifying exam.

The form of state certification of students is defined by the state standards of education and is reflected in the curricula of the Free Economic Zone. Usually state certification has two forms: 1) State exam; 2) Defence (viva) of qualification (bachelor's) paper.

State standards of education provide for the existence and observance of rules and requirements for the procedure of state certification. In addition, the defence of the qualification work contains propaedeutic procedures designed to obtain the basis for admission of students to the defence.

The administration of state examinations and defences of qualifying works is carried out at an open meeting of the SEC with the participation of members of the board and the obligatory presence of the chairman of the board. The work of SEC is carried out in the terms provided by the schedule of educational process. The state exam takes place at the approved time and in the audience specified in the documentation of preparation for the SEC.

The last link in the learning process is the defence of the thesis (project). This type of activity is characterized by the completion of the entire educational process and the assignment of appropriate qualifications to the student.

The supervisor should provide feedback on the work of his / her graduate, assessing all theoretical and practical aspects of the work with a probable grade, subject to successful defence. In addition to the response of the head, the work is accompanied by an external review – a scientist from the teaching staff, who works in the institutions of the Free Economic Zone of Ukraine and is a specialist in the subject of the diploma. The student is given 5–8 minutes to defend his thesis. After defending his work, accompanied by a presentation on a multimedia projector, the chairman of the board and members of the board ask students questions related to the theoretical and practical aspects of the diploma work. After receiving the answers read, if any, questions are asked by an external reviewer. After the student answers all the questions, the chairman of the board reads the response of the supervisor and the external review.

After the thesis has been defended by the last student on the list, the results of the defence should be discussed. The board members discuss the results in the same auditorium where the defence took place, with the participation of only the chairman of the board, its members and the secretary of the SEC.

In the situation of the COVID-19 pandemic lockdown *all elements of the Final Qualification Assessment at Borys Grinchenko Kyiv University have been relegated to the digital, remote or blended format with the use of ICT tools*.

The qualification assessment regimen was adapted to digital format as a framework (a legal procedure that results in the degree confirmation of a student), the string of consecutive activities according to the legal procedure described in the profile above, the „ritual" scenario (and experience for the student that is emotionally uplifting and sombre in nature, connects with the traditions of the university culture of Europe).

According to the law mandating Qualification Assessment, activities for foreign languages at Borys Grinchenko Kyiv university have been transferred to digital remote format in the following manner (Table 2):

Table 2

Qualification Assessment activities for foreign languages at Borys Grinchenko Kyiv university transfer to digital remote format

Qualification Assessment activities	Digital format	ICT tools used
State exam conduct (introduction, oral answers, grading, discussion, results)	Digital video conference; Remote test Video recording Voice recording	Zoom, Webex, GoogleMeet, Speech Texter, Android Apps, LMS Moodle, Webcam screenshot
State Exam card selection	Digital randomising	LMS Moodle, Google
State Exam discussion and questions	Digital video conference; Chat service; Mobile connection	Zoom, Webex, GoogleMeet, Android apps
State Exam assessment	Digital video conference; Automated grading system; Online/offline calculator	Zoom, Webex, GoogleMeet, LMS Moodle, Microsoft Excel, Google calculator
State Exam results declaration and appeal	Digital video conference Cloud services	Zoom, Webex, GoogleMeet, Google documents, E-mail Android Apps, Social media
Bachelor's project viva/ defence	Digital video conference Screen sharing File sharing Video recording Voice recording	Zoom, Webex, GoogleMeet Google Disk, Microsoft Power Pint, Cloud presentation tools (Prezi), Android Apps, Social media
Bachelor's project viva/ defence publicity and accessibility	Public announcement via digital media	E-mail, Android Apps, Social media
Bachelor's project submission	File sharing	Google Disk, E-mail, Microsoft Office tools, Android Apps
Bachelor's project review	Digital survey Digital assessment	Google forms, Microsoft Excel, Google Excel
Bachelor's project discussion and questions	Digital video conference; Chat service; Mobile connection	Zoom, Webex, GoogleMeet, Android apps
Bachelor's project assessment	Digital video conference; Automated grading system; Online/offline calculator	Zoom, Webex, GoogleMeet, Google forms, Microsoft Excel, Google calculator
Bachelor's project results declaration and appeal	Digital video conference Cloud services	Zoom, Webex, GoogleMeet, Google documents, E-mail, Android Apps, Social media

S o u r c e: Own research.

2. ICT TOOLS FOR FINAL QUALIFICATION ASSESSMENT IN THE FRAMEWORK OF COVID-19: SURVEY STUDY

2.1. Questionnaire overview

Based on the activity profile a survey was conducted among the participants of the Final Qualification Assessment at Borys Grinchenko Kyiv University foreign language programmes (Spanish, French, Italian, English, Mandarin Chinese, Japanese major) in order to assess the efficiency of qualification assessment transfer into digital format via various ICT tools employed.

The following participants of the digital Final Qualification Assessment were included into the survey as respondents: Students of senior year of bachelor's programme (53,4%); Assessment board members (15,5%); Faculty members (who took part in digital qualification assessment preparation and conduct) (20,7%); Bachelor project referees and supervisors (8,6%).

59 respondents total of all groups took part in the survey (Figure 1). The choice of respondent groups corresponded to the variation or similarity of tasks, performed through Final Qualification Assessment and, subsequently, the variation and similarity of ICT tools used.

The respondents in all groups spanned the foreign language Bachelor's programmes in proportional distribution measures: Spanish major programme – 32,8%, Japanese major programme – 19%, Mandarin Chinese major programme – 22,4%, French major programme – 15,5%, Italian major programme – 15,5%, English major programme – 8,6%.

2.2. Digital Final Qualification Assessment survey results

The overall digital qualification assessment experience on the scale of 1 to 5 was defined as mostly agreeable (5) by 50% of respondents, most agreeable (5) by 29% of respondents and less agreeable (3) by 17% of respondents.

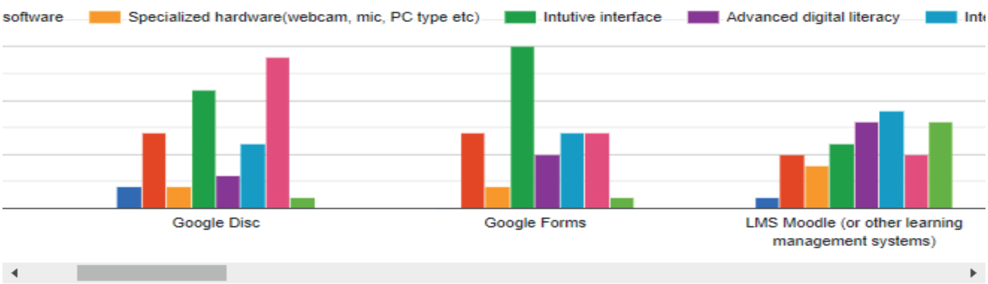
The respondents were asked to identify all the ICT digital tools that they have to employ the most in digital qualification assessment process. The highest scoring ICT tools by all the groups of respondents were: e-mail (93% of respondents), Google services (76% of respondents), videoconferencing services (84% of respondents), social media platforms (77% of respondents), automated testing systems and learning management systems (31% of respondents).

The ranking 1–5 of the ICT tools employed through digital qualification assessment process yields following tools getting the highest scoring (5) among all ICT tools identified and used: email services; google forms; Zoom video conferencing services; screen sharing services; Microsoft Office tool-kit and various social media platforms.

Across all ICT tools used throughout the digital qualification assessment process the respondents identified the following most prominent activities: Communication (synchronous); Communication (asynchronous); Collaboration; Information/file sharing; Summative assessment; Formative assessment; Peer review; Presentation;
Speech quality assessment; Brainstorming.

Information sharing and presentation are considered prominent for such types of tools as email, Google services, and Microsoft Office Toolkit. Both synchronous and asynchronous communication and collaboration is distributed proportionally among email services, learning management systems and various video conference services. The tools that feature summative assessment as a prominent activity are Google forms and LMS Moodle. Formative assessment as a type of activity features but does not dominate evaluation of ICT tools used qualification assessment process.

The following technical and user requirements, most prominent for ICT/digital tools employed throughout the digital qualification assessment process were identified (Figure 1): Bandwidth; Specialized software; Specialized hardware (webcam, mic, PC type etc.); Intuitive interface; Advanced digital literacy; Intermediate digital literacy; Elementary digital literacy; Customized training before use.



F i g u r e 1. Technical and user requirements, for ICT tools digital qualification assessment process. Sample evaluation card

S o u r c e: Own work.

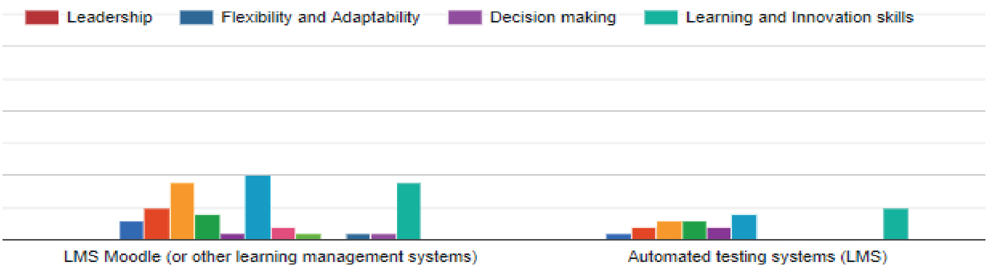
Intuitive interface is a the most important technical requirement for the future across the board of ICT digital tools that have been analysed. It is considered a leading technical requirement for such ICT tools as email, Google services, video conferencing services and social Media platforms.

Specialised software as a requirement is mandatory and ranking second for such tools as email and Google services. The only tool, employed in qualification assessment, that features customised training before use as a prominent requirement by respondents is the LMS Moodle platform.

Various levels of digital literacy have been identified in the survey. *Digital literacy is understood primarily as the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills* (ALA, 2020; DQ Report, 2019).

Advanced digital literacy as the requirement for qualification assessment ICT tools efficiency is attributed to such instruments as learning management systems, Microsoft Office toolkit and social media platforms. Such instruments that are used for final qualification assessment as Microsoft Office Toolkit, screen sharing interface, online randomizer, automated testing system, learning management system are evaluated as requiring predominantly *intermediate digital literacy*. *Elementary digital literacy* level is assessed as dominant for such tools as email, google disc, video conferencing, speech to text interfaces and social media platforms.

Across various ICT tools for the digital qualification assessment process the following skills and competences most widely implemented and practiced, drawn from various relevant 21st century skills frameworks (see section 1 of this paper) have been identified (Figure 2): Communication; Collaboration; Team work; Digital literacy; Emotional intellect; Interdisciplinary skills; Critical thinking; Leadership; Flexibility and Adaptability; Decision making; Learning and Innovation skills.



F i g u r e 2. Soft skills for ICT/digital tools in digital qualification assessment process. Sample evaluation card.

S o u r c e: Own work.

The survey has yielded the following representative results for soft skills featuring most prominently in the use of ICT tools for Qualification Assessment. Communication and collaboration rank as a type of skills most widely employed in the use of such instruments as email, Google services, video conferencing services and social media platforms. Team work collaboration ranks second most prominent skill employed via the use of Google disk, learning management systems and video conferencing services.

Relevance is attributed to learning and Innovation skills in the use of such ICT tools as a learning management system (ranking second after interdisciplinary skills), automated Testing System (offline, online and cloud based), Android apps and Microsoft Office tools. Creativity as a skill ranks 3rd in the use of Google services and ranks 1st in the use of Microsoft Office tools.

2.3. Final Qualification Assessment Tools Efficiency Ranking

The identified Final Qualification Assessment ICT tools have been subsequently subjected to Customer Satisfaction Evaluation Ranking (Dos Reis 2017; Morze, Makhachashvili, Smyrnova-Trybulska 2016), featuring the efficiency of ICT tools per education activity as the main criterion.

For the purpose of the ranking the Final Qualification Assessment ICT tools have been divided into 4 groups according to types: 1) Google cloud services (Google Disc, Google Forms, G-mail); 2) Video conferencing services (Google Meet, Zoom, Webex); 3) Learning management systems (LMS Moodle, Automated testing systems); 4) Microsoft Office tools (Word, PPoint, Excel)

All respondents had to rank the activity importance 1–5 for the selected ICT tools used (Figure 3).

		Ranking 1–5 by respondents						RC	SR
	Activity	**1**	**2**	**3**	**4**	**5**	**Sum**	**Rating coefficient**	**Total sum × coeff.**
1	Communication (synchronous)	2	7	15	10	20	54	54 / (59 × 5) = 0,18	54 × 0,18 = 9,72
2	Communication (asynchronous)	5	8	6	6	28	53	0,18	9,54
3	Collaboration	7	5	6	10	25	53	0,18	9,54
4	Information/file sharing	8	4	4	4	34	54	0,18	9,72
5	Summative assessment	1	7	17	17	11	53	0,18	9,54
6	Peer review/evaluation	9	3	12	18	10	52	0,17	8,84
7	Formative assessment	5	9	10	16	12	52	0,17	8,84
8	Presentation	3	7	16	10	17	53	0,18	9,54
9	Speech quality assessment	6	4	10	8	20	48	0,16	7,68
10	Brainstorming	2	8	13	10	19	52	0,17	8,84
	Total efficiency rating: (ER)								**9,18**

F i g u r e 3. Evaluation of Tool Type 1 (Google Disc, Google Forms, G-mail). Sample ranking score card

S o u r c e: Own research.

The efficiency rating (ER) for each type of ICT tools assessed in the paper has been calculated via a 3 step algorithm:

1. Rating coefficient calculation: ∑ of points per activity divided by x = (N(r)x5) => y experts, 5 points maximum per each activity rating.

$$RC = \sum(p)/(N(r) \times 5)$$

Where:
RC – is Rating Coefficient of an ICT tools type
∑(p) – is the sum of points per each activity, carried out via an ICT tool type
N(r) – is the number of respondents, that have assessed the ICT tool type efficiency

2. Summative rating (SR) of each activity per ICT tool calculation: ∑ of points per activity multiplied by RC (rating coefficient)

$$SR = \sum(p) \times RC$$

Where:
SR – is the Summative Rating of each activity per ICT tool
∑(p) – is the sum of points per activity, carried out via an ICT tool type
RC – is the Rating Coefficient of an ICT tools type

3. Total Efficiency Rating (ER) of a type of ICT tools assessed calculation: ∑ of summative ratings (SR) per each activity divided by N of activities evaluated for the ICT tool type

$$ER= \sum(SR)/N(a)$$

Where:
ER – is the Total Efficiency Rating of a type of ICT tools assessed
∑(SR) – is the sum total of summative ratings per each activity, carried out via an ICT tool type
N(a) – is the number of activities evaluated for the ICT tool type

According to the evaluation procedure the Total efficiency ratings for each type of ICT tools for Final Qualification Assessment are as follows: Tool Type 1 (Google Disc, Google Forms, G-mail) – 9,18; Tool Type 2 (Google Meet, Zoom, Webex) – 8,91; Tool Type 3 (LMS Moodle, Automated testing systems) – 8,60; Tool Type 4 (Microsoft Office tools: Word, PPoint, Excel etc.) – 9,48.
As can be inferred by the results, according to the surveyed case of Borys Grinchenko Kyiv University Final Qualification Assessment transference to digital format the highest efficiency rating – 9,48 – among all groups of respondents is attributed to Microsoft Office toolkit. Google cloud services are a runner up with the Total efficiency rating of 9,18.
It is worth noting that the activities scoring the highest summative rating (SR), realized effectively per each type of ICT tools assessed, are as follows: Tool Type 1 (Google Disc, Google Forms, G-mail) – Communication (synchronous) (SR=9,72), Information/file sharing (SR=9,72), Summative assessment (SR= 9,54), Presentation (SR= 9,54); Tool Type 2 (Google Meet, Zoom, Webex) – Communication (synchronous) (SR=9,54), Collaboration (SR=9,54), Speech quality assessment (SR= 9,54); Tool Type 3 (LMS Moodle, Automated testing systems) – Communication (synchronous) / Communication (asynchronous) (SR=8,84), Brainstorming / Formative assessment (SR=8,67); Tool Type 4 (Microsoft Office tools: Word, PPoint, Excel etc.) – Communication (synchronous)/ Collaboration (SR= 72). The Summative ranking score of 9,54 for every other activity realized by the ICT tool type.

CONCLUSION

All procedures and scenarios of the Final Qualification Assessment activities for foreign languages at Borys Grinchenko Kyiv university have been successfully transferred to the digital remote format with the use of various sets of ICT tools in the framework of the COVID-19 pandemic adjustments. This transference could serve as a best practice model for other universities of Ukraine and European countries both as an adaptable measure for prolonged lockdown and as a way to further advance of blended learning and further digitalization and democratization of educational process.

The survey results conducted among all groups of participants of Final Qualification Assessment for foreign languages have yielded representative data as to the efficiency of various ICT tools implementation for rigorous assessment procedure scenario. Microsoft Office toolkit ranks highest in efficiency among respondents, presumably, due to the least digital literacy level adjustments required of users at a short notice to carry out the full spectrum of necessary activities for Final Qualification Assessment. Various levels of digital literacy have been identified in the survey. Across the board, implementation of Final Qualification Assessment via various ICT tools requires of participants of educational process intermediate digital literacy. Implementation of learning management systems requires additional technical training of both students and educators for efficient use in high-stress environment.

Communication, collaboration and team work are assessed as most high ranking activities carried out within the use of all ICT tools for Final Qualification Assessment assessed. Subsequently, the corresponding soft skills are also evaluating as crucial in various combinations within the scenario of digital Final Qualification Assessment. This results corroborate the introduced in this study correspondence between communicative competence and ICT competence components, adapted for

Liberal Arts. Namely, the following components prove indispensable for all participants of Final Qualification Assessment in digital format: participation in group ICT initiatives, creating e-learning tasks, system using of ICT, presentation to the community the results of one's own research activities through the use of ICT.

The survey results will be furthered and elaborated in assessment of ICT tools efficiency and digital skills adaptability for separate groups of Final Qualification Assessment (students of foreign languages programmes, Assessment board members, staff members, reviewers) according to roles and tasks performed, as well as according to age and entry digital literacy level (the distinction in efficiency assessment among digital natives and digital immigrants).

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VISUAL LITERACY IN CONTEMPORARY CULTURE – COMPARATIVE RESEARCH

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Abstract: *In the paper, the author presents the results of comparative research conducted in the academic environment of Poland and Italy, the aim of which was to diagnose the state of knowledge and skills in the field of visual competences. Visual competences are the subject of education in the form of comprehensive literacy containing both aspects of visuality – knowledge of the image as a mental object and knowledge of the form that determines the shape and structure of the record, as well as informational conditions for the creation, retrieval, dissemination, collection and use of visual content.*

The cultural perspective of the conducted research on the level of visual literacy, which determines active visual communication, is closely related to the past, the pictorial and audiovisual civilization formation of the past, and the digital media of the present time. Contemporary communication is transforming and requires information competences. Visual reading and writing skills provide tools for the understanding and contextual analysis of cultural space in a pictorial aspect. The skills are based on intellectual, aesthetic, ethical and technological qualifications acquired through literacy.

Keywords: visual literacy, visual communication, visual competence, visual culture, comparative research.

INTRODUCTION

Research on visual literacy of contemporary youth covers those aspects of individual human resources that are the result of his intellectual development and depend on socio-cultural and historical factors that shape the personality. They are a set of features of the human habitus, elements of cultural capital that is accumulated during life. Seeing is one of the forms of communication such as reading, speaking and listening that enable you to function in society. In the course of education and upbringing, a man uses the visual skills of understanding, interpreting and applying the information obtained in this way for personal development and social acceptance. Visual literacy, as it was analyzed, is a comprehensive set of culturally dependent attitudes and behaviors, it is part of our visual knowledge that determines cognition and enables effective communication. The research is part of the wide current of popular contemporary debate on the quality of image culture, its impact on the level of participation in social life and the educational possibilities of targeting visual activities. They are an analysis of cultural dispositions in relation to traditional and modern forms of imaging.

The established research program was carried out on the basis of research analyzes: exploration, description and explanation of the causes of variability, and its aim is to determine the scope and quality of the phenomenon of communication in the sphere of symbolic communication through art. The results of the comparative research conducted in the academic environment of Poland and Italy are used to define the priorities of visual literacy teaching as an element of general knowledge, which enables understanding and contextual analysis of the visual space of contemporary culture and, in practice, effective information management (Wieczorek-Tomaszewska, 2014). The main implication resulting from the research is educational needs in the field of visual literacy education, relating to the transformations of contemporary information culture and its impact on the shaping of image culture and the educational process. Visual competences in this area are determined by the ability to recognize the forms of image messages and creativity in their application, combined with the ability to create information structures.

The state of research

In contemporary culture, there is a belief that the word is the primary carrier of content and intellectual values. The fact that the users of information were attached to the word meant that visual literacy as a research discipline could not achieve a rank adequate to its abilities for a long time. The term visual literacy in the context of visual knowledge was first used in 1969 by John Debes – the co-founder of the International Association of Visual and the creator of the definition – and defined the stock of basic skills and knowledge relating to the influenza of human visual competences that can develop through vision while integrating other sensory experiences.

Another aspect of contemporary visuality is visual communication, which in 1973 became the subject of analysis by D. A. Dondis. It enables the transfer of information by means of various media (images, press, books, posters, television, the Internet, etc.). The omnipresence of the image we witness today is based on visual forms of communication, such as illustration, photography, infographic, typography, animation or film, which are designed in such a way – according to artistic, aesthetic and, above all, functional principles – that they properly influence the recipient. DA Dondis‘ attention to the principles of constructing images, explaining the relationship between forms, the meaning of color and the semiotics of utterances and the theory of perception made it possible to look at the image as a work, which, if properly de-

signed, can be an alternative to the word, and the recognition of structures that build picture can be comparable with learning a language.
A critical position in relation to the metaphorical ambiguity of the image and the role of the visual language in conveying information was taken by M. F. Cassidy and J. Q. Knowlton in *A Visual Literacy: A Failed Metaphor?*, triggering a discussion about the legitimacy of creating a research area for the interpretation of visual forms that cannot be analyzed by definition (Cassidy& Knowlton, 1993). The polemic caused by this text is still the source of numerous statements illustrating dualism in relation to the problem of contemporary visuality, visual communication, image culture and visual culture. On the one hand, the image is defined as an independent form of expression subject to formal, iconographic and iconological analysis, according to the methodology derived from the scientific history of art; on the other hand, the role of visual representation is defined as subordinate to verbal and textual statements, fulfilling the role of complementary sense and meaning transmission. It should be emphasized that the educational meaning of visual literacy combines these two interpretative approaches, using on the one hand the cognitive potential of the image and the possibilities of iconological, semiological and informational interpretation, and on the other hand the complementarity of the visual form in relation to the text. The combination of both research attitudes allows for the practical application of visual literacy in the design of information and educational tools, e-learning and blended learning courses for the needs of current education. Today, visual literacy is the basic element of hybrid models and innovative methods of education (Pater-Ejgierd, 2010). The requirements for raising the level of visual literacy necessary to receive messages posted on the web have been defined by a set of competences in the document *Visual Literacy Competency Standards for Higher Education* (Visual, 2011).
Visual literacy research in educational environments (IVLA) shows the effectiveness of combining different methods of using the image. Currently, M. Wilkowski in *Introduction to digital history* (2012) draws attention to the difference in the perception of textual and visual information, which constructs the reception of written text on the basis of data ordering and a critical analysis of its elements. They are combined into linear sequences (sentences) focused primarily on facts – unlike the image interpreted with the help of context and analogy, based on the synthesis of the totality of knowledge, supported by a network of connections, subordinated to the structure of the statement (form).

1. RESEARCH METHODOLOGY

The conducted research was aimed at determining the scope and quality of the phenomenon of communication in the sphere of symbolic communication through art. They included the stage of: exploration, description and explaining the causes of variability. The results of comparative research conducted in the academic environment of Poland and Italy were to be used in defining the priorities of visual literacy teaching as an element of general knowledge, which enables the understanding and contextual analysis of the visual space of contemporary culture and, in practice, will enable effective information management.

The descriptive research was to answer the following questions: What?, When, Where and How?
The exploration of the social world from the level of understanding symbolic messages allows you to collect information about the scale of the phenomenon. The research covered communities at the level of national group divisions; comparative methods were applied to them, which enabled them to create, on the basis of differences and similarities, an image of the world perceived through symbolic communication, based on images decoded with images.
The attitude of societies to the world of images observed in the context of socio-historical development is the basis for determining the usefulness of symbolic communication today. The aim of descriptive research in this field will be to indicate the degree of connections between the way of perceiving reality through art, resulting from evolutionary and historical continuity, and the contemporary, postmodern character of social communication. In the exploration part, the so-called Aesthetic (Morawski, 1988) invariants that have shaped the way of thinking about art over the centuries, supported by research in related scientific fields, such as cultural history, art history, aesthetics, philosophy and anthropology.
The explanatory research included in the work was aimed at finding an answer to the question: why? – there are observed regularities and what are their consequences for the symbolic interaction determined in this case by art, consisting in the mutual, contextual adjustment of its participants, interpreting meanings and reading intentions (Kmita, 1982). In a broader, intercultural approach, this means comparative research on territorially and nationally diverse populations, in communication of which there may be barriers such as ethnocentrism, prejudices, stereotypes and language. Answers to these questions could be obtained after defining the attitudes of social communication participants in the context of dependent variables in the questionnaire interviews and interpreting them on the basis of knowledge about culture and cultural communication.
The main aim of the research was to understand and compare the phenomenon of communication in the area of virtual communication by young people from Poland and Italy.
The most important research goals are presented in Table 1.
Detailed problems are included in the following questions:
What image is in your life? In what situation would you like to get a painting? How do you perceive the socio-cultural reality in the context of the image culture? Can the religious image provoke reactions of transcendence? Does the image shape attitudes? What is the educational function of an image? Do works of art transfer national or universal values? What is the social knowledge of creating art collections?
The operationalization of the presented issues in the field of visual literacy, which entered the contemporary communication space of new media, subjected empirical control to the perception of the image – the information relay – shaped by the traditional system, based on ontological and epistemological foundations, which is part of today‘s times. The overriding assumption of the research has become the identification of contemporary phenomena, including the formation of a new way of perceiving various methods of visual presentation.

Table 1

Operationalization of factors and changes

1. Environmental exploration covering three generations

the grandparents	of the parents	of the children

2. Study of the respondents' aesthetic dispositions (model of aesthetic experience (Leder and other, 2004):

pictorial literacy skills

3. Ways of perceiving reality:

psychological aspect
anthropological aspect
informative aspect

4. Researching attitudes based on the factors of choosing to own a work of art:

fascination	interests
creative snobbery	reflexive-aesthetic
negation	

5. Hierarchy of the image function in the mediated perception of reality:

mirror image	function expression	function cognitive and educational function

6. Determination of the impact of the transgression function on a three-point scale:

domination of religious experiences	reflective nature	realistic nature

7. The influence of the image in shaping attitudes and building models of behavior. Research based on:

tolerance	sense of humor
solving the conflict	Conservatism
an atmosphere of approval	

8. Checking the scope of understanding the educational function of the image defined by:

values	knowledge	persuasion/ indoctrination

9. Defining the attitude to identity in the context of cultural pluralism by its:

negation (conservatism)	acceptance (pluralism)

10. The theory of collecting as an element of the sociology of everyday life and participation in culture. Collecting Motivations:

business	prestige (fashion)	snobbery
family traditions	expertise	
aesthetics	science	

Source: own study.

The following research techniques were adopted in the diagnostic procedure: For quantitative research: questionnaire, text analysis, projection technique. For qualitative research: participant observation – research by collaborative experience. For the implementation of selected research techniques, a questionnaire and a questionnaire for the projection technique were used (Pilch, 1995; Babbie, 2006).

The survey questions were asked in order to identify mentally in the context of historical, social and cultural changes and the level of participation in visual culture in the contexts of social life, at home, at school, in a peer and professional environment, in church, on the road, etc. The full range of questions in Polish (Survey) and Italian (Inchiesta) is available to respondents on the website.

1.1. Environmental exploration

Exploratory research was conducted on selected groups of young Poles and Italians. The respondents commented on the paintings they had stored in their homes over the years. It is an attempt to make an initial, general recognition of the relationship between the respondents and the work of art, and to determine the degree of aesthetic awareness. This is the penetration of the social environment of the respondents in the dimensions of cultural capital in terms of their status signs, such as the number of owned works of art, their origin, motives for purchasing, collecting and inheriting.

Table 2

A set of questions for environmental exploration

<table>
<tr><td>1. How many paintings are in your family home (you can give an approximate number)</td><td>3. Author (enter if you remember the author of the painting)</td></tr>
<tr><td>2. Title (provide a title for the image or describe what it represents)
<table>
<tr><td>a. still life_e. religious scene</td><td></td></tr>
<tr><td>b. portrait</td><td>f. abstraction</td></tr>
<tr><td>c. group portrait</td><td>g. information</td></tr>
<tr><td>d. genre scene</td><td>h. other</td></tr>
</table></td><td>4. Technique:
<table>
<tr><td>a. oil painting on canvas</td><td>h. collage</td></tr>
<tr><td>b. oil painting on cardboard</td><td>i. poster</td></tr>
<tr><td>c. watercolor</td><td>j. reproduction</td></tr>
<tr><td>d. pastel</td><td>k. photography</td></tr>
<tr><td>e. crayon</td><td>l. infographic</td></tr>
<tr><td>f. drawing</td><td>m. other g. graphics</td></tr>
<tr><td>g. graphics</td><td>n. I don’t know</td></tr>
</table></td></tr>
<tr><td>5. Date of creation / style / epoch (please indicate the approximate time of creation)</td><td>6. Since when the painting is in your home:
a. from „always“,
b. is a picture of my grandparents
c. my parents put him at home
d. is home thanks to me</td></tr>
<tr><td>7. If the painting has a story, describe it</td><td></td></tr>
</table>

Source: own work.

In order to determine the respondents‘ aesthetic dispositions through the information provided by them about the actual state of having or not having paintings in their home, the formal quality of works (type, authorship, date of creation, topic) and the degree of visual activity of individual groups of respondents (grandparents, parents, children) in the field of image acquisition, a survey form consisting of closed questions was created (Table 2).

Visual literacy tested the respondents‘ knowledge analyzed in terms of their knowledge resources on the situational context of images; in this case, it referred to events and ex-

periences related to the existence of an image in a specific environment of the family home. The classification of painting according to the theme was adopted on the basis of Janusz Kębłowski‘s Classification of Fine Arts (Kębłowski, 1973) (cf. Table 2).
The conducted analyzes involved the respondents‘ interpretative apparatus, in relation to the aesthetic experience, which is "a manifestation – a permanent testimony and celebration – of the life of civilization, it draws the resources of its development from it, in which it finds its final evaluation of its value" (Dewey, 1975). According to the *Model of aesthetic experience* (Belke, Leder, 2001), they are composed of previous experiences related to art (knowledge, interests, taste) resulting from interaction and social discourse. The classification and assessment procedure within visual perception uses the methods of image analysis (sensory identification, iconographic, iconological and semiological typology) in order to understand – as a result of cognitive and emotional processes.

2. CHARACTERISTICS OF RESEARCH

The presented scope of research was developed and carried out in 2016–2017 and repeated in an electronic version in 2017/2018 and 2018/2019 in Poland and Italy.
Both the first research of Polish and Italian youth, as well as the following ones, registered and revealed aspects of social life within the image culture, which aspire to be called informational behavior.
Online surveys were made available to respondents on the following websites: http://mwt.eu.interia.pl/polska.html and http://mwt.eu.interia.pl/italiano.html.
The measurements were preceded by a pilot questionnaire tested on a group of 47 people recruited from among academic youth up to 36 years of age. The consequence of this diagnosis was the specification of a set of closed and open questions, understandable to the respondents, as well as the development of a research strategy.

2.1. Characteristics of Polish research

The study, in the Polish edition, covered a group of students defined as the future elite of Poland, who, after graduation, obtain a status that enables them to exert real influence on shaping attitudes and ideas in society. The selection of the research group from the group of students was made due to the social representativeness and the cross-sectional nature of their defining personal patterns, as well as the possibility of determining their origin through mental and environmental penetration in three generations: the generation of grandparents, parents and children.
As a result of the methodological choices made, a group of 253 students of the Pedagogical University in Krakow at various fields and levels of education was explored: social and welfare pedagogy, social pedagogy, preschool and school pedagogy, social work, physical education, history, Russian language and library science and from the Jagiellonian University. in the field of European Studies.

2.2. Characteristics of Italian research

In a study in Italy, questionnaire forms were sent electronically to e-mails of students and academic staff provided by Italian universities, such as: architecture, urban planning, planning, history, contemporary history, history of medieval science, modern history, religious studies, town planning, pedagogy, medicine and others.

The study covered 48 universities in 20 Italian provinces: Arbuzzo [3], Basilicata [1], Emilia Romagna [4], Friuli Venezia Giulia [3], Calabria [3], Campagna [7], Lazio [10], Liguria [1], Marche [4], Molis [1], Piemonte [3], Puglia [5], Srdegna [2], Sicilia [4], Sydney [12], Toscana [7], Trentino Alto Adige [2], Umbria [2], Dalle d'Aosta [1], Veneto [4]. In total, 852 questionnaires were sent to Italian respondents. When designing the website form, the recommended strategies aimed at arousing the interest of the respondents were applied to obtain the maximum percentage of complete, returnable surveys. The introductory text contained the identification of the research center as well as the personalization of the survey's author's activities. Information about the type and purpose of the study was given, as well as acknowledgments for cooperation and participation in the study. As a result of the organizational and logistic activities undertaken, 132 responses were received, which is 15.5% in relation to the number of forms sent and is a greater value than the average results of received responses among the conducted online surveys of this type (5–10%). 132 people, aged 20 to 36 and studying or working in academic centers, took part in the Italian edition of the survey.

3. COMPARISON OF POLISH AND ITALIAN RESEARCH FINDINGS

From the conducted exploratory comparative studies of Polish and Italian environments, a picture emerges of two populations that are comparable in many respects. The social origin of the respondents, recorded over three generations (grandparents, parents, children), in both analyzed groups does not diverge from the moral norm in terms of the education of individual family members, initially patriarchal with the distinctive, dominant role of a man and, in subsequent stages, an emancipating woman. Also, the study of higher needs, defined by the symbolizing skills represented by the works of art, turned out to be a common need of both surveyed groups. Quantitative comparisons show a greater accumulation of cultural goods among Italian respondents and their families, with a 10% advantage over the Polish group of respondents. This advantage persists in all quantitative situations related to the so-called Basic imaging skill, i.e. the skill of visual perception involving observation, classification, typologizing and attributing images. The recorded results indicate that these skills were better mastered by Italian respondents who identify images through their authors, recognize performances, techniques of performance and are able to date images, often with style and form. They also remember situations related to images, which may indicate a more developed skill of symbolization.

The selection of the images possessed differentiates the studied environments in terms of their worldview and defines them by means of satisfying higher needs. Italians represent the realistic type in the pursuit of self-realization, reflected in the preferences for landscape, portrait, still life and genre scenes. On the other hand, the surveyed Poles indicated, next to the landscape, religious themes as the dominant images in the perception of reality, which fully reflects the world-wide diversity of Polish society. Both groups treat the possession of a work of art as a situation of social ennoblement, a manifestation of the bourgeois sense of wealth, or even a capital investment.

Unfortunately, they found it difficult to match their paintings with traditional painting techniques such as oil painting, watercolour, crayon, drawing, graphics. In the case of the Polish group of respondents, reproduction was ranked high. In Poland and Italy, the parent generation is the group that finances the purchase of works of art and at the same time influences the aesthetic choice. In Italy, parents most often buy 20th-century works, in Poland, similarly, children together with their parents choose the latest works from the turn of the 20th and 21st centuries, probably reacting to contemporary cultural and artistic events. Apart from parents, the young generation also influences the shaping of aesthetic preferences in Poland. In Italy, the generational message is stronger – it is family traditions and works of art owned and passed on to others that shape the sense of aesthetics.

Among the factors motivating to action, Italian respondents first declared their fascination, probably due to the common contact with works of art in their country. Nowadays, it is also justified by mass visual communication (the invasion of images on the street). Next, it is verified by interest, sometimes even snobbish, that may cause rejection of the original feeling of delight but evoke specific reflections.

Poles react less spontaneously than their Italian colleagues. First, the object must interest them, then it turns into a fascination, often conditioned by, say, creative snobbery – at this point a critical negation may appear – and finally, only at the end, just like in Italians reflection. In order to balance the above-noted consumerism of behavior, the respondents ambitiously and unanimously recognized the cognitive function as the main goal of visual perception of reality in both target groups. The cognitive processes triggered in this way construct a value-oriented knowledge structure and animate behavior.

A large differentiation occurred when defining the worldview of the respondents, verifying the earlier statements qualifying Italians as rationalists and Poles as defined equally by religion and reason. The analysis of the responses confirmed the Italian marginalization of religious needs in the context of meeting higher needs, but did not rule out reflection and romanticism in emotional behavior. Poles also distinguished reflection – an attitude of in-depth contemplation, and only secondarily, faith in mystical revelation as axioms of religious experience.

A separate research issue was the educational function, in which all respondents saw the potential of using the image to transfer knowledge. Then the responses differed, the Italians, in line with their pragmatic approach, recognized persuasion as an educational method of effective visual expression. Poles focused on the values that a simple visual message can elevate to the rank of an axiological message, e.g. regarding cultural pluralism, for which all the interviewees found a place in the visual space.

The most symptomatic research exploring the environment in terms of mentality turned out to be the hierarchy of factors that motivate collecting.

Poles, monumentally and a bit snobbish – as usual – placed prestige first. Then patriarchal – family traditions, and finally, in the third place – coupled with expertness, eruditionally conditioned – beauty. Placed in this context, at the end business, according to them, is an unjustified and unnecessary value, and perhaps even an anti-value.

Italians spontaneously, in accordance with the rules of collecting and the definition of art, put beauty in the first place, reflecting the charm of a centuries-old cultural heritage, taken over from the Greeks – beauty. Further, they placed, family, which distinguishes traditional Italian society –. Only in the third place, resulting from the definition of the position of family did they put prestige, but based on expertise, which logically and consistently conditions business.

CONCLUSION

The summary of the research once again shows the diversification of the perception of visual reality as a synonym of the symbolic world by Italian and Polish respondents. In Italy, attitudes, opinions and actions are justified by the evolutionary continuation resulting from the direction of development of modern Italian society subject to changes and modernizing transformations. Poles do not have such eloquence and intuitive lightness in interpreting visual activities. Their perception is burdened with axiology, erudition and educational role played by the image in communication. Interpretation of contemporary visual messages, dominated by a modern form of communication, requires elementary knowledge of the principles of decoding meanings in contextual cultural areas. The visual knowledge needed to read messages, deepened axiologically and formally, may constitute the qualitative potential of modern society and image culture.

The reference to the conducted research exploring the family, professional and social circles of young Poles and Italians and verifying their qualifications of searching, organizing, interpreting, evaluating and using information are the issues of visual competences and visual knowledge. The profile of an information user functioning within the information culture and media civilization has been defined in terms of information and education.

The visuality of the studied environments, observed in everyday life situations defined by work, education and entertainment, attitude to norms, principles and values, and determined by needs and ambitions, shows the competency and personality profile of respondents in terms of visual literacy and adaptation to the observed tendency of the dominance of pictorial knowledge in contemporary information space. The results of the research showed that to a higher degree than Poles, the studied Italian youth copes with adaptation in an environment where the quality of the perception of the visual message determines the level of the communicating community. Their assessment related to skills at the first level of pictorial identification was much more correct, which later affects the iconographic interpretations of topics. It is also much easier for her to relate the interpretation of the image to a wide cultural spectrum and transfer visual content to other levels of knowledge – intuitively without having to refer to great theories, ideas and values, as was the case with Polish respondents. The Polish youth surveyed turned out to be more ambitious, setting themselves more serious goals, but not having the ability to implement them and adapt to modern living conditions. The assumption of the study was to relate dependent variables (the so-called aesthetic invariants) to various forms of imaging, ranging from works of art through various spheres of visual activity within the iconosphere.

The cross-cultural research comparisons carried out indicated among the analyzed groups mental differences in behavior, attitudes and priorities, but at the same time confirmed the common cultural basis for both national research units. Operating the same research categories and the same interpretative scale for various populations made it possible to create a uniform cultural model of the contemporary young generation, referring to the model of the future social elite, justified at the beginning of the research, predestined in the future by education and cognitive attitude to reality, to influence and shape attitudes .

In view of visual behaviors within the information culture, based on digital information and communication techniques, the surveyed young people show knowledge of new instruments of transferring knowledge in the form of images (infographics). On the basis of a comparison with the results of Internet research in terms of media and visuality, it is possible to distinguish similar behaviors indicating that the visual knowledge possessed by young people is very often used to structure information, data and concepts. When analyzing the attitudes towards innovative forms of graphic recording and the transfer of data, information and knowledge – infographics, one can get the impression that graphic motifs, more complicated in terms of visual structuring, cause interpretation chaos and disruptions in the flow of content.

Therefore, and in view of the growth and dissemination of visual methods in the creation and transmission of knowledge, both in education and in mass communication, there is a justified need to shape visual competences among the young generation, based on visual knowledge, as well as deepening the knowledge of structuralizing images .

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USE OF ONLINE SIMULATORS FOR THE FORMATION OF PRIMARY SCHOOL LEARNERS' COMPUTING SKILLS

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Abstract: *The article offers an overview of existing online simulators, such as LearningApps, Liveworksheets, Wizer.me, OnlineMSchool.com, http://miksike.net.ua, for the formation of computing skills of primary school children; it provides the analysis of advantages and disadvantages of their use. The educational online environment Miksike (http://miksike.net.ua) operating within the educational project Miksike in Ukraine is an effective means of developing computing skills in primary school learners thanks to the Pranglimine subsystem created in this system. These simulators not only develop the skills of oral calculations, but also give the opportunity to actively communicate to participants from different European countries (Estonia, Lithuania, Latvia and Slovenia).*

Thus, primary school teachers are offered a set of ready-made ICT tools for learners to acquire numeracy competence as a key one. At the same time, the question arises as to the approximation of the content of tasks for the formation of students' strong numeracy skills to the content of the tasks of a particular lesson. Therefore, there is a need for the teacher to develop interactive tasks that involve performing arithmetic operations of addition, subtraction, multiplication and division in the sections of "Ten", "Hundred", "Thousand" and "Multi-digit numbers". In this context, we have analysed online services that allow teachers to create interactive tasks that provide instant feedback and automatically evaluate the results of students' calculation activities: LearningApps, Liveworksheets, Wizer.me. Thus, two directions of ICT use in the formation of computing skills are proposed: the use of ready-made online simulators and the use of online services to create interactive tasks. As a result of studying the relevance of the problem of using ICT in the formation of computing skills in primary *school learners, a survey of primary school teachers was conducted, which showed the need of the teaching community regarding the aforementioned teaching aids.*

Keywords: ICT, online environment, online service, development of computing skills, primary school learners.

INTRODUCTION

An essential feature of modernity is the rapid entry of information and communication technologies (ICT) in both professional and everyday life of a modern person. It is obvious that ICTs force the human brain to change and respond differently to information. Primary school learners are representatives of the digital generation, a generation that has been existing in both physical and virtual environment since childhood. According to the results of the international project EU Kids Online, in Europe 80–90% of children aged 3–6 use the Internet, and every second three-year-old uses a tablet or smartphone (Soldatova, Rasskazova, 2012), (Soldatova, 2018). In neighbouring countries, including Russia, a third of primary school children spend at least 8 hours online. A similar situation is observed in Ukraine (Skvortsova, Onopriienko, Britskan, 2019). As a result, today “digital children”, characterised by certain features of the cognitive sphere caused by the influence of the virtual world, come to school. It should be noted that according to Kondratenko, the Ukrainian psychologist who studies the impact of ICT on the personality of modern school children (Honcharenko, Vavryk, Vereshchak, Kondratenko, 2014), the virtual world acts like physical, demanding the formation of the child’s abilities that allow him/her to survive.

In today’s world, it is almost impossible to avoid a child’s contact with the virtual environment. Therefore, based on the desire of children of the digital generation to be in the virtual world, it is necessary to study the possibilities of using ICT in the educational process, in particular in the formation of computing skills. Thus, the educational process should be based on the possibilities of ICT, which provide teachers with powerful and modern teaching aids, in particular for the formation of computing skills in primary school learners, and thus have a positive impact on the effectiveness of this process. The negative effects of ICT can be corrected in the classroom through the dosed use of digital tools, as well as through the control and guidance of students’ learning activities by the teacher.

Digital teaching aids provide educators with a large number of options for creating drilling exercises. As proved by psychologists (Menchinskaya, 1950) to form a certain skill or subskill, students need an average of about 20 drilling exercises. This thesis is confirmed by research data in neurophysiology which demonstrate that neural connections are formed within 7 days of their actualization. In order to develop the skills and abilities the teacher will find very useful all sorts of online services that offer students a large number of similar tasks with automatic verification. Performing such tasks, the learner for some time, resorts to training, and the possibility of automatic verification provides feedback, and the learner has information about the correctness of the exercises done.

The process of forming a good computing skill involves not only the discovery by students of the essence of the method of calculation, the calculation of schemes that present the approximate basis of action, but also the performing of a number of drilling exercises. Based on the needs of modern primary school learners in the presentation of educational information in the form of digital content, the question arises about the use of various interactive exercises and online simulators to form computing skills in them.

The purpose of the article is to analyse existing online simulators and services that allow teachers to create digital content for the formation of primary school learners' computing skills. Also, to present the received experimental data on the application of digital aids in the process of formation of 2nd grade pupils' computing skills.

1. ONLINE SIMULATORS FOR THE FORMATION OF PRIMARY SCHOOL LEARNERS' COMPUTING SKILLS

Scientists Brown, Rediger, and McDaniel link the process of acquiring knowledge and memory with physiological processes determined by the coordinated work of neurons and the formation of neural connections, and consider a characteristic feature of the brain – neuroplasticity, which is manifested in the ability to reorganize each new task (Brown, Rediger, McDaniel, 2019).

Thus, the formation of computing skills involves the strengthening of certain neural connections. The first such connections are formed when the child understands the explained material and works with it 1–2 times. A more lasting connection arises when, as a result of longer practice, the piece of material studied is applied in different contexts. Strong neural connections are formed because of interval repetition over a long period, and the development of a new skill takes an average of 21 to 28 days (Oakley, 2020; The power of habit, n.d.). It has been experimentally proven that the brain develops new skills and connections within 7 days of starting regular training. However, the acquired new skill disappears without support as quickly as it appears (What is "neuroplasticity", n.d.).

According to neurobiologist John Brewer, the formation of neural connections in the brain is associated with training (Brewer, 1999). One such training Brown, Rediger and McDaniel call online simulators, but point out the possibility of achieving good results through developing the habit of focused and persistent work (Brown, Rediger, McDaniel, 2019).

Some online simulators for the formation of computing skills in younger learners are posted on authors' sites, in particular on the site *OnlineMSchool* (https://onlinemschool.com/), which was created by Dovzhik (Ukraine). Among a number of simulators in mathematics on this site there are also calculation exercises for primary school. These include 13 tests: addition of two natural numbers, subtraction of two natural numbers, addition and subtraction of two natural numbers, multiplication tables, multiplication of one-digit and two-digit natural numbers, multiplication of one-digit and three-digit natural numbers, multiplication of two-digit natural numbers, multiplication of two-digit and three-digit numbers, multiplication of two three-digit numbers, multiplication of two natural numbers, division of two natural numbers, calculation with two natural numbers, division with remainder. When working online with computer simulators, the system records long sessions and thus directs the learner to speed up work. Moreover, this, as proved by Kawashima, a Japanese researcher and the author of the method of human brain development with simple calculations for time (Kavashima, 2012), actualizes the work of a large number of parts of the brain. Simulators for the formation of computing skills in junior high school students are offered by the educational online environment Mexico (http://miksike.net.ua), which is positioned as an educational online system that is a means of developing oral computing skills.

The educational project *Mexico in Ukraine* has been successfully implemented since 2014 in accordance with the Memorandum of Cooperation between the Ministry of Education and Science of Ukraine and OK MIKSIKE (Estonia). Within the project, teachers, learners, and parents are given the opportunity to create and use both their own online learning materials and an online collection of materials created by teachers – participants of the project.

In the context of educational reform in Ukraine, the project is designed to serve as a practical tool that helps to create an effective educational environment using modern information and pedagogical technologies. In order to develop computing skills in the system of *Mexico* they created the subsystem of *Pranglimine* (est. Pranglimine). This is a kind of platform that is recommended to be used by the Ministry of Education and Science of Ukraine for the development of oral mathematical calculations in learners of secondary schools (letter dated 17.08.2016 / 1 / 9–437 *"On Methodological Recommendations for Teaching Subjects in Secondary Schools"*).

Pranglimine is also considered as a powerful mathematical simulator for training and competitions in oral calculations for different age groups of users. The participants of this project are representatives of European countries – Latvia, Lithuania, Estonia, Slovenia and Ukraine, which participate in the annual competitions in oral calculations. In 2018/19, more than 70,000 participants took part in the first online stage of the competition in Ukraine. For primary school students, competitions are held in the following age groups: "chomuchky" ("why-so's") (grades 1–3) and "doslidnyky" ("researchers") (grades 4–6).

At the *Pranglimine* training ground, participants can choose feasible tasks (for adding, subtracting, multiplying and dividing natural numbers and integers) that involve filling in gaps or comparisons.

Pranglimine simulators are characterised by a clear structure and order. The tasks are divided into three categories: training with natural numbers, training with integers and training with decimal fractions. The second and third categories contain 7 types of exercises (addition, subtraction, addition / subtraction, multiplication, division, multiplication / division and random), and the first – 9 types (additional: comparison and insertion of the missing number).

Also, each type of tasks has levels of difficulty (from 1 to 6) and training is possible in two modes – standard and sprint. In the mode, the standard passage through each of the levels is 40 seconds. The transition to a higher level is subject to a certain number of points. In addition, the user can select a training on only one level for 240 seconds.

In sprint mode, the entire activity takes 190 seconds. The transition to the next level happens after completing all 5 tasks. If an error is made, the level drops by 1.
After selecting a task, a field appears in front of the participant, which displays the time and number of points. Participants have to perform as many exercises as possible with a minimum of errors.
If the user is registered on the site, their result is displayed in the table. The table of results provides a data filter by grade of learners, educational institution and territorial feature.
Computing simulators in the educational online environment of *Mexico* at the *Pranglimine* training ground, qualitatively differ from all online simulators in that: 1) a fairly large number of computational tasks are offered; 2) after completing the tasks, participants immediately receive on the screen a report on both the number of exercises performed and the mistakes made.
Systematic training for contestants has become possible thanks to the mobile application *MiksikeApp* on *Google Play*, which allows them to improve their oral computing skills using a mobile phone or tablet. The application works in off- and online modes and provides a small fee depending on the technical characteristics of the smartphone or tablet. To become acquainted with the application, there is a 10-day free version that can be downloaded at any time.

2. ONLINE SERVICES FOR CREATING INTERACTIVE CALCULATION EXERCISES

The benefits of using computing online simulators are beyond doubt and are confirmed by neuroscience data. At the same time, the question arises about the approximation of the content of tasks for the formation of students' skills of robust computing to the content of the tasks of a particular lesson. However, the training process is preceded by the process of developing computing skills. Therefore, there is a need for the teacher to develop interactive tasks, which involve the implementation of tasks from the textbook or activity book, which implements the stages of formation of mental actions, according to Galperin (Galperin, 1998). In this context, we have analysed online services that allow teachers to create interactive tasks that provide instant feedback and automatically evaluate the results of students' computing activities: *LearningApps, Live worksheets, Wizer.me.*
The possibilities of the *Learning Apps service* (http://learningapps.org/) as a means of teaching mathematics to primary school learners are analysed in detail by Skvortsova and Britskan (Skvortsova, Britskan, 2018), so we will not dwell on the general characteristics of this service but will note only that this service is one of the cloud services *Web 2.0* for the organization and support of educational processes and is a free international open educational resource.
A characteristic feature of *Learning Apps* is that there is a bank of ready-made interactive exercises available to the teacher, including computational ones.
Also, the teacher has the opportunity to either create similar tasks to those offered by the service or create their own interactive exercises using the tasks from a textbook or activity book.

It should be noted, in this online service, calculation tasks are checked automatically, and the results are displayed in the virtual class journal – correct / incorrect.

As not all *Learning Apps* templates are suitable for creating computational training exercises, we will consider those that we think are appropriate to use to create interactive exercises. For such interactive tasks the template *Fill in the blanks* is the most suitable. This template allows the learner to enter the results of numerical expressions, or to enter unknown components. The disadvantage of this template is the inability to present the task in the form of an image of the task from the textbook or activity book; there is only the possibility of presenting the task in the form of text.

Teachers can also design calculation problems in the *Free Text Answer* template, but students should write the results of the numerical expressions below the expression. But this template allows you to download both text and images. If the task is loaded in the form of a drawing, it will look the same as in the textbook or activity book. The service instantly checks the completed tasks and allows the learner to receive the test results – the tasks in the green frame are performed correctly, and in the red – incorrectly.

Teachers can also download a task as a picture in the *Image Fragments* template. This template is convenient to use for computational tasks in the form of chains or tables. In this case, the learner does not enter the answer, but chooses the answer from the suggested ones. Thus, clicking on the pin opens the student's answer options, one of which he/she clicks the mouse on.

We see the expediency in creating interactive exercises for calculations in the template *Find a pair*. Here it is possible to present the task both in the form of a text and in the form of a drawing. When completing the task, students have to choose a numerical value for the expression and move it to the expression so that they are grouped. The advantage of *LearningApps* is that learners can be given a link to a task both as a link and as a QR code, and it can be downloaded to any gadget that is connected to the Internet.

Liveworksheets (https://www.liveworksheets.com/) is a designer of interactive worksheets that look like a regular activity book. The service allows the teacher to use ready-made tasks created by other teachers, and he/she can see in which template each interactive task is performed.

To create interactive worksheets, the teacher can download the pages of an activity book and, using keywords that match different templates, make each task of the book interactive. Moreover, learners can repeatedly perform tasks in order to obtain a perfect result. After the learner completes the task, the service instantly checks the correctness of the obtained solutions. Correctly performed tasks are marked in green and incorrectly performed or missed tasks in red.

Worksheet tasks are created in the template *Text field for writing the answer*, which involves writing numbers directly in the cells of the activity book. This template is the most attractive for creating interactive computing exercises.

It should be noted that the *Text box for writing an answer* template is similar to the *Fill in the blanks* or *Free text answer* templates of *Learning Apps*, but the ability to make a printed book page interactive thanks to *Liveworksheets* seems more attractive.

In addition, the *Liveworksheets* service has the ability to enter, namely in the solution schemes, the required numbers, which allows you to visualize the calculation process, to clearly present the approximate basis of computing activities.
In the tasks created in the *Movement* template, learners have to drag another equality to equality, which is a test of the correctness of the solution. This template is analogous to the *Learning Apps* template, but in this *Movement* template the task condition is overlapped by its answer, which is inconvenient. For training exercises for the formation of computing skills, the use of this template is quite limited due to the small number of this type of exercises.
An analogue of the *Learning Apps* template in *Liveworksheets* is the *Line Drawing* template. This template can be used in problems to calculate the values of expressions by selecting the answer from the proposed number. However, the number of expressions and the number of answers must match; extra numbers cannot be added, so in this template it is possible for the learner to guess the answer. Therefore, we will not use it as training exercises for the formation of computing skills.
The *Wizer.me* service (https://app.wizer.me/), similarly to *Liveworksheets,* is an interactive worksheet designer, on which teachers can create their own simulators for the formation of computing skills. The service allows the teacher to view and use ready-made interactive worksheets, but when viewing it is not possible, as in *Liveworksheets*, to find out in which template the task is completed. Let us limit ourselves only to the templates of this service, which allow teachers to create simulators for the formation of computing skills.
The *Fill in the image* template is analogous to the *Text box for writing a response* template in the *Liveworksheets* service – the task is downloaded as a picture from an activity book, but unlike *Liveworksheets* there is no text box for writing a response, it should be opened in *Wizer.me*. You can also consider similar templates *Free text response* and *Fill in the blanks* from the *Learning Apps* service. But the *Learning Apps* template does not allow you to download the task in the form of images.
Wizer.me also has a *Match Pair* template, which is similar to the *Line Drawings* template in *Liveworksheets* or the *Learning Apps Pairing Pattern*. But, as we mentioned above, we consider it inexpedient to use, because the number of numerical expressions and numerical results is the same, and at some stage learners can guess the answers.

3. FORMATION OF COMPUTING SKILLS OF ADDITION AND SUBTRACTION OF TWO-DIGIT NUMBERS USING ONLINE SIMULATORS AND INTERACTIVE EXERCISES

Experimental work on the formation of computing skills of addition and subtraction with the transition through the category continued in the I–II semester of 2019/2020 academic year in the 2nd grade of Ivano-Frankivsk secondary school № 11. In the I semester in 2-A, 2-B and 2-C classes there were conducted entrance testing sessions, the purpose of which was to determine two grades approximately equal in average indicators of the formation of computing skills of addition and subtraction with the transition through the category within 20. To select two classes for participating in the experiment we used the following research methods: the study of school documentation

– class journals, interviews with class teachers, testing of the students of two classes selected on the basis of analysis of documentation and content of conversations. The diagnostic test was designed according to the method of Agibalov (Agibalov, 1987). It contains 30% of reproductive tasks; 50% of partially productive; 20% of productive-creative tasks. A properly performed task of reproductive nature is estimated at 1 point, of partially productive – at 2 points, and of productive – at 3 points. When processing the results, the coefficient of test performance (K) was calculated – the ratio of the total number of points obtained by learners during the test to the maximum number of points per test, i.e. the total number of points in the correct performance of all test tasks.

Entrance testing was conducted in the form of independent work. Here is the content of test tasks:

Part I:

Variant 1	Variant 2

1. Calculate the values of the problems by performing an expanded record of the solution:

13 – 6 7 + 4 15 – 8	4 + 8 12 – 5 17 – 9

Part II:

2. Calculate the values of the problems in different ways:

14 – 7 5 + 8 11 – 5 6 + 5 15 – 9	15 – 7 6 + 9 11 – 5 5 + 8 13 – 7

Part ІІІ:

3. Arrange parentheses and signs of arithmetic operations so as to obtain true equality:

7…4…5…6 = 12; 3…7…6…7 = 9	7…6…4…9 = 8; 4…9…6…3=10

Table 1 shows the test results during the ascertaining experiment:

Table 1

The average coefficient of test performance by classes

Classes	Average number of points for Part I	Average number of points for Part II	Average number of points for Part III	Average number of points for the test	Maximum number of points for the test	Coefficient of test performance
2 – „A”	2,8	5,9	2,4	11,1	19	0,58
2 – „B”	2,82	5,95	2,5	11,3	19	0,59
2 – „C”	3	6,7	3,4	13,1	19	0,69

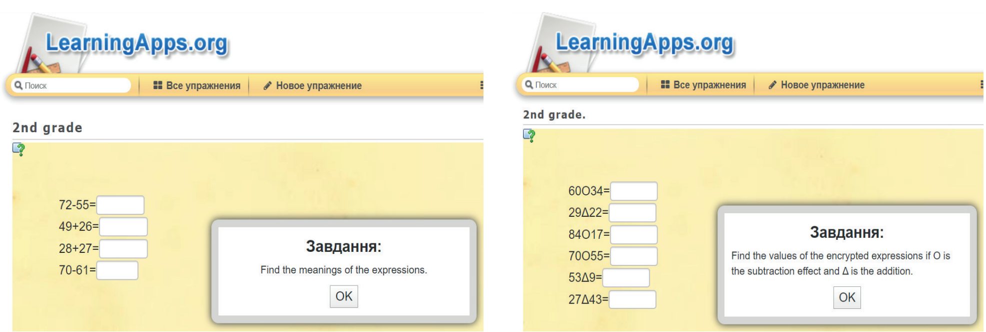
It should be noted that the table shows the ratio of the number of learners who have computing skills of addition and subtraction within 20 with the transition through the category to the total number of students in the class.

As you can see from Table 1, classes 2-B and 2-A are approximately the same in terms of averages, so they were selected as experimental and control classes: 2-A was selected as experimental and 2-B – control class.

The purpose of the formative experiment was to test the effectiveness of the use of digital tools in the formation of computing skills of addition and subtraction with the transition through the category in primary school learners.

In December 2019 – February 2020 and early March 2020 in the experimental and control classes there was a traditional training, during which learners mastered the techniques of calculation within 100 with the transition through the category: addition and subtraction in parts, bitwise addition and subtraction, addition based on rules for adding a number to the sum, subtraction based on the rule of subtracting a number from the sum, as well as rounding. During the traditional training in the school, students performed tasks using the material of teaching – a textbook and an activity book. Beginning on March 12, during the quarantine caused by the COVID-19 pandemic, computing skills were developed in the experimental class using interactive exercises created in the online service *LearningApps*, *Liveworksheets* and using online *Pranglimine*. Training in the control class took place without the use of interactive exercises *LearningApps, Liveworksheets* and online simulators.

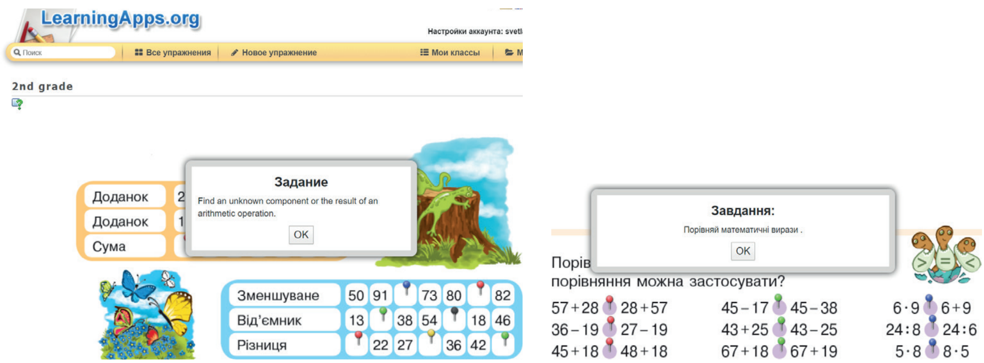
Based on the characteristics of learners – representatives of the digital generation, namely the clip of their thinking, taking into account the neurophysiological principles of human brain development by means of calculations (Kawashima, 2012) and interactive approach to learning (Oakley, 2020), in order to develop computing skills, we created a complex of interactive exercises in the online service of *LearningApps*. Thus, the system of interactive exercises contained tasks for calculations, presented in the traditional form, tasks presented in the coded form, in which the sign of the arithmetic operation of addition was marked by a triangle, and subtraction – by a circle (Fig. 1). The tasks were created in the *Fill in the blanks* template, which allows students to enter the results of calculations immediately after the equals sign.



F i g u r e 1. Interactive calculation exercises created in the *Fill in the blanks* template in the *LearningApps* service

S o u r c e: own work.

This is the most convenient template for creating interactive computing exercises. But this template does not allow you to download the condition of the task in the form of a picture – a screen from a textbook or an activity book. Therefore, to create interactive exercises based on the picture – the task screen from the textbook, it is advisable to use the template *Fragments of images*. In this template it is advisable to create interactive exercises for calculating the unknown components of the arithmetic operations of addition and subtraction (Fig. 2).



F i g u r e 2. Interactive calculation exercises created in the *Fragments of images* template in the *LearningApps* service

S o u r c e: own work.

In order to develop good computing skills, learners need to be offered a large number of training exercises over a long period of time. Therefore, we have prepared more than 20 interactive exercises in the templates of the *LearningApps* service. At the same time, taking into account such a feature of clip thinking of students of the digital generation as fast switching, students should be offered interactive exercises created in different services. Thus, learners will perform interactive exercises, which are presented in different forms, in significantly different patterns. Therefore, in addition to the *LearningApps* service, we also used the *Liveworksheets* services.

The Answer Text Box template in *Liveworksheets*, as well as the *LearningApps*' *Fill in the Blanks* template, allow teachers to create interactive computational tasks. Students should also write down the numbers that are the results of the calculations in the appropriate places, which are marked with boxes for writing answers. Unlike *LearningApps, Liveworksheets* has the ability to download a picture – a screen of the textbook task, which is much more attractive to learners (Fig. 3). Downloading the task condition in the form of a drawing makes it possible to direct the learner to use a certain method of calculation, focuses their attention on the individual steps of the indicative basis of action.

In addition to the interactive exercises created in the *LearningApps* and *Liveworksheets* services, the online classroom *OnlineMSchool, Mexico (Pranglimine)* was used in the experimental class. The tasks used with these simulators concerned the use of computing techniques within 20 of different complexity. The principle of interval learning was applied, when the performance of a certain type of task was repeated under the condition of a certain interval, which was at least one day (in each mathematics lesson).

F i g u r e 3. Interactive calculation exercises created in the *Text box for writing the answer* template in the *Liveworksheets* service

S o u r c e: own work.

In order to determine the effectiveness of the use of interactive exercises and online simulators in the process of developing computing skills, after the completion of experimental training, the testing of learners of experimental and control classes was conducted.

The testing was conducted in the form of independent work. The final test was also designed according to the method of Agibalov (Agibalov, 1987). Here is the content of test tasks:

Part I:

Variant 1	Variant 2

1. Calculate the values of the problems by performing an expanded record of the solution:

53 – 36 47 + 24 75 – 42	34 + 28 62 – 45 87 – 34

Part II:

2. Calculate the values of the problems in different ways:

24 – 17 25 + 28 14 – 7 6 + 9 65 – 24	45 – 37 64 + 28 11 – 5 5 + 8 85 – 33

Part Ш:

3. Arrange parentheses and signs of arithmetic operations so as to obtain true equality:

37…24…45…16 = 0; 53…17…26…17 = 79	74…16…37…17 = 0; 41…29…16…32 = 86

Table 2 shows the results of the final testing.

We should note that the table shows the ratio of the number of learners with certain skills to the total number of students in the class.

Table 2 shows that the average formation of computing skills of addition and subtraction in the experimental class is much higher than in the control class. This gives grounds to draw a conclusion about the effectiveness of the use of interactive exercises and online simulators in the process of forming elementary school learners' computing skills compared to traditional methods.

Table 2

The average coefficient of test performance by classes

Classes	Average number of points for Part I	Average number of points for Part II	Average number of points for Part III	Average number of points for the test	Maximum number of points for the test	Coefficient of test performance
Exper.	3	8,2	3,7	14,9	19	0,78
Contr.	2,45	5,88	2,43	10,76	19	0,59

CONCLUSIONS

Changes in modern society necessitate the use of digital tools. That is why learners of the digital generation, who started using the Internet at a preschool age, come to primary school today. Entering the virtual world causes changes in their cognitive development. Children are more actively developing those abilities that allow them to survive in the modern world.

The mechanisms launched by world progress no longer allow the child to use the virtual environment. Therefore, it is advisable to use ICT for educational purposes, in particular for the formation of computing skills, which significantly affects the effectiveness of this process, and the negative effects can be eliminated by adjusting the necessary dosage of the time of their use in the classroom.

Most primary school learners are characterised by clip thinking, which is dominated by visual perception of information through its presentation in the form of diagrams, pictures, or video images. This can be used in the construction of the educational process, when the use of digital tools, in particular online simulators, allows learners to quickly and efficiently master the training material, to develop their computing skills.

We analysed online services that allow teachers to use ready-made tasks *(OnlineMSchool, Mexico (Pranglimine))* and create interactive exercises to identify feedback and evaluate the results of computing activities of students *(LearningApps, Liveworksheets, Wizer.me)*.

The effectiveness of the use of online services for the formation of computing skills in primary school learners was evidenced by the results of the experiment. Thus, the diagnostic test was built according to the method of Agibalov (Agibalov, 1987), in which the design of tests takes into account four levels of learning by students. Those levels of knowledge acquisition were determined using test tasks of three types: 30% were reproductive tasks; 50% – partially productive; 20% – productive, i.e. creative tasks. A properly performed task of reproductive nature is estimated at 1 point, of partially productive – at 2 points, and of productive – at 3 points. The average values of the final test were determined by the experimental and control classes.

The results of the formative experiment showed the effectiveness of using interactive exercises and online simulators *(LearningApps, Liveworksheets and Pranglimine)* in the process of developing computing skills in primary school learners compared to traditional methods.

Prospects for further research are to create interactive tasks in other services, including *Wizer.me*, in order to form the computing skills of primary school learners in the concentration of “Ten”, “Hundred”, “Thousand”, and “Multi-digit numbers”.

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E-LEARNING USING MODERN TECHNOLOGIES SUPPORTING INNOVATIONS BASED ON A SCIENTIFIC APPROACH

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Abstract: *This paper focuses on the evaluation of virtual distance learning during the Covid-19 pandemic in IT (information technology) courses for Operating systems and CRM (Customer Relationship Management) systems. The evaluation is based on a decision matrix and Saaty's method for working with selected metrics (criteria), such as advice from a teacher, communication, meetings, testing, time, and understanding. Saaty's method is used to calculate weights for selected criteria to determine the significance for learning. The results show the division of criteria into two groups with higher and lower impact on learning. There is a big difference between them, and this imbalance is also visible in the test results, which are on average. Communication, meetings and advice from a teacher show lower influence on learning, but they are critical criteria. The reason for this fact is that if it is difficult to live, then it is also difficult to learn about new skills. Weakness is a practical activity in seminars; there were limits to work with IT at home but cloud and virtualization helped. The interest in education is positive. Many entrepreneurs (students) have stopped doing business and this time benefited from learning and thinking about the future.*

Keywords: E-learning; information technology; innovation; key competences.

INTRODUCTION

From a public point of view, e-learning is the use of information technology (IT) in education. The first ideas about e-learning date back to 1999 and are based on computer training (What is e-learning, 2020). Since then, e-learning has taken many years to develop a comprehensive solution for education, deep learning (McTighe & Silver, 2020), or effective tasks in blended learning (Sagan et al., 2019, p. 171). This form of education is aimed at universities, schools of various levels, and also enter-

prises. The reason is the offer of a standard method for learning about current trends, training on occupational safety, or training new employees.
The importance of e-learning is always visible. It is about acquiring new skills that are needed for better work. Throughout history, books, educational and scientific literature have been the main sources of information and knowledge. The global information society has the Internet and websites for distributing large amounts of information. Information is everywhere, but its value is knowledge and critical thinking about innovation with different relationships, such as social, emotional, and cultural (Markowitz & Bouffard, 2020). At the time of Covid-19, life is closely connected with digitalization and the virtual world. And again, e-learning is irreplaceable in building progress in an innovation-based society. On the positive side, e-learning also has experience with innovation (Jarrett, 2018) and the results affect education at all times (by default and times of crises). This approach is specified from the past, present, and is also a good idea for the future combination using art and science (Marzano, 2017).

1. THE ROLE OF INNOVATION IN SOCIETY

Strong pressure creates initial competition, which is everywhere at default times, and innovation is useful help. Innovations often focus on information technology (Brown (Author) & Heitsch (Narrator), 2020) to create a new combination of existing technologies and methods into a new concept or design. This approach requires new skills and time to validate and implement new ideas into practice. Many enterprises have their own research departments and conduct regular knowledge-sharing training to promote the quality of offered goods and services, customer loyalty, revenue, and brand reputation. 2020 is different because global society lives at a time of pandemic. It is hard to live, do business, and it is also hard to think about innovation. Certainly, it is difficult to think about innovations at a time when people have doubts about life and there are many limitations. From another perspective, it is an opportunity to think about new areas of business to be successful (Gladwell & Hill, 2020). In many cases, the business was stopped. It is hard to know about future business renewals. Thus, it is time to think about innovations using information technology (for example, to support e-shopping and contact customers through online tools), or to start a business in a new area that will help other people's needs. Perhaps everyone feels that it is now more about sustainable development than at other times.
And life at a time of pandemic fosters many innovations that are implemented into our lives. Of the many, there are several examples that show the implementation of information technology in order to continue doing business:

- Automatic online sensors for inventory monitoring (Scotti, 2020).
  There are sensors that measure temperature, humidity, and other necessary data, which are automatically sent to the application. Farmers check necessary conditions for stored grain or the silage.
- The zaparkuju.cz application for discovering new parking spaces (Novak, 2020).
  This is a quick orientation in urban areas with the simplification of online payment and the possibility of booking a parking space. In the Czech Republic,

there are also parking spaces for people with disabilities and a list of charging stations for electric cars.

- Chatbot Karel Klostermann as a digital guide (Scotti, 2020).
  It is a digital guide that writes to visitors on the Messenger platform. The application offers communication with the visitor and shows interesting places in Sumava.
- A tool for automating the sales of photographs (Scotti, 2019).
  This application generates keywords and automatically assigns categories to photos using artificial intelligence. It automatically sends photos to photo banks to save time and make money.

These applications are interested in the Internet of Things (IoT), automation, artificial intelligence, and social networking because they are well known to people in a global society. To develop this application, authors combine skills from the selected area and information technology. It is also about optimal communication with customers and building a better world. And again, e-learning and education help to better implement information technology in practice. By default, it is a multidimensional task and it is important to continue this process even at difficult times such as a pandemic.

2. LIMITATION FOR E-LEARNING AT A TIME OF PANDEMIC

The advantages of e-learning are visible in many aspects such as efficiency, speed, individual approach, and lower expenses (on travel, or reduction of profit due to loss of time spent on education). Where there are advantages there are also disadvantages. The latter are: little time to study, little or no feedback, weak motivation, and also better opportunities to cheat in education (E-learning advantages, 2020). Information technology is an important part of the education process. This situation is well illustrated by data on investment in educational technologies. It is estimated that the future development of e-learning investments will have reached about USD350 billion by 2025. The focus is oriented on e-learning software, language apps, video conferencing tools, and virtual tutoring (Li & Lalani, 2020).

Various platforms are used to arrange study lectures and documents. From a global perspective, tools such as ELMS (Easyclass Learning Management System), MOOC (Massive Open Online Courses), the Moodle platform or Zoom Classroom are well known. Default requests are for educators to create online courses so that they store course materials, create tests to manage exams with assessment, and track deadlines, as well as provide feedback to students. Other communication options between faculty members and students are e-mails, messages, chat via Skype, and WhatsApp. Video recordings and PowerPoint presentations were also useful, as the educator creates instructional videos and PowerPoint presentations are accompanied by audio commentary.

At the time of the pandemic (since March, 2020), initial full-time teaching was immediately stopped. E-learning is used for all forms of education, study materials have been created, and videos with tests. The Silesian University in Opava uses the MS Teams application for online communication. The lectures were at a good level because presentations at virtual conferences or webinars are a standard part of teaching work. It was new to some students who needed login or setup advice to attend lectures. Many of them sent additional questions by e-mail, Skype or chat in Teams application. Practical examples of seminars were a bit difficult. In full-time teaching, students see a way in which to solve these examples. It is time to think about solutions, and if possible then teacher goes to the student to repeat what is needed. The MS Teams application may project real application management and students see a solution. The teacher may also create a presentation with pictures and comments or video sequences, but still, it is one-way communication. From the teacher's point of view, the weak point was the absence of the possibility to see students' work with the application. The reason was that not all students had the opportunity to run the selected application on their own computer. In such a situation, it was an alternative choice to use an application in the cloud or life image with virtualization. Over time, it is good to evaluate lectures without full-time teaching according to metrics in order to better describe their changing impact on education.

3. EVALUATION OF VIRTUAL DISTANCE LEARNING WITHOUT FULL-TIME TEACHING IN CLASSROOM

Evaluation of education is a standard part of e-learning. Pragmatic results are visible in exams to prioritize the best ones, such as A or B or C. Another view is visible so that students have a better orientation in the topic. It is a good understanding of the necessary terms and knowing of optimal methods of work. Courses focused on operating systems and CRM (Customer Relationship Management) are about working with CRM systems and basic software, such as the operating system. Each student is an individual and what is interested in one it not interested in others. In these cases, training leads to inspiration in different IT implementations so that they may be combined for innovations. In this regard, metrics must reflect different preferences and goals. There are many approaches to evaluation, such as:

- Training metrics for measuring the effectiveness of e-learning (Ibraeva 2019).

Training is associated with increasing performance and success in business. Metrics focus on reactions, learning, behaviour, and outcomes. The reactions are about satisfaction with teaching, learning is about new skills and the level of knowledge, the behaviour is the ability to apply new skills in practice, the outcomes are visible in changes in society.

- Key learning metrics (Sharma 2018).

This approach prioritizes metrics such as completion rate, student progress, student satisfaction, manager (educator) evaluation, and student competence. The completion rate shows the level of student participation, the student's progress provides information on the success rate in online training and assigned tasks, and student satisfaction from online training. The evaluation of the manager shows active participation and motivation. For the last metric, student competence is the ability to declare that the student has the necessary skills and knowledge.

- E-learning success metrics (Yengin et al. 2011, p. 1396).

This method is more of a history, but it shows a comprehensive view of success metrics. There are metrics such as system quality, quality of information, service quality, user satisfaction, and network benefits. System quality monitors the level of user-friendly, safe, and fast. The quality of information focuses on competencies, well organized, and useful. Service quality is about availability, responsibility, and knowledge. User satisfaction is interested in the overall success and the network benefits are about saving time, but also in isolation and lack of contact.

The inspiration for this paper is based on a decision matrix (Boogaard, 2018), with which to evaluate learning at initial times (full-time teaching) and at pandemic times (virtual distance learning without full-time teaching in the classroom). It is a tool for analyzing individual options according to specified metrics (criteria). The necessary metrics were selected such as advice from a teacher, communication, meetings, testing, time, and understanding. Advice from a teacher focuses on the ability to help every student who needs it. Meetings are focused on the necessary interpretation about a given topic based on a syllabus of accredited courses on realized events. Testing always plays an important role; therefore this metric is also selected. The latest metrics focus on time and understanding. From the teacher's point of view, it is more about trust between students and educators. This aspect is important in communication between people, and it is more important at the time of pandemic.

The method of learning evaluation for lectures and seminar activities is derived from the method of creating a decision matrix. First, it is necessary to create a table in which the individual rows are focused on lectures and activities in seminars, in order to evaluate the various work during full-time and distance learning. The columns focus on criteria (selected metrics) for learning assessment (see Table 1).

Table 1

Evaluation of learning in focused courses on operating systems and CRM systems

Evaluation of learning according to the form of education	Selected metrics (criteria)					
	Advice from a teacher	Communication	Meetings	Testing	Time	Understanding
Default full-time teaching						
Lectures	4	4	3	3	3	3
Activities in seminars	5	5	5	5	3	4
Distance learning during a pandemic						
Lectures	3	5	5	3	4	4
Activities in seminars	2	1	4	2	2	2

Source: Own work.

Selected criteria (metrics) were evaluated on a scale from 1 to 5 (1 = weakest, 3 = average, 5 = best). By default, full-time teaching is a recurring classroom meeting based on an assigned schedule and an accredited course focused on operating systems and CRM systems. It is the starting activity and the rating is linked to the average number 3 in multiple criteria. Practical activities in seminars are preferred and assigned the highest number for advice from a teacher, communication, or meetings. This is also better for understanding because practical work supports a good orientation in the topic and students are in a better position to innovate in business. This criterion is evaluated 4.

During a pandemic, virtual distance learning changes the initial meetings and face-to-face speaking is limited. The learning was realized with the support of the e-learning website, the university information system, local disks, which are accessible via a web browser, familiar e-mail, and the Teams application for communication in virtual form based on microphone, headphones, and camera. On the positive side, meetings were not limited in time and teachers may respect students' preferences. This is not a schedule-based time. The higher rating is also for lectures, as educational documents have always been available as the default, and communication with students has taken place with the support of presentations through the Teams application (voice, pictures, videos, and chats). The weakness is evident in the activities in seminars. The reason is the limitation of the working environment to operating systems and CRM systems. It was impossible to teach in classrooms on computers and it was necessary to use cloud or mobile solutions. Another aspect was that it was easy to show the right capabilities of selected applications and operating systems for students, but in some cases, it was one-way communication. Students had no ability to repeat the necessary activities on their own devices or cloud applications. It was about patience and respect that this time was unexpected for everyone. These reasons have the effect that the evaluation of activities in seminars is lower. A higher rating is assigned to meeting because students were interested in continuing their education and inquired more and more through chat and e-mails.

It is good to see more a complex evaluation of learning based on multicriteria managerial decision making according to Saaty's method. Saaty's method was developed by Professor Thomas L. Saaty (Creative Decisions Foundation, 2020). Saaty's method is well known and permits one to take measurements in changing conditions. For the evaluation of learning, it is important to determine the weight of each criterion. This method is divided into a three steps:

- Creating a table to determine the Saaty's matrix S.

The created table (Saaty's matrix $S = s_{ij}$, where i, j = 1, …, n) is defined by the calculation specification for the evaluation of six selected criteria (n = 6), such as advice from a teacher, communication, meetings, testing, time, and understanding. The numbers of the matrix represent estimates of the proportion of the weights between two criteria i and j. The degree of importance is evaluated by numbers from 1 to 9: 1 – equivalent criteria i and j, 3 – slightly preferred criterion i before j, 5 – strongly preferred criterion i before j, 7 – very strongly preferred criterion i before j, 9 – absolutely preferred criterion i before j. Values 2, 4, 6, 8 – express intermediate levels (see Table 2).

- Specification of weights using a geometric diameter to be applied on the matrix S (Saaty, 2008).

The resulting weights v_i for i = 1, …, n are calculated according to the formula:

$$v_i = \frac{\left(\prod_{j=1}^{n} s_{ij}\right)^{1/n}}{\sum_{i=1}^{n} (s_{ij})^{1/n}} \quad (1)$$

(see Table 3).

- Validity verification of the matrix S to avoid inconsistencies.

Weight specifications may not always be correct. It is necessary to do a validity verification. To verify the validity of the table, it is necessary to calculate the consistency ratio (CR) using the consistency index (CI), the random index (RI) and the largest eigenvalue of the matrix (λ_{max}):

$$CR = \frac{CI}{RI} \quad (2),$$

where $CI = \frac{\lambda \max -1}{n-1}$, and RI = 1.24 for n = 6.

If CR is less than 0.10, it indicates that Saaty's matrix is reasonably consistent.

Table 2

Saaty's matrix for the evaluation of learning in targeted courses on operating systems and CRM systems

Evaluation criteria (metrics)	Advice from a teacher	Communication	Meetings	Testing	Time	Understanding
Advice from a teacher	1	1/5	1/2	1/3	1/7	1/7
Communication	5	1	1/2	1/3	1/5	1/7
Meetings	2	2	1	1/3	1/3	1/5
Testing	3	3	3	1	1/2	1/7
Time	7	5	3	2	1	1/2
Understanding	7	7	5	7	2	1

Source: Own work.

Table 3

Calculated weights for selected criteria (metrics) for the evaluation of learning in targeted courses on operating systems and CRM systems

Evaluation criteria (metrics)	Weights (v_i for i = 1, …, 6)
Understanding	$v_1 = 0.448$
Time	$v_2 = 0.250$
Testing	$v_3 = 0.129$
Meetings	$v_4 = 0.077$
Communication	$v_5 = 0.062$
Advice from a teacher	$v_6 = 0.034$

Source: Own work.

Last step is to validate the table to avoid inconsistencies. This is the consistency ratio CR, where CR = 0.102/1.24 = 0.082 (λ_{max} = 6.511). Because CR is less than 0.10, Saaty's matrix is reasonably consistent.

Based on the calculated weights, the selected criteria are divided into two groups. The first group (such as understanding, time, and testing) has a higher impact on learning. It is acceptable to have such results because the great benefit of learning is to understand the activities performed at a given time, and it is good to declare new skills by testing. The second group (such as meetings, communication, and advice from a teacher) has a lower impact on learning. From a pragmatic point of view, educational materials are available online, and there is no need to meet face-to-face or online in a virtual space. In addition, many resources are available on the Internet; therefore, students have opportunities to know about new approaches. However, there are difficulties in understanding and there is a lack of good orientation in the topic and suitable resources from the Internet. This disproportion seems to have a deeper meaning, and this is visible in the actual test results at the time of the pandemic without excellent results. From a pragmatic point of view, the teaching of test results (from A to F) was also different. At the initial full-time teaching, there is variability and students have exams from the entire spectrum. Now the exam period is in the middle (will end on August 31, 2020), but exams are completed in C and D. Education is always about mutual communication between teachers and students. It is the basis of work for understanding the implementation of information technology in practice and continuing innovations according to their own preferences and skills. It is the same during a pandemic. The following words of a student from a survey on learning experiences mirror this situation: "the subject is practically focused, the teacher communicated and lectured during the coronavirus … great".

CONCLUSION

Education is always important for all areas of human activity. In many cases, it is associated with the possibilities of information technology. This year is different. Covid-19 changes plans and many activities have been cancelled. The evaluation of learning during a pandemic has strengths and weaknesses. The great interest in e-learning and the fact that students are interested in participation at lectures in a virtual form are positive. Weakness was practical work in seminar activities. In some cases, it was one-way communication because it was difficult for some students to repeat the work with operating systems and CRM systems. Saaty's method was used for a more detailed evaluation of learning. Saaty's matrix S and weights were calculated for selected criteria to show the effect on learning. Understanding, time and testing have a higher impact on learning (more than 10%). And meetings, communication and advice from a teacher have a lower impact on learning (below 10%). This difference is not good and affects the test results, which in many cases reach an average level. This is also reflected in the large gap between intensive communication with a teacher (via the Teams application and e-mail) and exams with results between C and D. There are also a number of students who must complete the exam yet.

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DISTANCE LEARNING TOOLS AND TRENDS: LOCAL SURVEY OF UKRAINIAN EDUCATORS

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Abstract: *The paper considers distance learning tools and trends, as they are very relevant during quarantine. It also examines Ukrainian educators' level of knowledge and skills in using modern distance learning tools and trends. For this purpose, the present authors have designed and implemented a local survey for the Ukrainian university teaching staff (target group) who need to use distance learning tools and trends in their research and professional activity during quarantine. The authors offer ways of improving the Ukrainian educator's level of knowledge and skills in the use of distance learning tools and trends in their professional activity, especially under the quarantine conditions and the ways of development of the Ukrainian educators' digital competencies through the training and retraining of the teaching staff based at the National Pedagogical Dragomanov University in order to prevent gaps in their professional activity.*

Keywords: digital technologies, distance learning tools, distance learning trends, quarantine.

INTRODUCTION

The key resource of the digital society is citizens who are able to effectively and productively use digital technologies for their own needs (self-realization, work, study, leisure), as well as to achieve common economic, social and civilian goals. In this regard, the formation of digital skills and competencies of Ukrainians acquires special significance, which cannot be realized without the transformation of education (Economic Strategy of Ukraine, 2030).

The directions of modernization of education largely depend on the needs of the labor market, which, recently, is very dynamic. In the conditions of rapid development of high technologies, higher education institutions, first of all, pedagogical ones, need to make adjustments in aspects of their activity, in particular, to update the content of training.

The digital transformation of education opens wide prospects for improving the efficiency of the educational process, deepening the professionalism of educators. Requirements to teachers and lecturers are constantly updating. New and more sophisticated sets of competencies are required to meet the rapid changes in the digital society. The rapid spread of digital devices, their diversity, and popularity among students leads to the need for developing the digital competence of educators (Morze, Vember, & Hladun, 2019, p. 33).

The situation in the world, which has arisen due to the pandemic 2020, is leading to fundamental changes in the educational systems of many countries, including Ukraine. Due to quarantine measures, blended and distance learning technologies come to the fore. Now skills in using distance learning tools are necessary for all educators.

Research goal. This paper reviews the results of the recently completed study specifying readiness level of Ukrainian educators to use the distance learning tools. This attempts to address the following questions:

- analysis of the theoretical backgrounds of the research;
- analysis of the distance learning tools;
- analysis of the readiness level of the Ukrainian educators (from target group) to use of the distance learning tools according to the survey conducted.

Hypothesis: taking into account rapid development of the digital technologies, authors believe that the efficiency of the education in general will be increased by improving the development level of their Digital Competences, especially skills in using distance learning tools.

Research methods. The present authors have used the following research methods and tools for the investigation (2020):

- survey;
- interview of the Ukrainian educators;
- documents and content analysis;
- analysis of research papers.

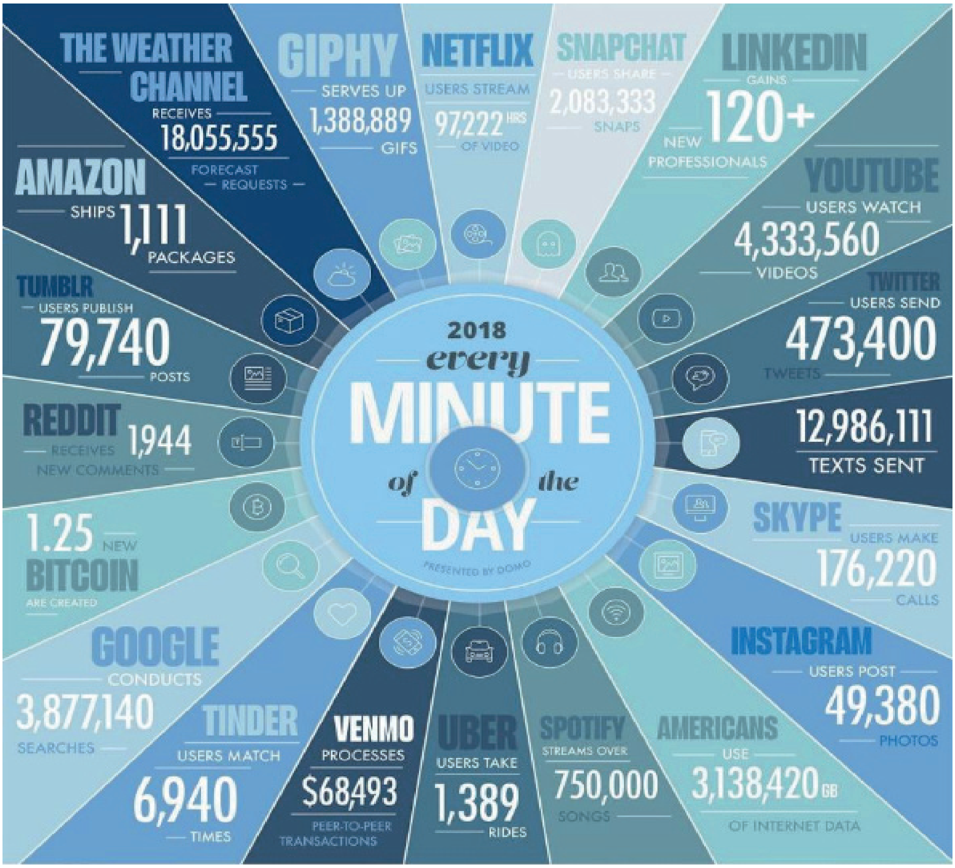
194 Ukrainian educators have taken part in the present research. The Ukrainian educators from the target group (university teaching staff from the National Pedagogical Dragomanov University, Kyiv, Ukraine), have been involved in this process.

The survey was created during this project which purposed to gain data on the readiness level of the university teachers to use the distance learning tools.

1. THE THEORETICAL BACKGROUNDS OF THE RESEARCH

Nowadays, the development of digital technologies leads to the transformation of business models, resulting in the constant introduction of new products and services, changing the work format/mode (outsourcing, online platforms, improved automation, robotics, etc.). Working in real-time mode with the use of digital data dramatically changes the ways of management, production, sale and use of products (Vyshnevskyi, Harkushenko, Kniaziev, Lypnytskyi, & Chekina, 2020).

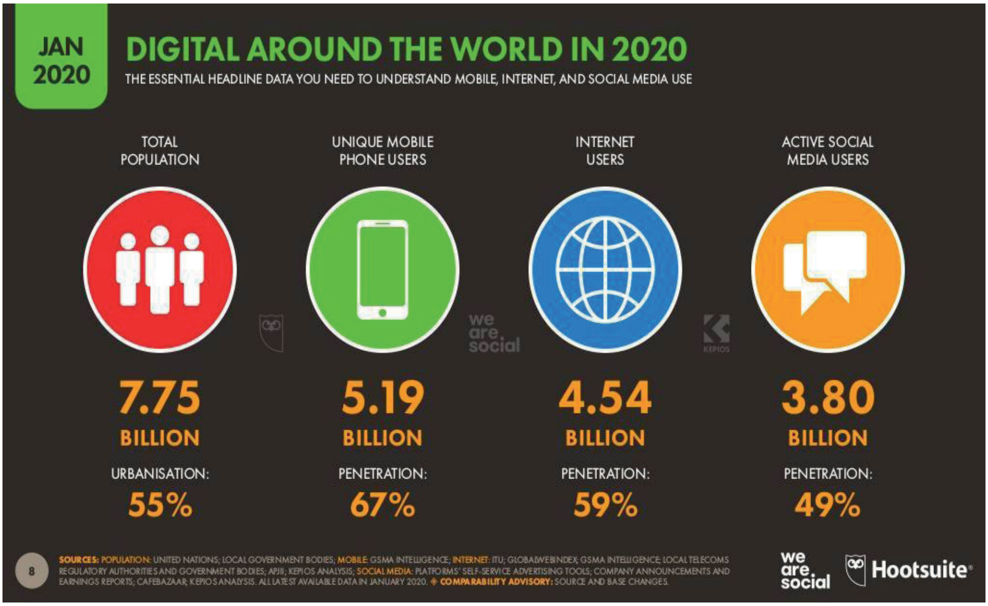
Fig. 1 (infographics) shows an example of the digital technologies entering to our daily life. The information graphics has been developed according to the data of such web portals as Statista, LinkedIn, Internet Live Stats, Expended Ramblings, Slash Film, RIAA, Business of Apps, International Communications Union, and International Data Corporation. This information visualization shows what happened in 1 minute of human activity using digital technologies in 2018 (Data Never Sleeps 6.0, 2018),



F i g u r e 1. The results of daily human activities using digital technologies in 1 minute in 2018

S o u r c e: URL: https://issuu.com/learningtreeintl/docs/data_never_sleep_6_-_infographic (accessed on 11.07.2020).

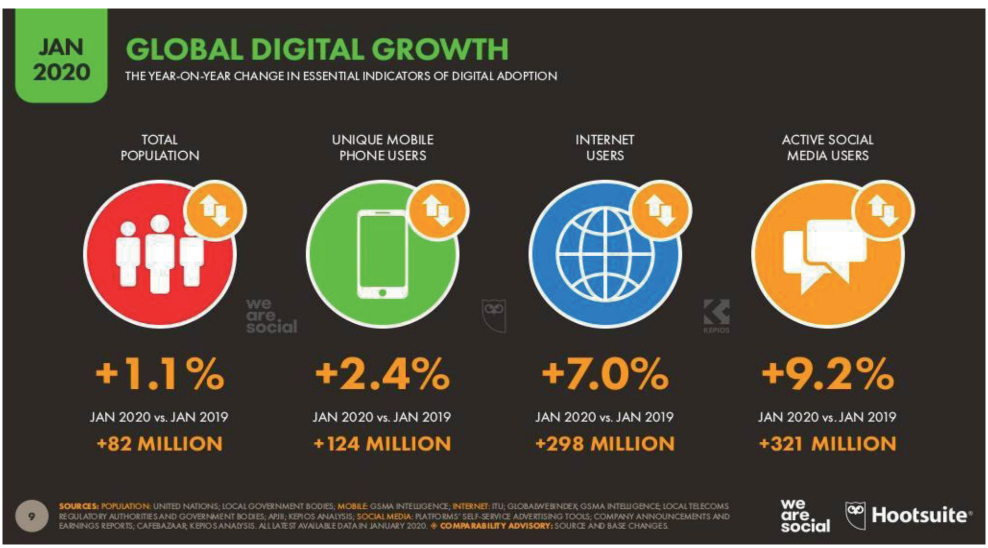
The statistics data of the *Datareportal* (supported by the agency We Are Social and the social media management platform *HootSuite*) also acknowledge that now the digital technology is an integral part of human life. At the beginning of 2020, it has been determined that more than 4.5 billion people are Internet users, i.e. almost 60% of the world's population can already be online, while 3.8 billion are already active users of social networks (Hootsuite & We Are Social, 2020). It is noted that 5.19 billion people in the world use mobile devices (Fig. 2).



F i g u r e 2. Statistics on the use of digital technologies in the world

S o u r c e: URL: https://datareportal.com/reports/digital-2020-global-digital-overview (accessed on 18.07.2020).

The dynamics of changes (increase) in the use of digital technologies in the world is presented in Fig. 3.



F i g u r e 3. Increasing dynamics of the use of digital technologies in the world

S o u r c e: URL: https://datareportal.com/reports/digital-2020-global-digital-overview (accessed on 18.07.2020).

This shows that digital technology is an integral part of human life. Digital transformation is becoming the basis of global economic development, which provides benefits to both consumers and businesses that adapt to the technological changes. Thus, in light of the pandemic 2020, digital and distance learning tools are very important tools of the modern education at all levels.

2. ANALYSIS OF THE READINESS LEVEL OF THE UKRAINIAN UNIVERSITY EDUCATORS TO USE DISTANCE LEARNING TOOLS ACCORDING TO THE LOCAL SURVEY CONDUCTED

The present research has based on the target group who needs to use distance learning tools in their professional activity. This target group consisted of 194 Ukrainian university educators from the National Pedagogical Dragomanov University (Kyiv, Ukraine).

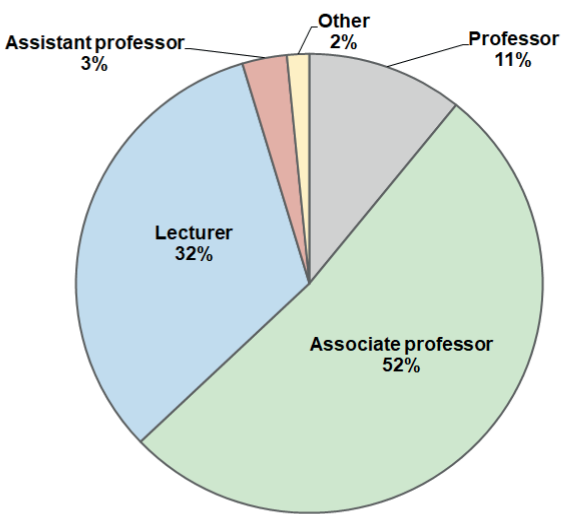
The online survey was elaborated (in Ukrainian) using Google Forms for gaining data on the Ukrainian educators' readiness level to use ICT in their professional activity, especially distance learning tools. We guaranteed participants that only anonymized data would be shared.

The survey was open for 3-month period between March 2020 and June 2020 (quarantine time). It contained information about modern distance learning tools.

The survey included 26 questions divided into three groups:

- general information (about educational role, discipline, age, sex etc.);
- questions related to the educators' professional activities with the use of distance learning tools under the quarantine conditions;
- determining the general distance learning readiness of the University educators under the quarantine conditions (problems, readiness for training, etc.).

The distribution of respondents by educational role is shown in Fig. 4.



F i g u r e 4. Distribution of respondents by educational role

S o u r c e: Own work.

As we can see from Fig. 4, the largest group of respondents is *associate professor* (52% of the participants – 101 people). The number of *lecturers* is 63 people (32% of the participants) and the number of *professors* is 21 people (11% of the respondents). The smallest group of participants is *assistant professor* (3% of the participants – 6 people). The "*other*" group includes moderators and department assistants who are not teachers. They are support staff of the university.

This is important to analyze and describe the readiness level of the educators from National Pedagogical Dragomanov University (Kyiv, Ukraine) to use distance learning tools and online learning tools under the quarantine conditions. They are teaching of the future teachers. Their future professional activity depends on how effectively university instructors will teach future teachers with the use of distance learning tools and online learning tools. Namely, the more effectively the university teachers will teach future teachers to use distance learning tools and online learning tools, the more effectively the latter will use them in teaching at school.

The data on the readiness level of the Ukrainian educators from the target group to use distance learning tools and online learning tools are presented in Tables 1–2 and Fig. 5–8 below.

***Q.**: Do you create distance learning activities during quarantine?*

All respondents answered "*yes*", but the next questions and answers will show the tools used by them.

***Q.**: What distance learning platforms do you use?*

Survey responses on distance learning platforms usage are shown in Table 1 (multiple answers are possible, that is why the total responses can be more than 100%):

Table 1

Responses distribution on distance learning platforms usage

Distance learning platforms	Responses
Google Classroom	30,41%
Moodle	68,56%
Microsoft Teams	1,03%
Tebo	0,52%
Schoology	0,52%
Other tools	4,64%
Don't use any platforms	0,52%

Source: Own work.

Survey responses on distance learning platforms usage distributed by educational role are shown in Fig. 5 (multiple answers are possible, that is why the total responses can be more than 100%).

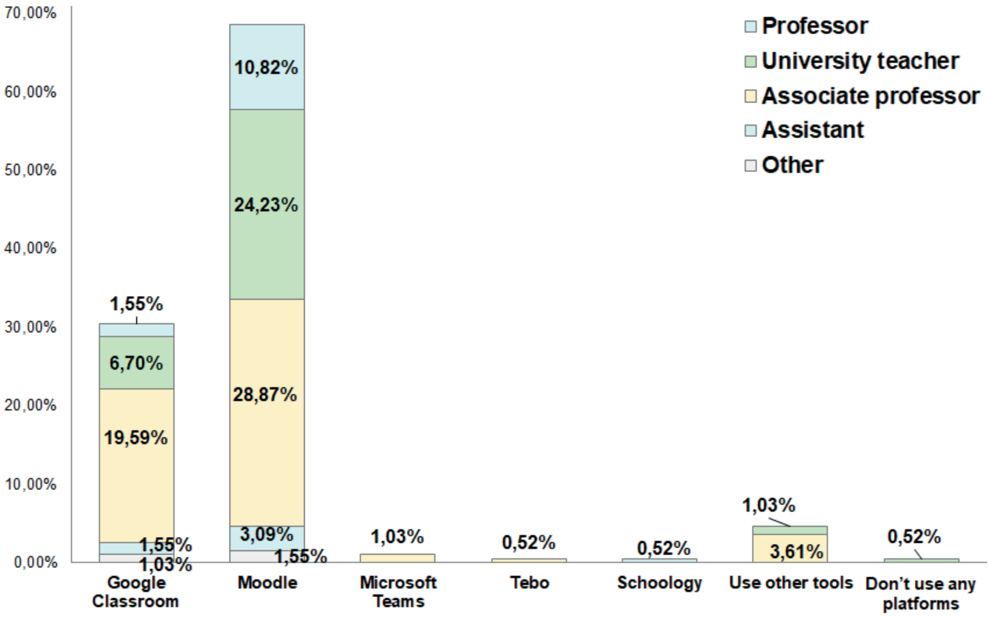


Figure 5. Survey responses on distance learning platforms usage distributed by educational role

Source: Own work.

As we can see from Fig. 5, almost all university educators have used distance learning platforms, especially *Moodle* (68,56%) and *Google Classroom* (30,41%). National Pedagogical Dragomanov University has its own educational environment based on *Moodle* (moodle.npu.edu.ua). That is why the common response to this question was "*Moodle*". In addition, educators have used *Google Classroom*, because it is freeware and friendly interface distance learning platform. Among the answers "*Other tools*" respondents sometimes wrote "*e-mail*", "*Zoom*", "*Telegram*", "*Viber*", "*Skype*" etc. It shows that educators do not know that these tools are not distance learning platforms.

Q.*: What tools for video conferencing meeting do you use in your professional activity?*

Survey responses on video conferencing meeting tools usage are shown in Table 2 (multiple answers are possible, that is why the total responses can be more than 100%). As we can see from Table 2, the largest group of respondents (53,09%) have used *Skype* as a video conferencing meeting tool. The popularity of this tool can be explained by the fact that teachers have previously used it for personal communication. As for *Zoom*, it is used by half of respondents (50%), which can be explained by a simple interface and the availability of browser and free versions of this software. At the same time, about 15% of educators from the target group did not use any tools. This means that there is a need to improve their skills in the use of distance learning tools and online learning tools.

Table 2

Responses distribution on video conferencing meeting tools usage

Video conferencing meeting tools	Responses
Google Hangouts Meet	11,34%
Zoom	50%
Microsoft Teams	2,06%
Skype	53,09%
Viber	6,19%
Telegram	2,06%
YouTube Live	8,76%
Other tools	3,61%
Don't use any tools	14,95%

Source: Own work.

***Q.**: What tools do you use for designing and creating electronic teaching materials (tasks, exercises, practices, tests, etc.) in your professional activity?*

Survey responses on using tools for designing and creating electronic teaching materials are shown in Fig. 6 (multiple answers are possible, that is why the total responses can be more than 100%):

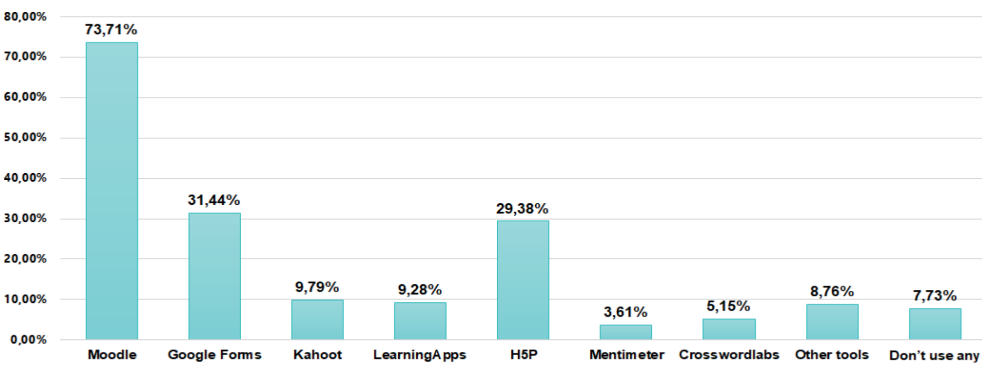


Figure 6. Survey responses on using tools for designing and creating electronic teaching materials

Source: Own work.

Fig. 6 shows that the most popular tools for designing and creating electronic teaching materials are *Moodle* (73,71%), *Google Forms* (31,44%) and *H5P* (29,38%). In this case, materials developed using *H5P* can be embedded in *Moodle*.

The group "*other*" includes the following tools: *Quizizz*, *Testmoz*, *Socrative*, *Liveworksheets*, *Actionbound*, *Edpuzzle*, *Wordwall*, *Baamboozle*, *Classtime*, *Hot potatoes*, *Crosswordlabs*, *Easy generator*, *Idoceo*, *Google Classroom*. But their use are not very popular (8,76%) among the tools used by the university teachers. This means that the teachers try to use *Moodle* (as a tool of education and information environment of the university).

At the same time, some respondents do not use any tools (about 8%), which indicates a lack of technical means for the development of electronic teaching materials and / or the need to improve their skills in the development of relevant digital competencies. The last issue needs further research.

***Q.**: Do you use MOOC platforms for the organization of distance learning?*

Survey responses on using MOOC platforms for the organization of distance learning are shown in Fig. 7 (multiple answers are possible, that is why the total responses can be more than 100%).

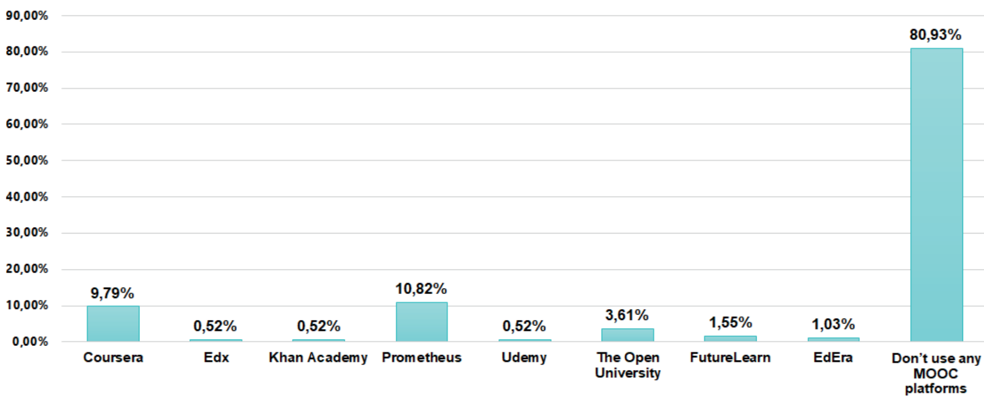


Figure 7. Survey responses on using MOOC platforms for the organization of distance learning

Source: Own work.

Analysis of the MOOC platforms usage is shown that educators from the target group prefer using *Prometheus* (http://prometheus.org.ua) – 10,82% of the participants, and *Coursera* (https://coursera.org) – 9,79% of the participants. *Prometheus* is the Ukrainian project for developing MOOCs (Strutynska & Umryk, 2016, p. 302). One of the reasons for using this provider by educators from the target group is the fact that all courses are in Ukrainian. *Coursera* is probably also used by them because it has many courses in Russian and/or with Russian (sometimes with Ukrainian) subtitles. The analysis of these data (in Fig. 7) has shown that probably most respondents (almost 81%) do not have enough information on how to use MOOCs for the organization of distance learning. It shows that educators from the target group need to improve their knowledge and skills in using MOOC and to embed them in distance learning.

***Q.**: Would you agree to advanced training (retraining, second higher education, self-study) in order to implement distance and online learning technologies in the educational process?*

Survey responses on the readiness of educators from the target group for advanced training in the use of distance and online learning technologies in their own professional activity are shown in Fig. 8.

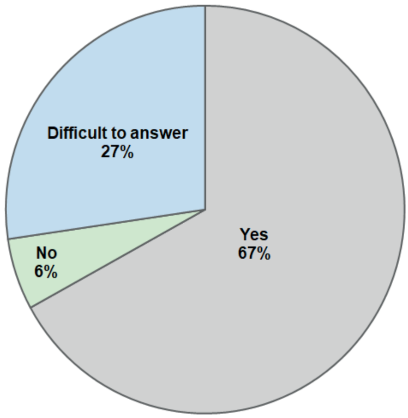


Figure 8. Survey responses on readiness of educators from target group to advanced training for the use of distance and online learning technologies in their own professional activity

Source: Own work.

As we can see from Fig. 8, most of the Ukrainian educators from the target group (67% of the respondents) are ready to advanced training for the use of distance and online learning technologies in their own professional activity. We are planning to outline the ways to improve their Digital Competences in this field in our further research.

3. THE WAYS OF IMPROVING UKRAINIAN EDUCATORS' DIGITAL COMPETENCES IN USING DISTANCE LEARNING TOOLS

The survey results show that the level of knowledge and skills of the target group in the use of the distance learning tools need to be improved.

Basing on the experience gained in this research and on the feedback received from the target group, authors are planning a scenario for the next ways of improving the Ukrainian educator's level of knowledge and skills in the use of distance learning tools and trends in their professional activity, especially under the quarantine conditions:

- analysis and adaptation of the best European practices in the use of the distance learning tools in the professional activity for training the Ukrainian educators;
- creating new modules concerned with the use of distance learning tools during teaching-learning process for retraining of the Ukrainian educators;
- implementation of new modules for improving the educators' Digital Competencies in using distance learning tools with the support of the Digital Educational Technology Center of the National Pedagogical Dragomanov University;
- inclusion of some units into the existing university courses for implementation of the distance learning tools and trends in the National Pedagogical Dragomanov University.

The authors also offer to improve the teaching-learning process in the field of digital competencies development through the training of future teachers in the National Pedagogical Dragomanov University to prevent of the gaps in their future professional activity.

CONCLUSIONS

Schools and universities around the world have completely or partially closed their doors to most students. On the one hand, the situation of educational institutions needs to be drastically changed, but on the other hand, it is a good chance to raise awareness and deepen skills related to using of distance learning technologies and understanding of distance trends among educators around the world.

The process of digitalization of all spheres of human life is unavoidable, and according to the practice of the world's leading universities, education should not keep aloof from this process. The problem of using distance learning technologies is extremely acute and relevant. Therefore, the analysis of the educators' level of skills and awareness in this matter is the starting point for decisive changes in improving the competence of educators and organizing the educational process in general.

In the future, the present authors are planning plan to design the models of the teaching-learning process in quarantine conditions.

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CHAPTER III.
E-learning in STEM and STEAM Education

Innovative Educational Technologies, Tools and Methods for E-learning
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STEM AND STEAM IN CONTEMPORARY EDUCATION: CHALLENGES, CONTEMPORARY TRENDS AND TRANSFORMATION. A DISCUSSION PAPER

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Abstract: *This article, research review, focuses on STEM and STEAM in contemporary education as research literature review and viewed by experts from different countries: Austria, Poland, Russia, Spain and Ukraine. The article aims to provide opinions, views and reflections by an international team of experts from 6 universities from West, Central and East Europe on important topics: A. Robotics and STEM Education: Challenges, Contemporary Trends and Transformation; B. Microlearning – Effective Methods of E-Learning. The paper includes the theoretical background of the topics discussed, research literature review, analysis of national and international experience, examples of practical achievements and a description of contemporary trends as well as reflections and conclusions.*

Keywords: STEM, STEAM, microlearning, robotics in contemporary education, challenges, trends, transformation.

INTRODUCTION

"Skills in Science, Technology, Engineering and Mathematics (STEM) are taking on more and more importance as a component of basic literacy in today's knowledge

economy. To ensure Europe's growth, we will need one million additional researchers by 2020" (European Schoolnet http://www.eun.org/focus-areas/stem).
The theme of the 11th Annual international scientific conference "Theoretical and Practical Aspects of Distance Learning" was „E-learning and STEM Education". The debate, which was held in October 2019 within the framework of DLCC2019 conference, focuses on STEM and STEAM in contemporary education as viewed by experts from different countries: Austria, Bulgaria, Poland, Russia, Spain and Ukraine. The article aims to provide opinions, views and reflections on important topics relating to Robotics and STEM Education: Challenges, Contemporary Trends and Transformation; Microlearning – Effective Methods of E-Learning, as expressed by experts from several universities, located in Western, Central and Eastern Europe. The paper includes the theoretical background of the discussed topics, an analysis of national and international experience, examples of practical achievements and description of contemporary trends as well as reflections and conclusions.

1. BACKGROUND OF STUDY AREAS

Active contemporary learning and teaching methods which could be used and could improve effectiveness in STEM education include: Problem–based learning; Project–based learning; Inquiry–based learning; Flipped Classroom; Digital Storytelling; Gamification (Smyrnova-Trybulska, 2019: 3–7)
Kommers (2019) in his research identified three main questions about Problem-Based Learning, in particular, in STEM education:

1. "From your current good practices, does the choice for PBL (ProblemBased Learning) as a framework for gaming, storytelling and simulations look as an appropriate one?
2. What do you see as the most important steps to be undertaken before PBL can be integrated in courses throughout your organization?
3. What additional elements would you like to be articulated sharper in the years to come?" (Kommers, 2019: 36).

Research devoted to interaction between tool and talk: how do instruction and tools support consensus building in collaborative inquiry-learning environments described in (Gijlers, Saab, Van Joolingen, De Jong, Van Hout-Wolters, 2009). In his own research (Schäfer, 2019) presents inquiry-based learning in mathematics as an idealized process on the one hand, and in actual implementation on the other. This was done "(…) against the backdrop of cultural-historical activity theory according to Roth and Radford (2011), which more precisely defines the theory for mathematics learning based on Leontiev (1978)" (Schäfer, 2019: 217).
Morze, Smyrnova-Trybulska and Gladun (2018) in their own study, conduct a comprehensive analysis of selected aspects of IBL in STEM-education. In particular, the authors analyse advantages and some aspects STEM education, contemporary trends in modern professions and present several examples of good practice (Morze, Smyrnova-Trybulska, Gladun, 2018: 361).
Höffler, Köhler, Parchmann (2019) stressed in their research that "At present, scientists not only are expected to be creative, resourceful, and inventive regarding their

research questions and to understand their field and research methods, but also need to determine how to teach, how to catalog, how to fill out proposal forms, and much more", devoted scientists of the future and an analysis of talented students' interests. Among STEM challenges, there is "(…) discussion around robotics and stem education could concerns, in particular key competences, selected legal regulations, good examples of the use of robotics in various schools in various countries, popularization, dissemination" (European Schoolnet, 2018: 1).

2. ROBOTICS AND STEM IN CONTEMPORARY EDUCATION – CHALLENGES, CONTEMPORARY TRENDS AND TRANSFORMATION

Experts from different countries discussed and reflected on rules and trends of development and effective delivery of robotics and STEM education.

Professor Theo Hug from University of Innsbruck noted that as for robotics in education, there are many hopes and technological promises regarding future developments. However, many of the descriptions on this subject that are available today are abridged descriptions corresponding with unrealistic expectations and reduced or misleading perspectives. This begins with widespread ways of talking about human-like characteristics of robots and claims of artificial intelligence (AI) where talking about artificial stupidity (AS) would be more appropriate. And it ends as far as future perspectives are related to exclusivity of innovation pathways suggested by global education industries. In many cases, educational potentials of digital media are squandered and pedagogically questionable developments are promoted. What we need, is critical analysis of the work of algorithms in our societies generally and especially in educational contexts rather than non-transparent claims that robots can act as intelligent teachers, empathic companions or autonomous parties enabling innovative learning cultures.

Professor Nataliia Morze from Borys Grinchenko Kyiv University, Ukraine answered this question and presented her point of view concerning the role and perspective of development of STEM and STEAM in contemporary education, using Ukraine as an example.

In order to meet the needs of our technological society and develop the desire and ability to engage the population in science and technology, STEM education should be implemented in elementary school. This is especially true for countries that aim to overcome the STEM gap, having a large number of job vacancies due to a lack of skilled workers. Unfortunately, Ukraine is one of those countries.

STEM training brings together an interdisciplinary approach and project-based approach, the basis of which is the integration of natural sciences into technology, engineering and mathematics. It is very important for primary and secondary school students to learn science, technology, engineering, and mathematics in an integrated way, as these areas are closely interconnected in practice and in life and close to the changes that are taking place in society. Now, the human sciences (from the word Art) are actively added to the listed science bases, and so they talk about STEAM education. STEAM education facilitates development of critical thinking skills and assists in solving issues that are necessary to overcome the difficulties faced by children in their lives.

1. The implementation of the STEAM approach in primary school creates a background for the development of students‘ interest in natural and technical disciplines. STEAM education through practical classes shows children the use of scientific and technical knowledge in real life. For the last three years, we at the University have been conducting an experiment with several schools to teach junior students the basics of STEAM (Smyrnova-Trybulska, Morze, Zuziak Gladun, 2016); Morze & Gladun, 2016). We have prepared an educational concept for teaching STEAM students, manuals and didactic materials for teachers. Based on our methodology, elementary school students design, build and develop products for the modern industry at every STEAM lesson. The students carry out a specific project, as a result of which they create their own prototype of a real product, explore its properties, put forward hypotheses for its improvement, discuss the problems that arise.

STEAM lessons are characterized by active communication and student teamwork. The discussion process contributes to free atmosphere conducive to discussion and expression. Students are not afraid to express their opinions, they learn to speak and present their views. Most of the time, children do not sit at their desks, but test and develop their projects. They keep in touch with the teacher and their teammates. STEAM lessons are fun and dynamic, which prevents children from being bored. Children do not notice how time is spent in class, and they do not become tired at all. Such lessons provide children with positive motivation to learn. When busy constructing machines, bridges, structures, they are increasingly interested in science and technology. When children are actively involved in the process, they remember the lesson well, master cognitive research methods, formulate hypotheses, and test them. Students acquire skills in science education and corresponding STEAM competencies. Now we are planning to check the positive changes in the formation of the following important *skills*: “Critical thinking, Reading comprehension, Active listening, Speaking, Complex problem solving, exercising judgment and decision making, Writing, Monitoring, Active learning, Time management, Coordination, Systems analysis, Mathematics, Social perceptiveness, Systems evaluation Instructing, Science, Learning strategies” (Jang, 2016: 290(7)).

Knowledge: “English language, Mathematics, Computers and electronics, Engineering and technology, Administration and management, Customer and personal service, Education and training” (Jang, 2016: 290).

Work activities: “Obtaining information, Taking decisions and solving issues, Interacting with computers, Communicating with supervisors, peers, or subordinates, Updating and using relevant knowledge, Reviewing data or information, Identifying objects, actions, and events, Processing information, Documenting/recording information, Organizing, scheduling , and prioritizing work, Thinking creatively, Establishing and maintaining interpersonal relationships, Evaluating information to determine compliance with standards, Interpreting the meaning of information for others, Monitoring processes, materials, or surroundings, Communicating with persons outside organization, Assessing the quantifiable characteristics of products, events, or information,

Judging the qualities of things, services, or people, Training and teaching others, Scheduling work and activities, Preparing objectives and strategies, Coordinating the work and activities of others, Provide consultation and advice to others, Developing and building teams, Inspecting equipment, structures, or material, Coaching and developing others, Guiding, directing, and motivating subordinates" (Jang, 2016: 291(8)).
STEAM-education consists of the following main stages: question or problem, discussion, hypothesis, design, construction, testing and improvement, conclusions, presentation of results. These steps are the basis of a systematic design approach. In turn, coexistence or the combined use of different opportunities is the basis of creativity and innovation. Therefore, the simultaneous study and application of science, technology and the arts can contribute to numerous new innovative projects.
It is also important to invite modern, developing industries into the core components of STEM education. One such area is robotics. After all, robotics is a universal educational tool that is acceptable for all ages – from elementary students to university students and academics. Robotics is an applied science that studies the project design, development, construction, operation and the use of robots (Morze, Strutynska, Umryk, 2018).
The use of educational robotics allows for identifying the students' technical talents in the early stages and to develop them and help forming STEAM competences as a whole. Therefore, the problem of training robotics specialists , and in particular, the training of future teachers of STEAM-education, and in particular, robotics, becomes extremely important.
Robotics training gives students the opportunities to solve real life problems that require knowledge of STEM subjects, including:

- Mathematics (spatial concepts, geometry – to understand the ways of movement of robots);
- Physics (electronics, principles of operation of sensors, which is the basis of robots);
- Technology and Design (design of devices, parts of robots, their construction),
- ICT (programming of robotic systems).

Robotics training provides pupils and students with practical experience in understanding the technological components of operating automated systems; adapting to constant changes when managing complex systems; the use of previously acquired knowledge in real situations. Robotics attracts the attention of scientists as a means of empowering pupils and students, and in the process of learning robotics, young people can take an active position as co-constructors, rather than as passive recipients of knowledge or consumers of technology. When it comes to robotics in the context of its use in the educational process, they are talking about a new direction in education – „educational robotics".
Professor Xabier Basogain from University of the Basque Country, Spain answered the question: Can you indicate any of the activities that your research group performs for in the STEAM area? and presented his position and an interesting experience. "Our group develops different activities to promote STEAM in education. For

example, the most recent has been a summer course entitled „Integrating STEAM Education in the Schools of Euskadi".
The example, the most recent has been a summer course entitled „Integrating STEAM Education in the Schools of Euskadi" (University of the Basque Country)
For example, the most recent has been a summer course entitled „Integrating STEAM Education in the Schools of Euskadi". The course is aimed at primary, secondary and university professors in the context of the summer courses of the University of the Basque Country (Course "Integrating STEAM Education in the Schools of Euskadi". https://www.uik.eus/en/incorporando-educacion-steam-en-las-escuelas-de-euskadi).
"I would like to highlight four sections to give an overview of the course:

1. What is STEAM?

STEAM education has been created as a unifying curricular paradigm in which students are trained in four different disciplines, in addition to the arts: science, technology, engineering and mathematics, in an interdisciplinary and integrated manner. First developed in the United States of America (USA), now attempts are being made to implement STEAM education in several countries, both in the public and private education systems.
The course presents a description of the current state of STEAM, an analysis of the main obstacles in the development of STEAM in the classrooms, and proposes methodological alternatives and curricular disciplines that help the incorporation of STEAM Education in Euskadi Schools.

2. Methodologies

Our proposal is born from a techno-pedagogical vision; therefore, we consider it crucial to have the ability to design didactic proposals that include the STEAM competence along with other curricular competencies and in an integrated way. The proposal to include STEAM in our classrooms is based on the methodological change that includes working on solving real problems, inquiring as a means to acquire knowledge, and integrating active methodologies and competencies.
One of the ways that can be explored is the inclusion of makerspaces in regulated training environments: collaborative, flexible and innovative makerspaces that are inevitably accompanied by active methodologies for education.
Addressing a STEAM project requires considering many questions and reflections such as: Where do we start as teachers? How to launch a STEAM project? What must be considered? What STEAM proposals exist? STEAM: How much, where and how? Design of educational ecosystems. STEAM and the school curriculum.

3. Curricular disciplines

This summer course identifies the following main obstacles to the implementation of STEAM in school systems: 1) the curriculum in mathematics is obsolete and, therefore, physics, chemistry and biology are studied with obsolete tools and perspectives; 2) the students are not educated in solving complex problems that require higher level mental processes, which involve higher level cognitive modules, known as System-1; 3) Students still use paper and pencil to solve problems, while complex problems require for their resolution an iterative process of experimentation and discovery. This iteration process in turn requires computational micro-worlds or ecosystems for its implementation and manipulation.

Our proposal is called Computational STEAM, which consists of a set of curricular strategies to address these three fundamental obstacles to successfully incorporating STEAM into the classroom. These strategies are designed to:

- Allow interdisciplinary integration of STEAM areas.
- New curriculum: Discrete Calculus, Differential Vector Geometry, Computational Cybernetics, and Probabilistic Computing
- Educate students in areas of problem-solving methods appropriate to their age.
- Address the high demand areas of modern society.
- Develop in students the great potential of System-1.
- Integrate the computational ecosystem model as a world that the student can explore and iterate solutions for problems called Type-B.

The course analyzes the type of problems taught in Mathematics and Science in primary and secondary education in Organisation for Economic Co-operation and Development (OECD) countries called Type-A problems, and presents other types of problems, called Type-B problems, which prepare the students to perform better in today‘s modern society.

4. Microworlds and computational Ecosystems

We use the *Scratch* and *Snap* programming graphical environments to iteratively experiment with Type-B problem-solving processes, processes that must be implemented in a computing environment.

We present computational examples of areas of modern mathematics appropriate for their integration into primary and secondary school classrooms (see Fig. 2).

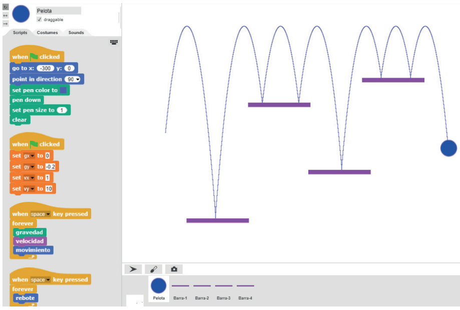
Online Course. This course was held last July in Bilbao with more than 30 participants. And then we created an online course version with the title “STEAM Education in the Schools of Euskadi: First Steps” (Online Course “STEAM Education in the Schools of Euskadi: First Steps”. https://www.uik.eus/en/educacion-steam-en-las-escuelas-de-euskadi-primeros-pasos). The aim of the course is to introduce the concept of STEAM Education in the community of teachers of Euskadi.

The course is aimed mainly at teachers of primary and secondary education in Euskadi, regardless of the specialization or course that they impart. In addition, the course is designed for all future teachers of primary and secondary education, and in general for students of education-related degrees.

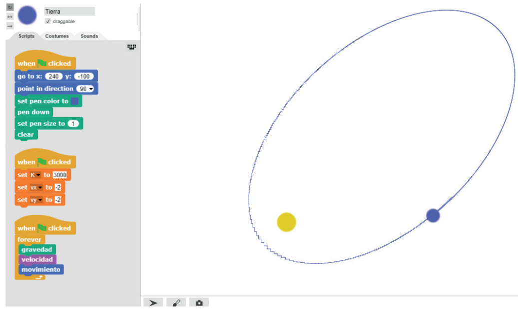
The course is held on the online course’s platform of the Summer Courses Foundation of the University of the Basque Country / Euskal Herriko Unibertsitatea (UPV / EHU). It is a learning platform based on Moodle.

The participant must complete a set of tasks related to the contents of the course, including works, multiple-choice questionnaires, and participate in the module forums.

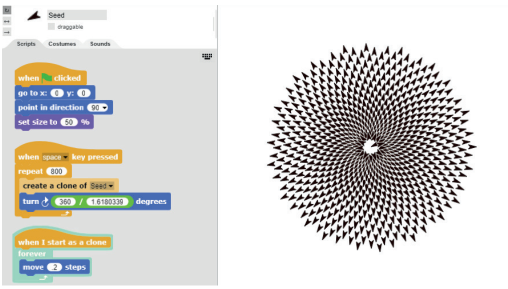
The course guide is structured in the following sections: Learning Competences and Objectives, Contents, Methodology and Work Plan, Evaluation Activities, Calendar and Bibliography.



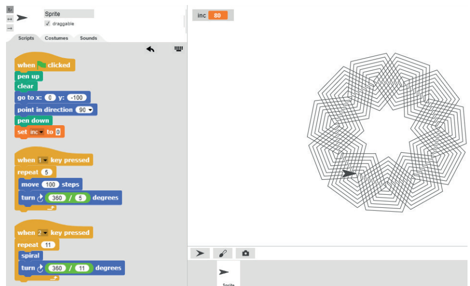
Example 1. Bounce of a Ball



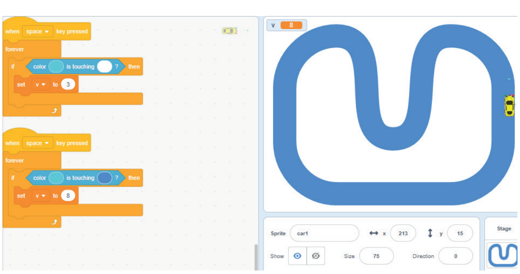
Example 2. Law of universal gravitation



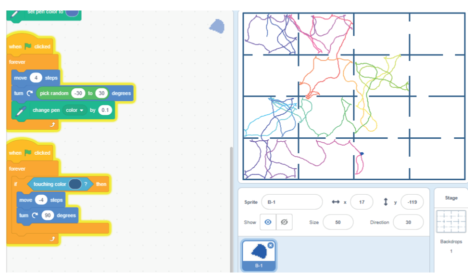
Example 3. Golden Ratio
and Fibonacci numbers



Example 4. Polygon Spiral Sides



Example 5. Driverless car



Example 6. Butterflies Study

F i g u r e 2. Computational ecosystems of modern areas of mathematics appropriate for integration in primary and secondary school classrooms

S o u r c e: Online Course "STEAM Education in the Schools of Euskadi: First Steps". https://www.uik.eus/en/educacion-steam-en-las-escuelas-de-euskadi-primeros-pasos.
Example 1 and Example 2: https://snap.berkeley.edu/collection?user=steam-euskadi&collection=SP-D1;
Example 3 and Example 4: https://snap.berkeley.edu/collection?user=steam-euskadi&collection=SP-D2;
Example and Example 6 https://scratch.mit.edu/studios/20686472/.

The course is held on the online course's platform of the Summer Courses Foundation of the University of the Basque Country / Euskal Herriko Unibertsitatea (UPV / EHU). It is a learning platform based on Moodle.

The participant must complete a set of tasks related to the contents of the course, including works, multiple-choice questionnaires, and participate in the module forums.

The course guide is structured in the following sections: Learning Competences and Objectives, Contents, Methodology and Work Plan, Evaluation Activities, Calendar and Bibliography.

Professor Theo Hug continues discussion. If we want to foster educational processes in the first place and not predominantly instrumental learning and behavioral modification towards unquestioned goals, then we have to think beyond the promotion of coding skills and computational thinking – then we rather have to focus on future oriented co-creative practices and data ethics, on educational benefits for all learners, communities and milieus, on viable forms of interaction with various sorts of non-human agents in educational contexts, and on the relevance of media-cultural contexts for processes of building up and organizing knowledge as well as for transformative learning and education.

Moreover, we have to explore effects as well as opportunities and limitations of practices and discourses in educational robotics concerning its three basic meanings, namely educational robotics (1) as technology education focusing on coding skills and digital fluency in robotics and mechatronics, (2) as an umbrella term for instructional learning formats and practices aiming at the utilization of robots, AI and machine learning in learning and training contexts generally, (3) as moral training for chatbots and social humanoid robots aiming at moral machines that behave and decide like humans. In doing so, we can sound out and create opportunities for responsible innovation pathways beyond financial interests of global education industries or power-political interests. Accordingly, educational robotics can be much more than "an innovative method of increasing the attractiveness of science education and scientific careers in young people's opinion" (Lepuschitz et al., 2019: p. v). There are many innovation pathways in education if any.

According to Professor Krzysztof Gurba, Pedagogical University of Krakow, since STEM represents science, technology, engineering and mathematics and STEAM represents STEM plus the Arts the difference seams technical and moderate. But this A in STEAM is important not only literally, as it adds a humanizing element to the teaching of students, but also methodologically, as it is necessary to supplement the quantitative methods for testing theories and hypotheses, with qualitative methods characteristic for arts, which allow the construction of hypotheses and the reconstruction of theories.

This complemented approach also gives a chance for a kind of "pull back", a longer distance enabling a wider view, a broader context and background, the so-called big picture and, as a result, learning to look at research in an extended way. While quantitative methods are a model for science, STEAM can additionally present achievements resulting from the use of a wide range of qualitative methods.

This broader perspective of the exact knowledge taught in schools and universities, expanded to include humanities, language arts, dance, drama, music, visual arts, design and new media, also coincides with the expansion of new educational technologies. The result consists in obtaining new contexts for strengthening science education with a humanistic element, for example in the form of various applications of immersive virtual environments, where peer-to-peer contact between learners becomes more direct, despite the lack of face-to-face contact.

Professor Tatiana Noskova from Herzen State Pedagogical University of Russia stressed that “In 2019, a digital platform for personalised learning was created in Russia with the participation of Sberbank and the Agency for Strategic Initiatives. Based on the presentations of this platform, it can be concluded that it is positioned as a set of conditions for solving numerous “traditional” problems of school education – low educational motivation, divide between knowledge and practical activities, overload of teachers and school administration with routine work, lack of parents’ awareness and participation of the educational process. The digital platform with the help of artificial intelligence systems has the ability to automate most of the routine operations traditionally performed by a teacher (checking works, replicating materials, searching for new resources, etc.), thereby freeing up teachers’ time for interaction with students according to their interests and needs. In addition, it provides modular design of programs and diversified work of children in the classroom and at home (Noskova & Yakovleva, 2020). Undoubtedly, the ideas of personalisation of education, embedded in the design of this platform, make it possible to set and solve not only primarily the tasks of teaching, but also the tasks of upbringing and personal development. Therefore, the ideas of STEM and STEAM education with the help of this platform get a new embodiment.

In summary, it is important to stress that the most important competences include: mathematical competence and competence in science, technology, and engineering; digital competence (Recommendation of the European Parliament And of the Council of 18 December 2006 on key competences for lifelong learning (2006/962/EC)). A lot of formal documents includes and stresses importance of engaging in STEM education, for example “In order to motivate more young people to engage in science, technology, engineering and mathematics (STEM) related careers, initiatives across Europe started to link science education more closely with the arts and other subjects, using inquiry-based pedagogy, and engaging with a wide range of societal actors and industries. While the definition of those competences has not changed much over the years, the support of competence development in STEM becomes increasingly relevant and should be reflected (…)” (Council Recommendation of 22 May 2018 on key competences for lifelong learning, p. C 189/3). Regulations in this respect exist in other countries too. For example, Spanish legislation is based on several main documents. The European Committee of the Regions is calling for measures to promote science, technology, engineering and mathematics (STEM) education in Europe, especially among girls and women. With an opinion prepared by Csaba Borboly (RO/EPP), President of Harghita County Council, the EU‘s assembly of local and regional representatives calls on the European Commission and the Member States to support STEM-re-

lated initiatives at local and regional level, to ensure necessary investment and to tackle shortages in this field in the planning of cohesion policy (EU STEM Coalition, 2019).
In the Spanish Basic Education Curriculum the different key competences that the student must achieve are described, and among them is the mathematical competence and basic competences in science and technology (LOMCE, 2013). Mathematical competence is described as applying mathematical knowledge to interpret, describe, explain and give answers to problems related to the needs of life, using modes of thought, representation and tools typical of the area (Decreto 236/2015, 2016).
The autonomous communities of Spain have developed different plans to develop STEM / STEAM. For example, STEMadrid is the Plan designed by the Community of Madrid to promote the study of STEM disciplines among students from Madrid. (STEMadrid, 2019). In the Basque Country the Basque Government Department of Education encourages and supports STEAM Education through the STEAM Euskadi Education Strategy (STEAM Euskadi, 2019).
Based on the analyzed sources and the authors' experience, one can distinguish the following main *challenges* in STEM education:

- Using the innovative methods and pedagogical approach adequate to the STEM, STEAM education.
- Teacher skills on STEM should be increasing and permanently developed (LLL)
- Gaps: Fundamental skills gap, Post-secondary education gap, Demographic gap, Geographic gap, Belief gap (Guijosa, 2018)

An analysis of experts' opinions allows you to distinguish the following trends in STEM education and transformations:

- Increasing rule of informal and extracurricular STEM education
- "Shift from 'learning to code' to 'coding to learn'
- Growing demand for 'bilingual' engineers (computer science + expertise)" (5 STEM education trends for 2020)
- Using methods and tools for effectiveness and successful networking and collaboration on STEM (in global scale)
- The promotion and dissemination of experience-based STEM learning in classrooms and workplaces.
- Personalized STEM learning (e.g. using AI, AR)

CONCLUSIONS

The mathematical competence as well as competence in science, technology, and engineering; digital competence included in the 8 key competences are, recommended by European Commission (EC) (Recommendations EC, 2006). Young people and students should be prepared in the fields of STEM education for successful functioning in digital society as well as for careers in contemporary and future professions which require adequate competences. Important and effective modes for popularization and dissemination of STEM education include formal regulations as well as extra curriculum education and activities, festivals, workshops, training, competitions, Olympiads etc.

We agree with the authors that potential pathways for overcoming challenges could include “Attracting more students and teachers to STEM education through a global approach from primary education to continuing professional development”…, “Breaking the barriers between subjects with pragmatic initiatives (teacher training sessions, publishing contents, sharing best practices, etc.) to improve the quality of STEM education by building on each country’s strengths”, “Evaluating and integrating curriculum and pedagogical innovations” (European Schoolnet, 2018: 23)

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AN APPROACH TO TEACHING ARTIFICIAL INTELLIGENCE IN SCHOOL

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Abstract: *New realities in the digital age determine the comprehensive and rapid penetration of artificial intelligence in all areas of contemporary life. The article motivates the need to introduce the discipline "Artificial Intelligence" in high school and proposes an approach to the practical realization of this training. The possibility for development of a possible curriculum, selection and structuring of appropriate educational content, classification and creation of a package of learning tasks on the separate topics and sections in the curriculum are discussed. Opportunities are offered for the implementation of links with other school subjects, as well as with the everyday life of students.*
In the last two years, AI has been studied in various forms by more than 200 students from several experimental schools. The interest and motivation of students is constantly growing. Based on the experience gained and the results obtained, we can say that the discipline of AI can be successfully introduced in different degree, in different forms and in different volumes in the school education in Bulgaria.

Keywords: Artificial Intelligence (AI), Logic Programming, School Education.

INTRODUCTION

We are experiencing the beginning of a revolution that radically changes the way we live, work and interact. In its scale, scope and complexity, what we call the "Fourth Industrial Revolution" has no analogue in our history so far (Schwab, 2016). Artificial intelligence (AI) is now all around us – from self-driving cars and drones, intelligent agriculture, "smart" houses and cities (Chamoso, 2018) to virtual assistants, intelligent healthcare (Komninos, 2006) and so on. All this determines the need to train a wide range of IT professionals who in the near future must successfully manage all these processes. To achieve this goal, training in AI must begin at school.

The article presents an approach to conducting training in the subject "Artificial Intelligence" in secondary school, considering the following several aspects: creating an appropriate curriculum; structuring the learning content, according to the school methodology; providing interdisciplinary links with other school subjects; creating a system of learning tasks for the individual basic topics of classical AI, related to both the basic algorithms for solving problems through search and the presentation of knowledge through rules. The authors will share their experience in the study of AI and will present some opportunities to increase the effectiveness of training. The rest of the article is organized as follows: Section 1 provides a brief overview of research in this area. Section 2 discusses our approach to AI education in secondary school. Section 3 presents the possibility for classification and structuring of learning tasks, and in Section 4 the authors share their experience from conducting this training. Finally, section 5 presents the final concluions.

1. RELATED WORKS

Early in the digital age, the possibilities for AI training were discussed in (Jones, 1985), noting the crucial importance of this training.

Learning AI in school is a challenge, as the basic concepts and algorithms are too abstract and difficult to learn due to the lack of enough knowledge of students in school. In addition, teachers are not sufficiently prepared for this challenge. In the course of their university education in pedagogical specialties, they either did not study this discipline at all or have only a vague idea.

In Fahimirad (2018), the educational consequences of digital technologies on learning and teaching opportunities are discussed. According to authors of this article the main goal is to anticipate the role of AI in the future nature of education worldwide. The problems of the integration of AI in the various educational institutions are also considered and the challenges in the learning of AI in terms of training and teaching are discussed. An overview of the application of AI training and its use in special education is discussed by Drigas (2013).

Nevertheless, modern realities place an urgent need to start teaching AI in high school. The White Paper on the Artificial Intelligence of the European Community sets out the main directions in its development. According to the document, more than 20 billion euros will be raised each year under the Digital Europe, Horizon Europe and European Structural and Investment Funds programs. In addition, priority is given to developing the skills needed to work in the field of AI and to adapt the education systems of individual European countries.

Despite the demands and expectations of the digital society, the experience in studying AI in school level education worldwide is insufficient. This motivates us to offer an approach and to share our experience in implementing such training in Bulgarian high school (Glushkova, 2019).

2. OUR APPROACH TO AI EDUCATION IN HIGH SCHOOL

One of the main challenges in the development of the curriculum is its presentation in an abbreviated but correct form, so that on the one hand students get a more complete picture of the multidisciplinary field of AI, while on the other hand they are able to master the basic concepts and methods using algorithmic pseudocode, demonstration examples and practical tasks. A serious challenge is the transformation of the abstract and multi-layered content of classical and modern AI into a form accessible to students, without losing the authenticity and correctness of the teaching material. Perhaps the most important step in this process is the design of the curriculum. For this purpose, we have formulated the general philosophy, which is based on the following two possibilities:

- “Lighter” option – to look for a creative and entertaining presentation of the learning material, for example, in the form of a game.
- “More serious” option – a systematic and in-depth study of the basics of the discipline with a certain degree of formalization.

Both options have disadvantages and advantages. The second option is associated with more risks related to both the insufficient basic training of students and the need for additional specialized qualification of teachers. Despite the difficulties, we chose the second option, as we want to present more fully and in considerable depth the considered algorithms and concepts of classical AI. To make it easier for students, we try to include a variety of practical tasks, additional rubrics, such as interesting facts, short biographies of the creators of AI, etc., which will ultimately make the learning material more attractive. We will consider our approach in several aspects: creating a curriculum, developing and structuring the learning content, links with other school subjects and creating a system of examples and learning tasks.

2.1. Curriculum development

The AI curriculum developed by us and approved by the Ministry of Education and Science of Bulgaria is basic and is intended for training high school students in secondary schools as well as in some vocational colleges. The curriculum is structured in four sections and includes twenty selected topics. Each school, according to its specifics, the form of education, the type of classes, etc., determines the topics that will be dropped and the topics that can be expanded and supplemented.

The main goal of the training is to acquire knowledge, skills and competencies related to the basics of AI. To achieve this goal, it is necessary to fulfill the following:

- acquire knowledge about the subject and tasks of AI and its role in the Industry 4.0;
- acquire the knowledge of the agent-oriented paradigm and agent architectures;
- acquire knowledge and skills for solving problems through searching;
- acquaint with the opportunities for knowledge presentation and semantic modeling;
- acquire knowledge and skills for modern trends in the development of AI, such as the „Internet of Things”, intelligent agents, machine learning, cognitive robotics, etc .;
- acquire skills for independent solving of specific tasks and problems.

The structure and the main topics of the developed curriculum are presented in Table 1.

T a b l e 1

Structure and main topics in AI curriculum

Sections & Topics
Section 1: Introduction to Artificial Intelligence (AI)
1. Definition of AI. Origin and history.
2. Modern AI. 4th technological revolution (Industry 4.0). The relationship between AI and Industry 4.0
3. Agent-oriented paradigm. Agent architectures
Section 2: Solve problems through search
4. An overview of search problem solving methods. Complete search methods.
5. Exponential explosion. Concept of heuristics. Heuristic search methods. Algorithm A *.
6. Local search methods. Climber's method. Evolutionary strategies
7. Constraint Satisfaction Problems
8. Search in competitive spaces. Game spaces.
Section 3: Knowledge and semantic modeling
9. The concept of knowledge. Classification. Presentation of knowledge..
10. Presentation of knowledge through logical rules.
11. Semantic models. Classification. Semantic networks.
12. The concept of ontology. Ontological engineering.
Section 4: Selected topics from modern AI
13. Intelligent agents. General definition. Mental properties. Rational BDI agents.
14. Intelligent user interfaces. Personal assistants. Motivation and use.
15. Internet of Things (IoT). Basic concepts. Applications.
16. General architecture. Building IoT applications.
17. Machine learning. Definitions. Classifications. Approaches.
18. Selected methods for machine learning.
19. Cognitive robotics. Types of work. Architecture.
20. Cognitive robotics. Robot programming.

S o u r c e: Own work.

2.2. An approach to learning content development

The approach to the development of the learning content can be presented as a sequence of the following steps:

1. Structuring the learning content.
2. Creating a template (standard) of individual topics.
3. Consistent transformation of individual topics.
4. Completion of the main content with additional sections, such as additional knowledge, short biographies of the classics in the field of AI, interesting facts, practical tasks, etc.

The structuring of learning knowledge within a specific template is especially important for greater clarity and easier perception by students. We use two different templates to present new knowledge. In the first of them, we initially introduce informally descriptively the new knowledge, formally define the new concepts and present the algorithms textually or as a pseudocode. Then we present a typical example by discussing the application of the acquired knowledge in the specific situation. We offer assignments for independent work with gradually increasing difficulty. If necessary, additional knowledge is offered in the topic. A glossary of terms entered is available at the end of the topic. Each topic is accompanied by additional assignments, through which the students can work individually or in groups at the beginning of the next lesson. The curious facts related to the development of various fields in AI, as well as those related to scientists, bibliographic films, key achievements, etc. provide an opportunity to increase the activity, motivation and curiosity of students.

The second option for presenting the learning content is related to the introduction of a specific motivating example, which cannot be solved with the knowledge gained so far. By provoking the activity of students and their desire to experiment and make specific assumptions, the new learning content is motivated. The new concepts and rules are defined, and when they are related to a new algorithm, it is described by formal means. A good approach is to use a certain programming language through which students can directly check the correctness of their assumptions and conclusions.

As can be seen from the presented structure, our desire is to introduce the difficult and abstract learning content by decomposing individual small meaningful parts and to provide more practical examples, entertaining and interesting challenges for individual and group work. Formalizing basic algorithms using pseudocode is another challenge for authors. Because students already know that algorithms can be represented in different ways (verbal, graphical, formal), we have adopted the approach of using pseudocode, supplemented and extended with more descriptions, comments and clarifications.

2.3. Using of knowledge from other school subjects

AI is an interdisciplinary field, the basics and terminology of which can be found in various theories and concepts of philosophy, modeling, mathematics, linguistics, economics, psychology, sociology. The aim of the authors is to provide abstract and difficult concepts of AI both through relations with the common knowledge and interests of students and with other school subjects.

The connection of AI with mathematics is on many levels. Since much of the required knowledge is not fully studied in the school mathematics course, the authors briefly introduce this additional knowledge. For example, for modeling a state space, it is necessary to introduce additional knowledge of graph theory; in the presentation of knowledge through rules, the basic operations and laws of classical and predicate logic are introduced; in determining the complexity of a particular algorithm, knowledge of mathematical analysis is introduced. Probability theory, statistics, etc. are also widely used.

The relationship of AI with informatics and programming is natural. Initially, by presenting the algorithms in pseudocode as well as later by implementing them in different programming languages, knowledge of both recursion and basic algorithms and data structures is required. In the training in the field of „Presentation of knowledge through logical rules“ it is proposed to use a declarative style of programming through the language Prolog. Training in computer science in the school course through C ++, C # or Java can be especially important in the implementation of practical tasks such as robot programming, game development, and the creation of intelligent agents, etc.

The using of knowledge in biology, geography and physics are also very important in understanding AI. For example, evolutionary strategy and genetic algorithms are directly inspired by Darwin‘s theory in biology. The coloring in several colors of the neigh-

boring administrative districts is a typical example of „constraint problems“. The various methods of searching for routes in a road map stimulate students to use their active knowledge of geography, and the knowledge of mountain terrains is used mainly in clarifying the „climber‘s method“, etc. Programming robots, their movement and interaction in the real world requires in-depth knowledge of physical laws and mechanics. Students' natural desire to play can be used both in examples of many search algorithms and, in particular, in the topic „Searching in competitive spaces or games". Games „8-puzzle", cards, „Eight Queens", „Chess", „Go" and many others are an excellent, well-known basis for introducing theoretical material.
The authors believe that the introduction and use of not yet studied additional material in various school disciplines is not a problem. Motivating the need for this knowledge can increase students‘ curiosity and activity. Conducting independent research and seeking additional information is also a goal of the training.

3. CLASSIFICATION AND STRUCTURING OF LEARNING TASKS

Table 2

Classification of learning tasks

Topic in AI	Methods and Algorithms	Main Tasks
Search in the status space (SS). Complete methods.	Route planning by SS expanding	Planning the route from home to school
	Tree-Search algorithm	Movement of a robot in a square grid
	Graph-Search algorithm	The "commercial traveler" task
	Search at equal cost	Search for a route between two cities with minimal costs
Heuristic search	„Greedy Search“ algorithm Algorithm A*	Generate a route with a given air distance between cities. With the least coins you can return a balance of X cents Finding the optimal route between two cities.
Local search	The "climber" method	The task "Eight Queens"
Evolut. strategies	Genetic Algorithms	The "Eight Queens" task through a fitness function
Constraint Problems	Algorithms for solving constraint problems	Coloring of the folklore areas in Bulgaria with a minimum number of different neighboring colors
Competitive spaces. Games.	Search in competitive spaces. Min-Max algorithm Alpha-beta search	Competitive game for two players. Assessment of a specific position in chess Score a position in a card game.
Knowledge processing with logical rules.	General knowledge. Facts, rules and goals	Presentation and processing of knowledge from history, literature, geography, etc.
	Variables and logical operations.	Family relationships
	Unification. Backtracking.	Tasks similar to Einstein's problem
	Recursion	The game for the Towers of Hanoi, Calculate n!
Logical conclusions	Search tasks.Stack, queue, combinatorial tasks	Tasks,similar of the "Farmer and wolf " problem Route to the Black Sea
Semantic modeling	Ontological modeling	Bulgarian writers, Remarkable personalities
Application of AI	Applied tasks and games	A task for children-talents

Source: Own work.

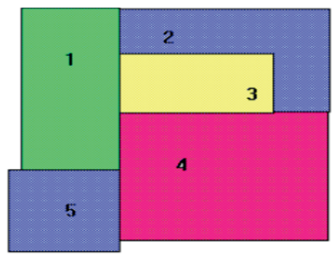
The main goal of the training is for students to acquire knowledge, skills and competencies related to the theoretical foundations and opportunities for practical applications of AI. For the successful mastering of new knowledge it is of special importance the selection of appropriate learning tasks that motivate the introduced knowledg and are related to the daily activities of the students.

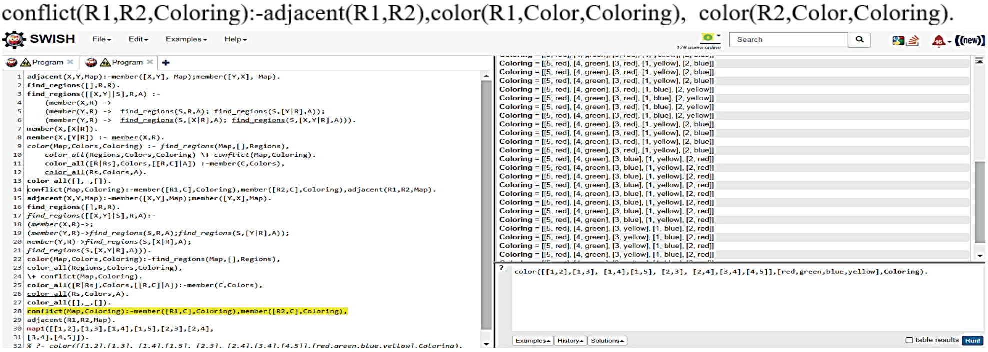
For the purposes of AI training, we believe that the use of logic programming languages is appropriate. Prolog is specially developed for AI applications. It is a declarative language and in order to solve a problem, it must be described correctly as rules and facts. Prolog interpreter derives the conclusion using different inference rules and logical laws. Prolog is extremely useful for solving problems in AI in topics related to searching, planning and presenting knowledge.

The authors have developed and propose a classification of the learning tasks on the main topics of the curriculum (Table 2).

For example, when mastering the algorithm „Constraint Problems", which is inherently quite abstract, we solve the following problem: "To color adjacent plain areas with a minimum number of colors, with no two adjacent areas of the same color". In Prolog, one solution is presented in Figure 1.

```
adjacent(1,2).     adjacent(2,1).          // neighborhood description
color(1,red,a).    color(1,red,b).
color(2,blue,a).   color(2,blue,b).        // Presentation of the colors of the areas through facts
conflict(Coloring):-                       // Conflict rule
adjacent(X,Y),
color(X,Color,Coloring), color(Y,Color,Coloring).
adjacent(1,2).  adjacent(2,1).  adjacent(1,3).  adjacent(3,1).
adjacent(1,4).  adjacent(4,1).  adjacent(1,5).  adjacent(5,1).
adjacent(2,3).  adjacent(3,2).  adjacent(2,4).  adjacent(4,2).
adjacent(3,4).  adjacent(4,3).  adjacent (4,5).  adjacent(5,4).
color(1,red,a).  color(1,red,b).  color(2,blue,a).  color(2,blue,b).
color(3,green,a).   color(3,green,b).   color(4,yellow,a).
color(4,blue,b).    color(5,blue,a).    color(5,green,b).
conflict(Coloring):-  adjacent(X,Y),   color(X,Color,Coloring),
color(Y,Color,Coloring).
conflict(R1,R2,Coloring):-adjacent(R1,R2),color(R1,Color,Coloring),  color(R2,Color,Coloring).
```





F i g u r e 1. Programming and solving the search problem by Prolog Interpreter

S o u r c e: Own work.

Another task for studying problem-solving algorithms by searching and application of AI is the task for children-talents: „In one family there are 5 siblings, on 4, 5, 6, 7 and 8 years old, respectively, who have different talents. One child's name is Nevena, and another child plays the piano. Ivanka is 4 years old and does not understand mathematics. The child who is a programmer is one year older than Ivan. The child who plays the guitar is 7 years old. The girl Joanna is not 8 years old. Stanko is 5 years old and he is younger than the child who loves literature. How old is every child and what is his/her talent?”. One possible Prolog – solution is presented in Figure 2:

Program

```
% Create a table
:- use_rendering(table,[header(d('Name', 'Talent', 'Age'))]).
children(Ds) :-     % each child on the list contains name, talent and age
    length(Ds, 5),
    member(d(ivanka,_,4), Ds), member(d(_,guitar,7), Ds),
    member(d(ivan,_,_),Ds),    member(d(nevena,_,_), Ds),
    member(d(stanko,_,5), Ds), member(d(_,programmer,_), Ds),
    member(d(yoanna,_,_),Ds),   member(d(_,literature,6),Ds),
    member(d(_,piano,_),Ds),   member(d(_,math,_),Ds),
    member(d(_,_,8),Ds),     ((member(d(ivan,_,6),Ds), member(d(_,programmer,7),Ds));
    (member(d(ivan,_,7),Ds), member(d(_,programmer,8),Ds))),not(member(d(ivanka,math,_),Ds)),
    not(member(d(nevena,piano,_),Ds)), not(member(d(yoanna,_,8),Ds)),
   Ds= [d(_,_,4),d(_,_,5),d(_,_,6),d(_,_,7),d(_,_,8)].
/* we want the list to be sorted by age */
```

children(Children).

Children =

Name	Talent	Age
ivanka	piano	4
stanko	math	5
yoanna	literature	6
ivan	guitar	7
nevena	programmer	8

Next 10 100 1,000 Stop

```
?- children(Children).
```

F i g u r e 2. Solving the task by Prolog Interpreter

S o u r c e: Own work.

Cross school subjects links are very important in school education. For example, on the topic „Facts, rules and goals ” we can look at problems with family relationships by making interdisciplinary connections with literature and history. We clarify the way of setting facts and the correct description of predicates through the surnames of Elin Pelin‘s novel „The Geraks“, the historical novel „The Iron Candlestick“ by Dimitar Talev; we build family trees of bulgarian national hero Vasil Levski and the king Krum dynasty, etc.

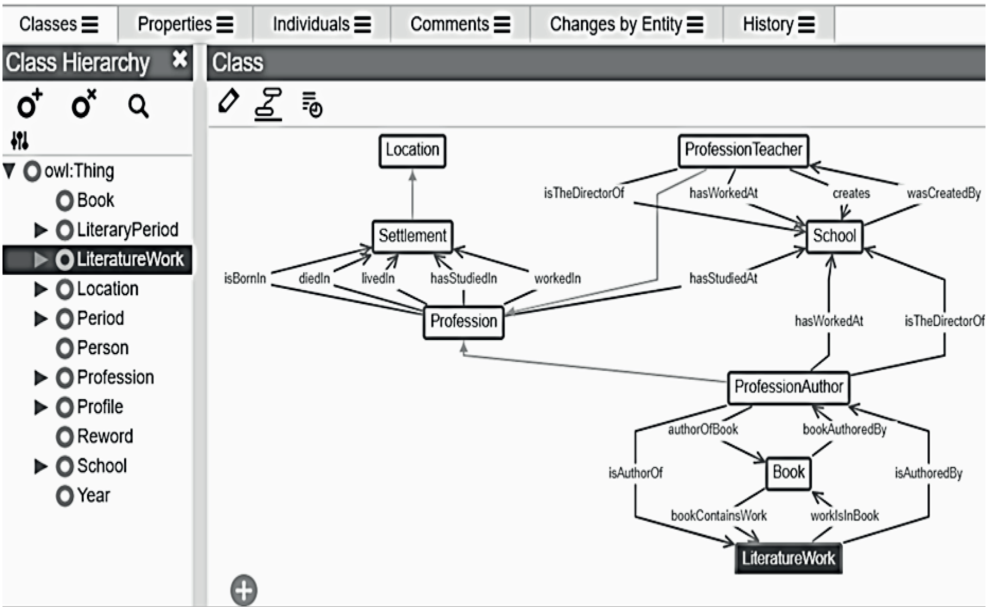
```
arc('Sofia','Klisura',237). /*Database with distances between cities*/
arc('Sofia ','Ihtiman',53). arc('Klisura','Karlovo',33). arc('Karlovo','Kazanlak',55).
arc('Kazanlak','StaraZagora',37). arc('StaraZagora','Plovdiv',102).
arc('Ihtiman','Pazardjik',59). arc('Pazardjik','Plovdiv',50).
h(Path,Goal,H).       /*use algoritm Best-First Search*/
([Node|Path]Goal,H) :- stright_line_distance(Node,Goal,H).
best_first([[Goal|Path]|_],Goal,FinalPath):- reverse([Goal|Path],FinalPath).
best_first([Path|List],Goal,FinalPath):-extend(Path,NewPaths),  append(List,NewPaths,NewList),
    sort(NewList,Goal,SortedList),  best_first(SortedList,Goal,FinalPath).
extend([Node|Path],NewPaths) :-
    findall([NewNode,Node|Path],(arc(Node,NewNode,_),not(member(NewNode,[Node|Path]))),  NewPaths).
reverse([],[]).
reverse([X|Rest],List):- reverse(Rest,NewRest), append(NewRest,[X],List).sort([],Goal,[]).
sort(List,Goal,[MinPath|SortedList]):- min(List,Goal,MinPath,NewList), sort(NewList,Goal, SortedList).
min([Path1|List],Goal,Path2,[Path1|NewList]):- min(List,Goal,Path2,NewList),
    h(Path1,Goal,H1), h(Path2,Goal,H2), H2<H1,!.
min([Path|List],Goal,Path,List).
/* Query is:?- best_first([['София']],'Стара Загора',Path)*/
```

F i g u r e 3. Solving task for searching a route

S o u r c e: Own work.

The connection with biology education are tasks and games such as „Guess the animal", and for connection with geography can be used tasks to find a route between two cities in Bulgaria. Finding such a route can be presented as a problem and can be programmed on Prolog (Figure 3).

In training on topics related to environments for semantic modeling through ontologies, one can also consider tasks related to writers, the works written by them, genres, plots, as well as various relations such as birthplace, facts from the biography, etc. (Figure 4). The free program environment Protégé of Stanford University can be use for the training (https://protege.stanford.edu).



F i g u r e 4. Creating an ontology for Bulgarian writers in the Protege

S o u r c e: Own work.

4. OUR EXPERIENCE: RESULTS

The experience we have in working with students in secondary schools in the last two years shows that this discipline can be studied both as a compulsory subject in innovative classes (eg Math High School – Plovdiv) and as an elective subject in interest clubs in different types of schools and vocational high schools (Secondary school in Brezovo, Vocational High School of Electronics and Electrical Engineering, etc.). While these schools have professional or specialized training in the field of computer science, it is interesting to try to create a club of interests in the humanities classes. In the Humanitarian High School in Plovdiv, a club was established under the project "Education for tomorrow". The adapted curriculum includes certain introductory topics. In order to enter this new and atypical for them matter, the students got acquainted with the concept of „problem", defined by the initial state, purpose, goal, possible operators, model of transitions and function of costs. Numerous diagrams, images, specific situations and examples are used to visualize and illustrate the set goal. We decided to find out to what extent the methods known as „search methods“ can be understood and applied by students with humanitarian interests. In order to more fully master the different ways of searching, it was necessary to introduce a set of new concepts. When choosing the learning tasks, we were guided by the understanding that they must be in accordance with the interests of students and be related to their familiar everyday life. For example, as an introductory example in the rather abstract algorithm „Tree search“ we used the profiled classes and profiled school subjects in every of them in the high school.

In the last two years, AI has been studied in various forms by more than 200 students from several experimental schools, classes and clubs. The interest and motivation of students is constantly growing. As a result, the average success of the training is within the limits of the excellent grade. Based on the experience gained and the results obtained, we can say that the discipline of AI can be successfully introduced in different degree, in different forms and in different volumes in the school education.

CONCLUSION

Based on the approved curriculum in the last two years, the authors create textbooks and teaching aids in which the approach shared in the article is applied in practice (Stoyanov, 2019).

The proposed curriculum and the developed teaching resources can be used for training of students from the mathematical high schools in Bulgaria, as well as of students from different professional, profiled or innovative classes. In addition, it can also be used by students in various specialties to understand the fundamental concepts of AI. The proposed classification of basic tasks related to the teaching of AI in secondary schools is exemplary and in development. Choosing appropriate learning tasks can help in understanding and presenting abstract and theoretical knowledge. The use of the declarative style of the Prolog logic programming language enables the presentation of the problems in a clear and understandable way and promotes the development of the logical, algorithmic and abstract thinking of the students. The combination of Prolog and Java programming languages provides the basis on which students can program the knowledge base and goals of intelligent agents. This is one of the main tasks in the development of multi-agent intelligent systems needed to create „smart“ homes and cities, „smart“ health and agriculture, education, etc.

Our plans are to complete the process of creating textbooks and manuals with learning tasks while expanding the range of schools in different regions and cities in Bulgaria. The history of the development of human civilization – starting from the agrarian, and then the first, second and third industrial revolutions –has nowadays reached the fourth industrial revolution, in which the turning points contain the main characteristics of AI (Geng, 2018; Russel, 2016). With this course, we hope that the students will form the belief that in AI there are many more tasks that need a solution, as well as call forfuture researchers.

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FLEXIBLE SYSTEM OF REMOTE APPLICATIONS AND TEACHING WITH SENSORS

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Abstract: *Methods of remote teaching and e-learning have become necessity in recent times. The paper describes modular system of real workplaces accessible remotely. The system was designed in LabVIEW environment offering fast implementation of new modules even for inexperienced programmer. On the other hand, its structure is open for adding parts and modifications. The paper explains method of achieving such modular structure and flexibility for implementing of new workplaces. Sensor applications were added as needed for the education process at our institute. Web Service tool included with LabVIEW and possibility of application interfacing with html and JavaScript code is presented. This allows presentation of data on remote computer without the need to install LabVIEW Runtime Engine.*

Keywords: LabVIEW, DataSocket, remote experiments, measurement, Web Services.

INTRODUCTION

Nowadays, many common measuring or laboratory devices have a digital interface for communication with PC via internet and remote access tools. The measurement and control technology as a whole becomes more complex. The remote access workplaces are becoming increasingly important. The progress in web technologies influences development of software aids oriented for measuring applications. One of most typical measurement software certainly is LabVIEW (Laboratory Virtual Instrument Engineering Workbench). This approach for the implementation of laboratory measurements has the advantage of flexibility, and the possibility for remote measurement and control over a local network or internet. In the paper we present a software system designed in LabVIEW which allows overcoming some weaknesses of a common remote access system. It has a modular structure which improves software security of workplaces. The system is based on communication between the DO module, controlling a workplace, and the GO module, distributing data and access. Several workplaces were designed, as described in Kamenský et al. (2018), and used for distance learning or for demonstration. We continue building other new applications. Two of them are presented in this paper with other improvements including the use of Web Service.

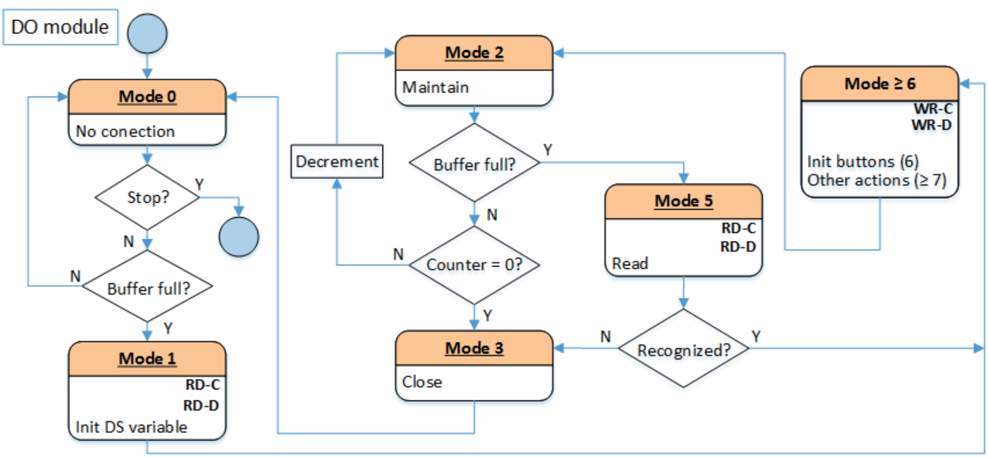
1. MODULAR AND OPEN CONCEPT

There have been many attempts to create applications with remote accessed at our institute e.g. based on C#, Java, JavaScript. We gradually realized two main problems preventing their usage for education. The first was software or rather network security issue when network administrator was unwilling to make the target PC available externally. The second obstacle was related to staff turnover in the workplace when even minor software modifications essential for adapting to actual pedagogical process were time consuming or impossible for a teacher which was not designer of the original application. Finally, a few years ago we started the creation of a new system with the aim to overcome those problems. We decided to use the graphical programming language G of the LabVIEW environment and chose modular and open concept allowing the design of parts of the system in other languages too. Hence our intention was also to create system with the prospect of a rising designer/user community. The LabVIEW environment and related tools and libraries belong to standard equipment at academic and industrial workplaces dealing with distributed or automated measurement. It offers high efficiency for the development of small applications interacting with laboratory equipment especially for non IT oriented community. It can simplify the task of measurement control, automation and distribution. It is still possible to design large applications and add modern features such as Web Services. Plenty of references can be found in the academic community referring to remote access established using LabVIEW, e.g. in García-Guzmán et al (2017) or Singh et al. (2015). A general dedicated web publishing tool is in development and there is no steady solution. Designers are naturally looking for tools intended for the same environment which they use for the type of work – such as Matlab2Web for Matlab in Gula and Žáková (2017). Our department is oriented for instrumentation and measurement and the LabVIEW is an essential tool of our everyday work. Encouraged by the progress towards internet distribution of data and control, we decided to develop our new educational and training system in LabVIEW.
Our system is based on a pair of modules: GO and DO. To access the remote workspace or a target application called DO module the user communicates over a superior GO module. For every DO and GO module pair the GO module is identical. It means that with the same GO module the addressed target application can be chosen by ID. If several workplaces should be accessed in parallel, then administrator leaves running more GO modules on server computer. The user actually accesses remotely one of those GO modules and the connection with the target PC is managed inside the GO module application. Its purpose is to accept commands from a remote user and forward them to a target application or to distribute results for the remote user. As we

divided the part controlling measurement from the module providing web publishing, once the GO module will be updated, it can be employed for all DO modules without any code change.

The DO modules are unique, each carrying its own identifier (ID). The target application could be located on any computer within the local network, which stays not directly visible from outside and hence protected against software attacks.

Software module works as a state machine and can be simply presented by a block diagram. In Figure 1, a block diagram of a generalized DO module is shown. A state is called mode here. The modes 1 till 5 are designed for managing communication with GO module. The application starts in mode 0 waiting for initial command coming into opened DataSocket buffer. In mode 1, the application is being prepared for cooperation with GO module. DataSocket variables are initiated – we use separate variables for commands and data and for every direction. In this phase user button labels has to be initiated. Therefore the "*Button Init*" command is sent to GO module followed by jump to mode 6 where data variable with labels is generated. Mode 2 is then dedicated to maintaining the communication by checking if a new command was received or time expired, which means the connection with GO module was interrupted. Note that every data exchange here is initiated by GO module which also has to send "*Refresh*" command within time out for the case when there is no action from a remote user. Otherwise the connection and the variables are closed in mode 3. After regular command was received in mode 2 it is subsequently recognized in mode 5.



F i g u r e 1. A block diagram of the DO module

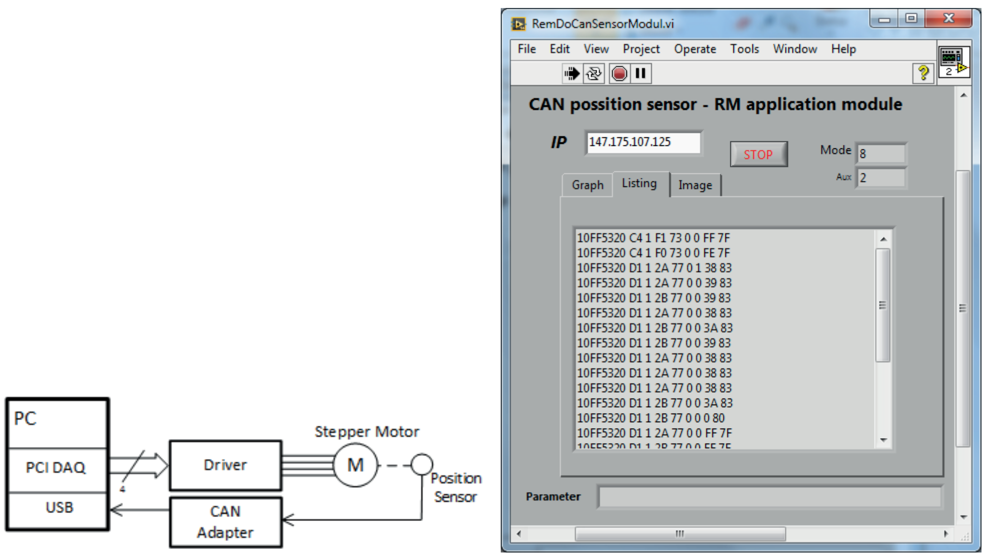
S o u r c e: Own work.

According to the command value, the application jumps from mode 5 to one of execution modes starting from mode 6. It is generally possible to jump again into mode 6 and resend labels. In our case we do not change labels after initialization and we jump to modes 7–12 during reactions to user actions. It is not strictly necessary to follow this DO module structure until the communication rules like command and data syntax or appropriate replies etc. are met.

For the GO module the block diagram is not very different (Červeňová et al, 2016). The blocks which have equivalent counterparts on the GO module side are underlined in Figure 1. Beyond that, also mode 4 is implemented in GO module as waiting for a reply and upper modes for processing replays and distribution data.

2. IMPLEMENTATION OF A NEW MODULE WITH SENSOR

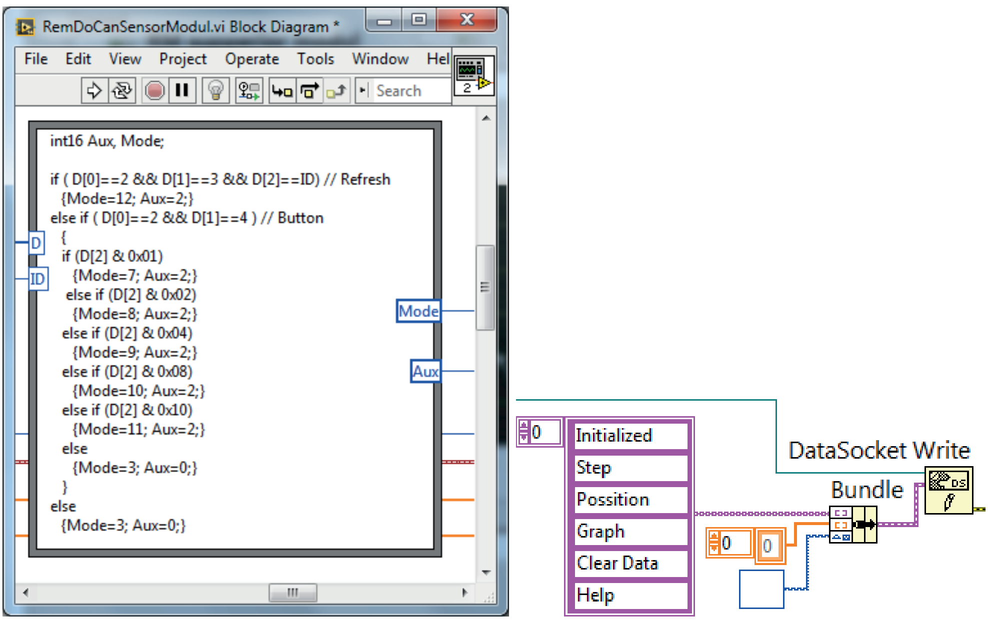
Many types of workplaces can find application in education process. They are subjects of changes according actual needs. For the purpose of teaching diagnostics we were preparing new workplace corresponding to block scheme depicted on the left-hand side of Figure 2. The main part here is the rotating position sensor RT8CN with the CAN output. The exercise is aimed as an introduction to data distribution via the CAN bus (see CAN data in Figure 2) to get students prepared for lessons oriented on systems used in cars. For the remote control of the position a stepper motor has been added. A local PC sends sequence of pulses to motor driver and collects new sensor data from CANSUB adapter. A new LabVIEW DO module has been designed which distributes control and data to the remote user (via GO module) with functionality predefined by the teacher in the role of a designer.



F i g u r e 2. Ablock scheme of the rotary position sensor (left) and its CAN data, as shown in the Listing tab of the DO module (right)

S o u r c e: Own work.

The target application is based on case structure where every mode from Figure 1 corresponds to one case. During the design of a new workplace we simply use an older DO module application as a template and modify it. The modes 1–5 operating general connection with GO module remains almost unchanged. Just the formula note in mode 5 has to be modified according functionalities of upper modes. On the left-hand side of Figure 3, the node already adapted for workplace with rotary sensor is depicted. It implements conditional branch which reads command located in input array *D*[] and decides about mode where the reaction of the DO module will take place. Jump to modes 7–11 correspond to button pressed on the GO module side and mode 12 handles a timeout command. Node 6 stays apart of formula node as it is used only during initial process when button labels are defined. On the right-hand side of Figure 3 the preparation of DataSocket data variable containing button labels is shown. DataSocket variable is a cluster comprising three different types: string array, double array; image. During the initialization of labels only a string array is filled where the zero items is always a text to be shown in *Parameter* text indicator and items number 1–5 are desired button labels. The button marked as *Step* moves the stepper motor in one cycle of steps, *Position* reads new set of CAN data from the rotary sensor into the *Listing* tab, the Graph refreshes time trend of positions in th e*Graph* tab, *Clear Data* erases memory of positions and *Help* shows help in the *Image* tab. In Figure 2, the *Listing* tab of the DO module with CAN data has been shown; (uttons will be available on the GO module side.



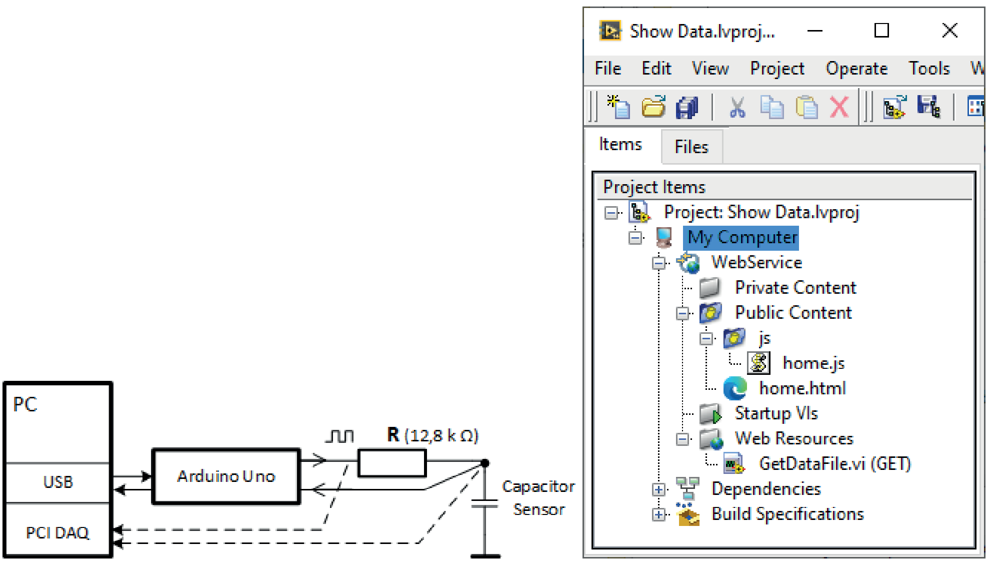
F i g u r e 3. A block diagram of parts of the DO module: The Formula node used in mode 5 for processing the received command (left) and the initialization of labels via the DataSocket variable of the cluster type (right)

S o u r c e: Own work.

2.1. Sensor data available over Web Service

Web publishing does not automatically mean that data will be available on all devices with a web browser. The LabVIEW environment offers handy web publishing tool – Remote Panel – which assumes LabVIEW Runtime Engine running in the background of remote PC. The engine is not compatible with systems of small mobile devices. Fortunately, LabVIEW supports Web Services representing technology compatible with the environments of mobile phones. Request for modification of data distribution capabilities in our system and for Web Services arose during last coronavirus-affected semester.

The students attending the course Microcomputer technique were not allowed to come into laboratory and stayed working from home. Firstly, we had to adapt laboratories to a new situation. Some partial tasks were performed by simulation using an online tool Tinkercad. Later students got alternative job to an original Arduino project – the old project involved temperature/humidity sensor. As they usually own Arduino Uno without a peripheral board, they had to design own capacitive position sensor built from two metal plates sliding towards each other. Such a capacitive sensor should be connected in a serial with a known resistor and they had the task of designing the Arduino firmware generating pulses to RC circuit and measuring deceleration of the signal edge at the capacitor as a delay.

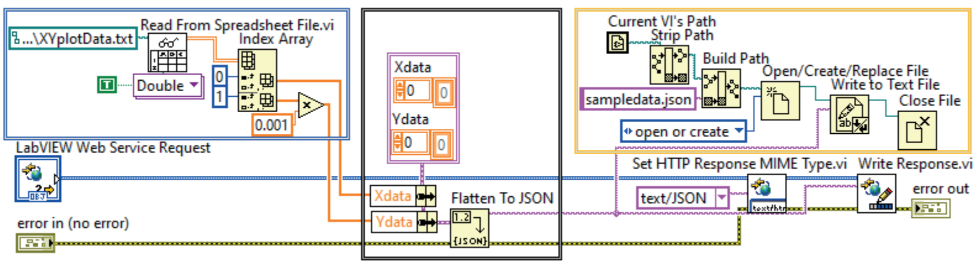


F i g u r e 4. A scheme of the new workplace with Arduino and the home-made capacitive linear position sensor (left) and the LabVIEW project items window with Web Service used for data distribution (right)

S o u r c e: Own work.

Students do not own complex measuring devices and we needed to give them possibility to remotely investigate signal shapes in described sensor circuit. Therefore a new remotely accessed workplace was built in our laboratory according to scheme shown on the left-hand side of Figure 4 with Arduino Uno as a pulse generator and a DAQ (Data AcQuisition) card sampling signals at the input and output of sensor RC circuit. The structure of DO module of workplace with capacitive linear position sensor is similar to previous case of rotary sensor. Number of cases and also branching in mode 5 is the same. The button labels sent in mode 6 had to be changed to:

Delay, *RCinWave*, *RCoutWave*, *Trend*, *Help/Clear*. The main task was changing implementation of modes 7–11 which has to handle button pressed commands. If *Delay* was pressed, then the delay value of pulse edge slowed by the RC circuit is obtained from Arduino and added into the Listing indicator and internal array. The *RCinWave* button is processed by sampling of pulse signal at the input of RC circuit using DAQ card and drawing the curve into *Graph* tab. *RCoutWave* means the same for the output of the RC circuit. *Trend* replaces the curve in *Graph* tab by a stored trend of delays. The *Help/Clear* button has dual functionality. It erases stored trend data and shows next help page in *Image* tab.
Another challenge in the adaption of laboratories for home work was to distribute data even to small devices. Many students had to move from dormitories to the countryside where probably only mobile phone internet connection was available. For such cases control of remote application was not possible in our system as GO module was published by Remote Panel. We decided to expand the application with Web Service. In the block scheme of the GO module, we implemented saving graph data to a file every moment when a new graph draw command (reply) is received from the DO module. Then a LabVIEW project was started (Bauer, Ionel, 2013) which includes Web Service. Here we added new .vi file working as a small application which reads the data from the data file and passes it in the JSON (JavaScript Object Notation) form for next processing.

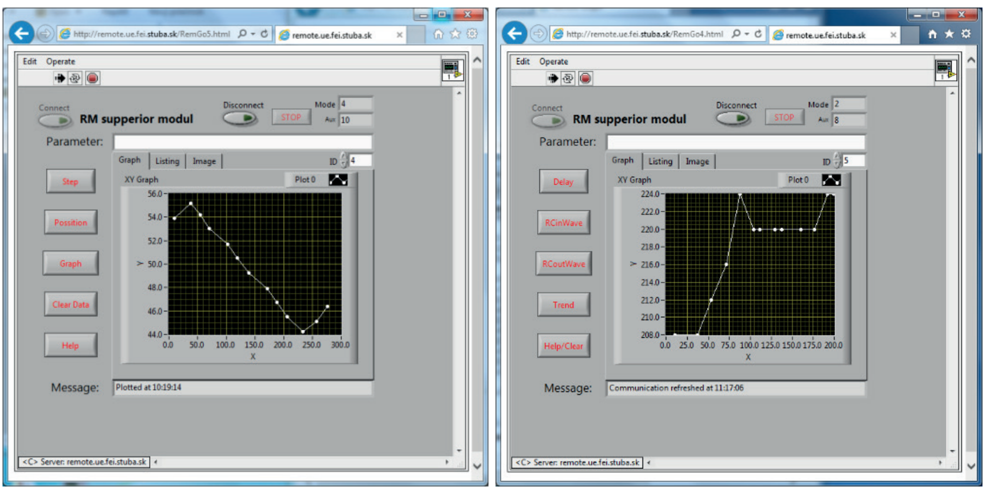


F i g u r e 5. Block diagram of *GetDataFile.vi*
S o u r c e: Own work.

On the right-hand side of Figure 4, the project items window is shown. It mainly consists of one .vi file and of a Public Content directory of WebService composed from .html and .js file. Block diagram of *GetDataFile.vi* is depicted in Figure 5. It receives Web Service request and writes JSON data in response. Except nodes serving the Web Service the block diagram is visually divided into three parts (frames): reading data from spreadsheet file, converting to JSON format, saving JSON data to another file. The main implementation of publishing data to the remote user is achieved in JavaScript file *home.js*. Here AJAX HTTP GET request is realized over *getJSON()* method with the parameter of URL address where the request is going to be sent. A copy of local *document.URL* has to be modified to point to *GetDataFile: URL = URL.replace* (*"home.html", ""*) + *"GetDataFile"*; JSON data of the response are visualized using Google Charts based on HTML5/SVG (the latest evolution of HyperText Mark-up Language/Scalable Vector Graphics) technology with no plugin requirements. Line Chart is used for drawing a graph and Table for showing the data in a numeric form.

3. APPLYING OF THE SYSTEM AND DISCUSSION

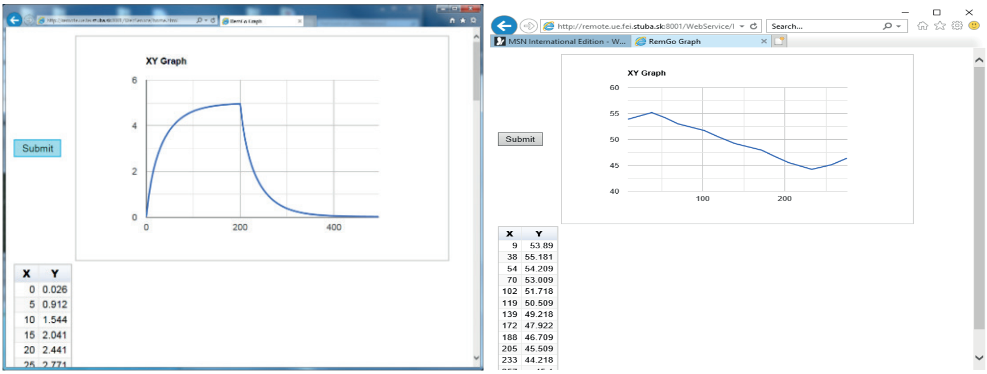
Designed sensor workplaces can find application in several subjects. However, as discussed in previous chapter they were intentionally targeted on subjects Technical diagnostics and Microcomputer techniques. Both workplaces can run in our laboratory and be accessed remotely in parallel. Actually it is possible to let them run on the same computer, however, we used two separate computers every hosting different local DO module. Control was realized via two GO modules running on one server computer, see RemGo5 and RemGo4 in Figure 6. There is no predestination how GO and DO modules are pared. Rotary position sensor with CAN output uses ID 4 while workplace of capacitive linear position sensor has ID 5. The user can establish connection for any ID from any GO module. If the selected ID would be occupied the connection is not established.
If ID 4 was chosen in GoModule5 like on the left-hand side of Figure 6 then student of diagnostics can turn the stepper motor (button *Step*) after that read new CAN data from sensor (*Position*) and draw trend into a Graph (*Graph*). DO module maintains a safe direction of rotation such that there is not risk of damage of rotary position sensor. In Figure 6 the allowed interval was set to 45–55% of 30 turns range. During semester we rescaled y-axes and let students calculate the interval from CAN data (see *Listing* tab in Figure 2).



F i g u r e 6. Superior modules RemGo5 (legt) and RemGo4 (right) accessed from the web browser

S o u r c e: Own work.

GoModule4 presented on the right-hand side of Figure 6 was paired with workplace of capacitive sensor where the position should be evaluated from capacitance in RC circuit by Arduino firmware. Such was the task for students of Microcomputer techniques and the workplace enabled them to check output signal (button *RCoutWave*) of RC circuit when pulse signal is at the input (*RCinWave*) which helped them implement Arduino firmware generating pulse signal and measuring delay (*Delay* – shown in *Listing* tab) representing deceleration of rising or falling edge of signal at capacitor. Other possibility of the workplace is to observe stability of delay (*Trend*). For visibility of trend fluctuation during the short time test presented on the right-hand side of Figure 6 (x-axes in seconds), the teacher located in the laboratory manually moved with the electrode of the capacitor.



F i g u r e 7. A distribution of measured data using Web Service: data from the rotary position sensor (left); data from the linear position sensor (right)

S o u r c e: Own work.

As the task of design of Arduino firmware measuring position with capacitive sensor was performed during substitute study from home it was important to distribute data also for students without availability of complete technical equipment for remote access. Adding Web Services and supplementary page based on JavaScript as described in chapter 2.1 the graph data could be shown also on computer without the LabVIEW runtime engine (cf. Figure 7) or on the mobile phone. This implementation does not allow control of the workplace but still helps to easy check shape of signal from RC circuit. On the other hand, the page with JavaScript also displays data from rotary position sensor if ID 4 is used with RemGo5 module like on the left-hand side of Figure 7. This underlines the flexibility of the modular system where the new GO module with modified functionality can be used with the older DO module.

For the workplace with capacitive linear position sensor we finally took a quick quiz oriented on parameters of PWM signal generated from Arduino for excitation of RC circuit and on parameters of the output signal sampled at capacitor sensor. The quiz was open after preliminary student experiences with the workplace and was strictly time limited. From 10 students of the subject Microcomputer technique the answers of 5 of them were completely right and other two students answered partially right. Remaining 3 students (30%) were not able to answer correctly within time limit.

CONCLUSION

The system of remote accessed workplaces has been described in the paper. It is based on modular concept and on cooperation of pairs of superior and target module. Modularity facilitates more flexible target application design as presented for modules of sensor application. Two such workplaces have been created simply by adapting previous sample application keeping rules of communication with the GO module. As it follows, there are no demands on knowledge about web technologies of designer of a new target module.

The system presented here was originally developed in the LabVIEW environment. Modular structure can help to overcome the requirement for the installation of the LabVIEW Runtime Engine on a remote device. The extension of the superior module has been proposed using Web Services and JavaScript, where Google Charts helped to visualize measurement results. Modified superior module can be employed even for older workplaces and target modules with full functionality. Compatibility with both sensor applications discussed above has been presented. The results of the quick quiz in reference to the Arduino term project with the home-made capacitive linear position sensor demonstrated the usability of the corresponding remotely accessed workplace for students working from home in makeshift conditions.

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UTILIZATION OF MATHEMATICAL SOFTWARE IN FAVOUR OF TUTORING PROCESSES

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Abstract: *Maths Support Centres are becoming increasingly importance in the Czech Republic. The existence of these centres can have a positive influence on the mathematical preparation of students of engineering. Also, students of other study fields can utilize these services for professional development. As the suitable interconnection with educational procedures, the information technologies can be considered. In the context of using the information technologies, several teaching techniques were proposed in the form of ideas, which can be applied in favour of efficiency of the tutoring processes. Some of them would be e.g. based on the adaptive feedback strategy with regards to the pedagogical cybernetical approaches. In this paper, the possibilities of mathematical software are presented with a view to utilising them in the feedback process of tutoring in the Maths Support Centre at Tomas Bata University in Zlin. In the presented proposals, the geometry was selected as the most frequently appeared and favourite topic obtained in the frame of the previous quantitative analysis of students' preferences.*

Keywords: Maths Support Centre, pedagogical cybernetics, feedback strategy, mathematical software, geometry, GeoGebra, quantitative analysis.

INTRODUCTION

In the frame of a preparation of the Czech university students, the Maths Support Centres (Patikova, 2016; Zidek & Kotulek, 2019) have a significant role. As the main aim, the efficiency of understanding mathematical topics and building teaching strategies can be considered. There exist many teaching strategies based on an individual approach of each tutor, because the academical experiences can bring to the tutoring the students the original approach. In this strategy, the including the information technologies can enrich the feedback process (Cevik et al., 2015) in the tutoring. In this paper, the extension in the form of the software utilization is practically presented.

In the Czech Republic, the network of the existing Maths Support Centres has an extending trend. The first centre was established as the Maths and Stats Support Centre by the head of the Department of Applied Mathematics and Computer Science – Assoc. Prof. Maria Kralova (the author e.g. of publication: Kralova & Lasak, 2018) from the Faculty of Economics and Administration of the Masaryk University. The second Maths Support Centre was built by the Department of Mathematics by Dr. Zuzana Patikova (Patikova, 2016) under the guarantee of the Faculty of Applied Informatics of the Tomas Bata University in Zlin. The third centre is located at Department of Mathematics and Descriptive Geometry at the VSB – Technical University of Ostrava with the leadership of Dr. Jan Kotulek (Zidek & Kotulek, 2019). The fourth centre is being prepared at Faculty of Education of the Palacky University.

In each centre, a structure of the provided topics depends on the particular study fields of the departments. There are appeared topics based on the pure and applied mathematics focusing the mathematical analysis, algebra, geometry or statistics. The problems of economics and also control engineering practice can be seen as the examples of a wide spectrum of various study fields.

The classical teaching strategies applied by academics in the frame of the tutoring can be enriched by procedures with aim of providing the fast help and a feedback to student in the centre. Using the support in the form of information technologies can be suitable implemented in this process. In the article (Barot, 2017), the proposal of the adaptive control strategy was presented for purposes of application in the maths support centres. Generating the computer based mathematical examples was described in (Barot, 2019). Both proposals were the extension with regards pedagogical cybernetics (Granic et al., 2009; Gushchin & Divakova, 2015). In pedagogical cybernetics, the similar concepts of feedback principles are considered in favour of an achievement of the efficiency and appropriate control quality of realized processes. Tutoring the students can be suitably classified as a part of the feedback procedure in which information technologies can be helpful.

A simplification of the explanation steps can be appropriate in case of a situation when one tutor provides information for a number of visiting students in a group. On the previous proposal (Barot, 2017), based on general recommendation of the free-available software or e.g. some simplifications in approaches of solving the integrals (Barot, 2018), this paper concretely presents possibilities for supporting the geometrical discipline in the centres.

The topic of geometry was preferred by students of the Department of mathematics with Didactics at Faculty of Education, University of Ostrava in the realized quantitative research with 1100 proposals of the software utilizations in mathematics. At second, the analysis also confirms the statistical significance of the students approaches based on selection of mathematical fields, topics, and problems. The utilization of the geometrical software or the augmented reality has been frequently used in the education, e.g. in (Kmetova et al., 2019; Lavicza & Papp-Varga, 2010). This type of application of information technologies can be generally seen in the field of the STEM education, e.g. in (Hott & Dibbs, 2020). The significant important freeware solution for these applied purposes is GeoGebra (Korenova, 2017). A wide spectrum of types of the geometrical models have been proposed by the GeoGebra community. Therefore, the geometrical modelling belongs to possibilities of the modern information technologies which have proposition to be a part of the feedback educational process. Therefore, the utilization can be a suitable tool in the realization of the tutoring the students in the maths support centre. In this paper, possibilities of the GeoGebra's solution in favour of the tutoring are described.

1. APPLIED ADAPTIVE FEEDBACK CONTROL STRATEGY WITH REGARDS TO TUTORING PROCESSES

With regards to the general principles of cybernetics, pedagogical cybernetics (Granic et al., 2009; Gushchin & Divakova, 2015) have the same principles as well as technical cybernetics frequently does within the control system theory (Corriou, 2004). The same background is built on the feedback strategy (Cevik et al., 2015) in the frame of control some process or processes. Therefore, each educational process, which fulfils the principle of the feedback control, can be seen as a part of cybernetics. Due to a wide spectrum of individual behaviour of students, the modelling can have a significant role in the feedback process. Extended proposals of strategies inspired by the cybernetical disciplines can be seen e.g. in adaptive control strategy used in educational conditions (Barot, 2019). Moreover, the cybernetical principles can be bound to the statistical modelling with utilization of the cybernetical mathematical models in the quantitative research, as discussed by e.g. Vaclavik et al. (2019).

In the adaptation approach, the teacher is situated in the role of the controller and the student as the controlled object in the frame of the feedback control with the re-identification. The re-identification is based on the continuously based exploration of the student's results. This step can be supported by the using the information technologies (Barot, 2017).

As a particular procedure, using the generator of random numbers in a construction of systems of the linear equations (Barot, 2019), simplification of solving the partial fractions in computing the integrals (Barot, 2018) or the general role of the free-available software (Barot, 2017) can be practically used with complementing the professional experiences of each member in the maths support centre. For applications of proposals in the frame of pedagogical cybernetics, the math support centre fulfils the assumption for their useful realization.

2. DESIGN OF QUANTITATIVE ANALYSIS OF PREFERRED MATHEMATICAL SOFTWARE OPTION

For the particular proposals of the study tools using the mathematical software, the opinion of students about the preferred software solution was analysed and identified through quantitative research, with its structure and aims described in this session.

In the section of results, only the most preferred software possibility is therefore used for the designed tools for purposes of the tutoring process for the Maths Support Centre in Zlin, where the wide spectrum of mathematical topics has been considered e.g. for study fields of automation and control, management and economics, security technologies, computer sciences, information technologies.

The opinions of students were analysed in the frame of the defined task. Task was consisted of declaration of 51–100 own defined mathematical examples with the analytical solution and the solution occurred in the own selected mathematical software tool. The respondents were the students at the Department of Mathematics with Didactics at the Faculty of Education at University of Ostrava. Between both institutions, the applied research of the educational strategies has been realized and published yet e.g. (Barot, 2017). The main idea is the connection of the development of the new or modified educational proposals with the practical application in the environment of the Math Support Centre.

There has been existed a wide spectrum of solutions based on numerical or symbolical computational core of software. The most frequently required topics can be bound on the university mathematics e.g. linear algebra, geometry, mathematical analysis, functions, combinatorics, statistics and probability, arithmetic. E.g. in most popular category of the STEM education (Hott & Dibbs, 2020), the geometrical modelling holds the significant position with regards the improving student's steoremetrical imaginations. GeoGebra software solution can be considered as the important geometrical tool used in the field of the education, as can be seen e.g. in the quantitative study by Lavicza and Papp-Varga (2010).

The main aim is the selection of the most preferred option of using the software solution according to the students' practical choices in their task (51–100 own defined mathematical examples). However, the following research question confirmation is necessary to accept the statistical dominance of the obtained option (the rejection of homogeneity of frequencies in contingency tables). There are considered the following research questions RQ1–RQ4 bound with the declaration of the statistical hypotheses $1H$–$4H$.

RQ1: Are there statistically significant differences between the study field combinations and the selection of particular mathematical software options?

RQ2: Are there statistically significant differences between the mathematical field and the selection of particular mathematical software options?

RQ3: Are there statistically significant differences between the mathematical topics and the study field combinations?

RQ4: Are there statistically significant differences between the mathematical topics and the selection of particular mathematical software options?

All these defined hypotheses will be tested on the significance level, as is assumed in the methods of the mathematical induction, which belong to the quantitative approaches (Gauthier & Hawley, 2015). The statistical significance has the important role in the applied quantitative research in the social sciences, e.g. (Lackova, 2014; Simbartl & Honzikova, 2016; Polasek & Javorcik, 2019) and is carrier in the engineering applications (e.g. Barot et al., 2020 in Print).

In the present quantitative research, the observed parameters will be divided into several categorical variables for each record of each students' example: mathematical software, mathematical field, mathematical topic, study field of the student. Due to the character of these considered categorical variables, the Chi-Squared test (Gauthier & Hawley, 2015) will be considered for the testing the hypotheses.

$1H$: $1H_0$ (in $1H_1$ is missing "not"): There are (not) statistically significant differences between the study field combinations and the selection of particular mathematical software options on the strictly defined significance level of 0.001.

$2H$: $2H_0$ (in $2H_1$ is missing "not"): There are (not) statistically significant differences between the mathematical fields and the selection of particular mathematical software options on the strictly defined significance level of 0.001.

$3H$: $3H_0$ (in $3H_1$ is missing "not"): There are (not) statistically significant differences between the mathematical topics and the study field combinations on the strictly defined significance level of 0.001.

$4H$: $4H_0$ (in $4H_1$ is missing "not"): There are (not) statistically significant differences between the mathematical topics and the selection of particular mathematical software options on the strictly defined significance level of 0.001.

3. RESULTS

For purposes of Maths Support Centre at the Faculty of Applied Informatics, the following results of the quantitative research influence the type of the proposed mathematical tools. Concretely, the respondents were the students at the Department of Mathematics with Didactics at the Faculty of Education at University of Ostrava, who studied Application of the Computational Technologies in Mathematics during this summer semester in their 1st year of the bachelor study programme. The tutoring processes can be than widely enriched by these mathematical software solutions.

3.1. Students' Preferences Analysed in Quantitative Research

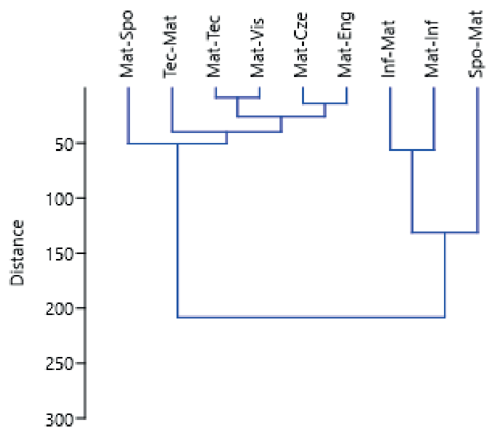
The realized quantitative research contained 1100 records of proposals of 13 students' own definitions of mathematical problems (51–100 examples for each student). The following statistical results were obtained in the following software: MS Excel (statistical description and descriptive plots) and PAST Statistics v. 4 (Hammer et al., 2001) (cluster analysis, testing the normality of data and testing the hypotheses). For the total number of 1100 proposed examples, the average value was 84.69 proposed examples.

For the teaching the mathematics at the 2nd grade of the primary school, the respondents are prepared at the Department of Mathematics with didactics at the Faculty of Education at University of Ostrava. Respondents had a pair of study fields. Mathematics (Mat) is bounded on the 2nd field: Sport (Spo), Informatics (Inf), Technical Education (Tec), English (Eng), Visual Arts (Vis) and Czech Language (Cze).

According to distributions of relative frequencies, 3 mathematical topics were frequently appeared: Algebra with 419 proposals, Geometry with 406 proposals, and Functions with 247 respondents. As the most frequented option, GeoGebra was selected in 472 proposals, i.e. 42.9% of total records.

The wide spectrum of selected spectrum of used mathematical software are at the combination of the study field of Mathematics and Informatics. 192 records of examples (i.e. 17.46%) was computed using the Photomath at combination of the Sport and Mathematics.

With regards to the study field combinations of respondents, the similarities in the utilization of the mathematical software can be seen in Figure 1, where the results of the cluster analysis can be seen. The following interesting similarities were detected: 1st similarity between Inf-Mat and Mat-Inf (focused on informatics), 2nd similarity between Mat-Cze and Mat-Eng (focused on languages), 3rd similarity between Mat-Tec and Mat-Vis (graphical proposals). Two main groups can be seen in the second option of study field with mathematics: informatics (major and minor) and sport (major) in comparison to other study combinations. The cluster analysis was computed with the setting of the Ward method, which has been frequently used for purposes of the analysis of the Euclidean distances between considered data set.



F i g u r e 1. Similarities in Utilization of Mathematical Software Across to Study Field Combinations

S o u r c e: Own work.

Using by the Chi-Squared test in the contingency table (occurred proposals for each study field combination according to option of software), the p value was $1.86 \times 10^{-249} < 0.001$. The degrees of freedom were 56 and the Chi-Squared Criterion was 1369. The zero hypothesis $1H_0$ was rejected in favour of the alternative hypothesis $1H_1$. Therefore, there are statistically significant differences between the study field combinations and the selection of particular mathematical software options on the strictly defined significance level of 0.001, as was defined in RQ1.

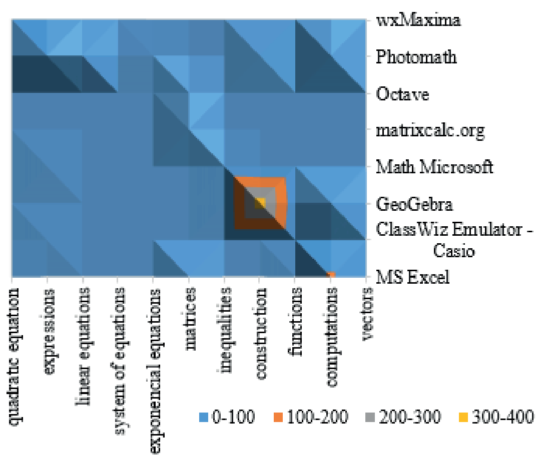
For reason of unexpecting combination of major topics (Algebra, Geometry and Functions) and the most occurred software possibility of GeoGebra, other mathematical topics instead of the geometry belong to solving the problems using by this software. The students provided the examples of geometry and also functions by the software of GeoGebra. The reason is the advantageously integrated computational system (CAS) into the GeoGebra core.

In the frame of the Chi-Squared test in the following contingency table (occurred frequencies of mathematical topics and the selected software), the p value was $6.69 \times 10^{-306} < 0.001$. The degrees of freedom were 32 and the Chi-Squared Criterion was 1549.2. The zero hypothesis $2H_0$ was rejected in favour of the alternative hypothesis $2H_1$. Therefore, there are statistically significant differences between the mathematical fields and the selection of particular mathematical software options on the strictly defined significance level of 0.001, as was defined in RQ2.

The most particular content of the proposed mathematical problems were geometrical constructions and computations. The study field combinations for this phenomenon were Spo-Mat (with 12.18% of 1100 records) and Mat-Inf (with 9% of 1100 records). Other particular types of problems were distributed uniformly with the lower occurrence.

In the frame of the Chi-Squared test in the contingency table (occurred frequencies of mathematical problems and study field combinations), the p value was $4.70 \times 10^{-236} < 0.001$. The degrees of freedom were 80 and the Chi-Squared criterion was 1380.5. The zero hypothesis $3H_0$ was rejected in favour of the alternative hypothesis $3H_1$. Therefore, there are statistically significant differences between the mathematical topics and the study field combinations on the strictly defined significance level of 0.001, as was defined in RQ3.

As can be seen in Figure 2, the most particular content of the proposed mathematical problems was the geometrical construction for the mathematical software GeoGebra (with 31.72% of 1100 records).



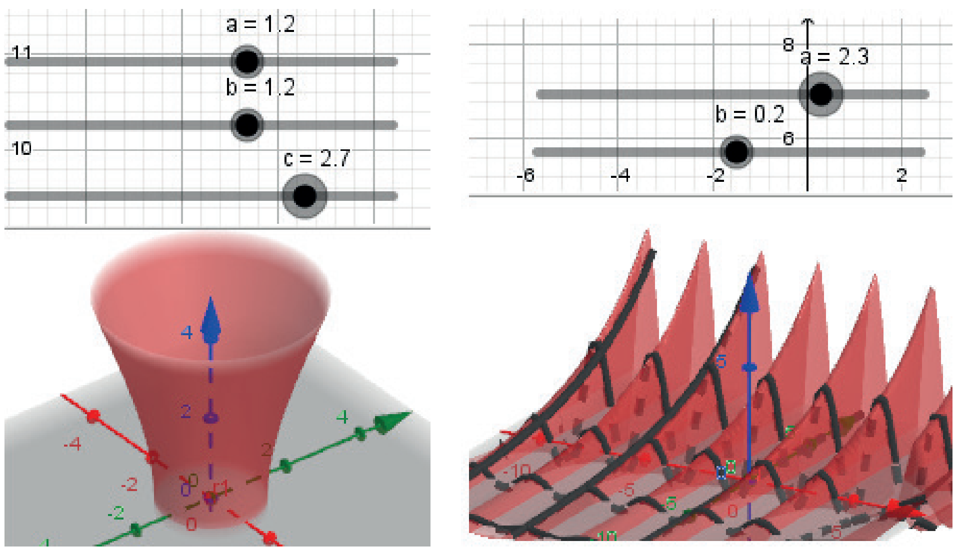
F i g u r e 2. Occurrence of Proposed Mathematical Topics with Regards to Software Options

S o u r c e: Own work.

In the frame of the Chi-Squared test in the contingency table (occurred frequencies of mathematical problems and study field combinations), the p value was $0 < 0.001$. The degrees of freedom were 70 and the Chi-Squared Criterion was 2082.7. The zero hypothesis $4H_0$ was rejected in favour of the alternative hypothesis $4H_1$. Therefore, there are statistically significant differences between the mathematical topics and the selection of particular mathematical software options on the strictly defined significance level of 0.001, as was defined in RQ4.

3.2. Proposals of Geometrical Models in Favour of Utilization in Maths Support Centre

As was proven in the quantitative analysis in the previous section, appearances of *p* values in each confirmation of research questions expresses, that there are the statistically significant differences between the frequencies in each of the contingency. With the highest value of frequency, therefore the GeoGebra software is considered for the construction of the educational tools for the Maths Support Centre. The following proposals can be advantageously used also by other tutors across the network of the existing Maths Support Centres in the Czech Republic. The topic can be advantageously included in the feedback adaptive control strategy of the educational approach of tutors. These files will be free-available for each student. The sense of these implemented solutions is expected in the form of the improving the efficiency of the tutoring in the field of the geometry, which can be further suitably used also in the problematic mathematical analysis.



$$\frac{x^2}{a^2}+\frac{y^2}{b^2}-\frac{z^2}{c^2}=1$$

$$f(x,y)=\sin(ax)e^{by}$$

F i g u r e 3. Proposals of Dynamical Models of Hyperboloid and Multidimensional Function

S o u r c e: Own work.

On the GeoGebra platform, the geometrical constructions can be advantageously based on the integration of the slider, which can influence the parametrical settings of models. This aspect can be appropriately used as the variables in the analytical description of the considered geometrical objects.

The importance of the analytical geometry can be seen in the mathematical analysis in the frame of the solving the integrals for the multivariable cases, where for the definition area of integrals is the stereometrical imagination the necessary assumption. With regards to the integrating the parametrization of the analytical expression of geometrical objects, there were constructed dynamical models of: a circle $\{(x - m)^2 + (y - n)^2 = r^2$, with parameters $m, n, r\}$, a parabola $\{(y - n)^2 = 2p(x - m)$, with parameters $m, n, p\}$, a hyperbola $\{(x - m)^2/a^2 - (y - n)^2/b^2 = 1$, with parameters $m, n, a, b\}$, an ellipse $\{(x - m)^2/a^2 - (y - n)^2/b^2 = 1$, with parameters $m, n, a, b\}$.

In the three dimensional case, the parametrization of the real function $\{f(x, y) = sin(ax)\ exp(by)$, with parameters $a, b\}$ and a circular hyperboloid $\{x^2/a^2 + y^2/b^2 - z^2/c^2 = 1$, with parameters $a, b, c\}$ were proposed in the form of the dynamical models in GeoGebra, as can be seen in Figure 3.

The study area of the mathematical analysis was supported by the following models $\{x = argmin(f(x, y) = x^2 + 4xy + y^2; y \leq ax + b)$, with parameters $a, b\}$ (Figure 4), which can enrich the imagination of solving the extremes of the multidimensional functions of the real variables considering the constraints in the form of inequalities, as can be seen also in (Korenova et al., 2020 in Print).

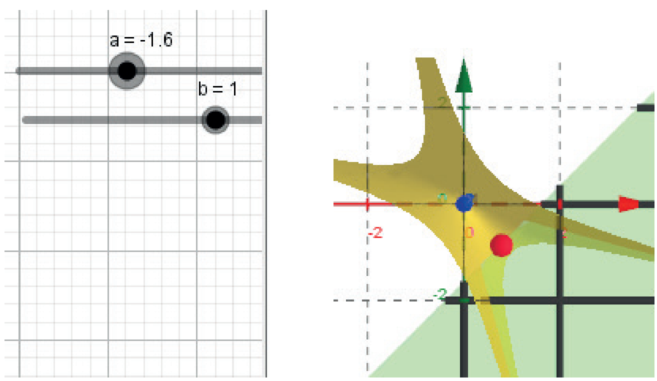


Figure 4. Proposals of Dynamical Models of Constrained Optimization Problems

Source: Own work.

CONCLUSION

In favour of the particular utilization, the proposal of geometrical modelling options was described for purposes of their implementation in the Maths Support Centres. As the obtained option in realized quantitative analysis, the geometrical topic was selected and focused on the utilization of the geometrical modelling. Particularly with regards to statistical significance, differences were identified between the study field combinations and the selection of particular mathematical software, the mathematical fields and the selection of particular mathematical software, the mathematical topics and the study field combinations and between the mathematical topics and the selection of particular mathematical software options.

Opportunities of the application of the geometrical advantages has been widely described in case of educational field yet. However, this presented approach can be suitable in case of application of these principles in the frame of tutoring the students in the Maths Support Centres as a part of the adaptive control teaching strategy. The geometrical modelling can enrich the students' imaginations in the technical fields and can be advantageous for the suitable understanding the following topics of control system theory based on e.g. the optimisation and mathematical analysis, where the geometrical theoretical background has been frequently integrated. Future research can possibly analyse the efficiency of the implementation of practical proposals presented in this contribution.

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E-LEARNING IMPLEMENTATION – FROM ACTION TO EQUITY IN AN INTERNATIONAL HIGHER EDUCATION INSTITUTION

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Abstract: *Considering that higher education institutions are key players within the learning society, it is reasonable to expect that Information and Communication Technologies (ICT) mean changes to lecturers, students and universities. This research combines culture, ethics and technology with the purpose of achieving "ethicultural" sensitivity, and educational equity at a international higher education institution with several campuses in Portugal and Angola. The empirical results seem to demonstrate that a pure technological perception about education condemns any e-learning paradigm, because "glocality" imposes combined ethical and cultural dilemmas and to minimise potential failures, it is crucial to involve all stakeholders to have "ethicultural" sensitivity as a prerequisite for mutual understanding in national and international successful e-learning implementation.*

Keywords: Higher education; Ethics, Culture, Equity, E-learning.

INTRODUCTION

According to Arias-Oliva et al. (2004, pp. 47), binomial ICT/education intends "to improve also the well-being of the entire world", and e-learning is globally recognised as a requirement for future social and economic development (Richards, 2004). Governments and educational institutions intend to use this vision of knowledge society (Lallana, 2004); however, to presume that technology by itself entails education is unrealistic and condemns any e-learning paradigm (Weaver, 2002) because novel technologies impose substantial ethical and social changes on education (Anderson, 2006).

These ethical and social changes are explicit in international distributed-learning environments as a result of tensions between global and local contexts; for instance, knowledge transfer procedures reveal unequal outcomes due to cultural constraints (values, language, etc.) (Altbach, 2004).

E-learning promotes the existence of e-University as a strategic response to novel educational context (MacKeogh, 2008; House of Commons, 2005); however, ICT development must cherish the ethical and cultural values as a precondition for social development (Sawhney, 2000).

Bearing in mind the cultural and ethical impact in each context, this research's conceptual framework combines culture, ethics and technology with the purpose of achieving full compliance concerning the social, organisational and educational equity objectives. In addition, determining the project boundaries is essential in order to develop a high quality in practical research.

1. THE RESEARCH

1.1. Research context

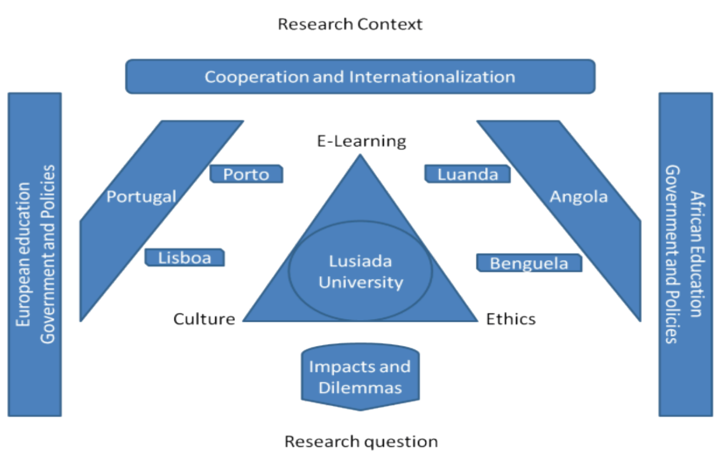


Figure 1. Research overview

Source: Author, 2017.

The research is conducted in the international context of a University with several campuses in Portugal and Angola. The importance of e-learning is recognised by the educational institution as a way to promote organisational innovation; the project started some years ago and the last milestone comprised the idea of developing technological solutions and a curriculum that integrates ethical and cultural guidelines (consistent with the knowledge gap argument of Arias-Oliva et al., 2004). From the analysis of figure 1, it is noticeable that there is a trade-off between planning and current ethical and cultural practices due to their influence in different contexts being open to e-learning.

1.2. Research strategy

This research underlines a three dimensional analysis (e-learning, ethics and culture) through an interpretative analysis of empirical data (following Walsham, 2006). It includes interviews, field notes, documents, focus groups and participant observation. This choice enabled an "action-case" methodological approach in order to balance interpretation and intervention (Braa & Vidgen, 1999; Davison, 1998) and facilitate findings comparison validation (Yin, 2009). Preliminary data collection was administered in September 2015 during a visit to Angola, and lasted for three years, in which the researcher completed various field procedures (grant credentials and access to case study site, field assignments and facilities analyses) (Yin, 2009), as well as developing personal contacts with locals (cultural and organisational context recognition). The data analysis was conducted within a broader framework of the hermeneutic cycle (Klein & Myers, 1999), which asserts the feedback process between the whole (the Institution) and the parts (campuses in Portugal and Angola).

2. LITERATURE REVIEW

The literature review presented in this chapter shows that educational technology is fast-moving and new insights are continuously appearing, and the search was repeated to produce a longitudinal review, sometimes influenced by emerging issues on data analysis.

2.1. E-learning

The current literature seems to neglect an important discussion: to examine issues on overlap of ethical and cultural quandaries related to e-learning implementation, namely across countries (Portugal and Angola in the context of this research).

In that sense, it is essential to understand the global perspectives of e-learning intervention, which needs a multi-stringed approach (Anderson & Grönlund, 2009). El-Sherbini and Azer (2008), for example, refers to the e-learning complex connections between strategies, design, and technologies, which encompass the following components of policymaking: strategic planning and vision; curriculum and content; use of the internet and acceptable use policies; quality assurance and accreditation; conductivity, infrastructure, and networks; professional development; intellectual property and copyright; cost, finance, and partnerships. Conversely, others authors focused on different lists of suggestions, such as factors as leadership, culture, structure, design and technology, as well as delivery management; Laurillard (2008) on cultural, intellectual and practical activities; or Khan (2005) which have pointed that it is important not to overextend the arguments to say that the e-learning process can be divided into two major phases: content development, and content delivery.

For each of these dimensions, organisational dilemmas (localisation, collaboration, etc.) should be considered associated with strategy and policy, namely to ensure equity and access to education. Consequently, ethical and cultural sensitivities need a closer look that should highlight differences across institutions and countries, and furthermore help to shed light on new issues that may be of special relevance in the context of this research as for instance fairness and equity.

2.2. Technological infrastructure and services

The e-learning implementation at university settings is a complex task, which starts with a strategy for developing the basic technical infrastructure (de Vries, 2005). According to Blinco, Mason, McLean, and Wilson (2004, p. 2), this "infrastructure often describes a bottom layer of an architectural description or diagram, indicating network hardware components, communications processes, services and protocols". According to Anderson (2008), globally, the internet is a basic network infrastructure for e-learning; however, it is also necessary to consider components at local networks, as well as personal tools and equipment that make learning activity possible. Particular importance on this assumption assumes management systems, namely because the e-learning evolution involves four general categories of technological systems: Learning Management Systems (support administrative tasks) (Lassila & Poyry, 2007); Managed Learning Environment (including the whole range of information systems and processes, which contribute directly or indirectly to learning and learning management) (Winter, 2006); Learning Content Management Systems (allowing developers to store, manage and provide access to content used in e-learning) (Abazi-Bexheti, 2008); and Virtual Learning Environments (the components in which students and tutors participate in several online interactions, including online learning) (Weller, 2007).

Furthermore, other technological factors can affect the global use of e-learning. Macpherson, Homan, and Wilkinson (2005, p. 42), refers that while technology can be an enabler, it can also be a barrier when capacity and access are limited due to infrastructure issues (portals, repositories, digital libraries, search engines, and e-Portfolios). Or, specifically to the universities in developing countries (e.g. Angola in the context of this research), Suhail & Lubega (2011) refers that not only physical access to a computer and an internet connection, but also to the reliability of the connection and the bandwidth are the most critical issues that impede the process of technology integration. On the other hand, Nielsen (1997) refers to usability problems that may arise due to variations in behaviours and cultural differences, and Unwin (2008) mentioned the most important factors which includes training for teachers in e-learning at all levels, and awareness-raising about the value of e-learning (see value added section).

2.3. Computer-mediated communication (CMC)

According to Zhang (2004), CMC is transforming classrooms to make learning a more interactive, diverse and enjoyable experience. This can be through online interactive classrooms, interactive group discussions and tutor/student sessions, or empowering of students/teachers interactions by designing more flexible and intuitive interfaces (Klein & Huynh, 2004).

Following Weaver (2002), implementing a balanced approach is needed to avoid ignoring technology tools, or fixating too much on technology for e-learning.

2.4. Requirements for the e-University

As noted in the discussion above, e-learning embraces some challenges becoming a key element of higher education, which are enhanced if crossing national or regional boundaries.

The implementation of e-learning at the traditional universities have been discussed by several authors (e.g. Goodfellow & Lea, 2001) confirming that it makes a crucial contribution to higher education mission. From this perspective, it is vital to grasp the theoretical foundation of e-learning relevance in face of university role.

2.5. Internationalisation

Higher education institutions operate in a highly complex environment (political, economic, academic, social and cultural), namely in the face of internationalisation programs where private and for-profit institutions are flourishing. Nevertheless, the value added by international accreditation is improving a market position demonstrating quality when prejudices exist against institution or country. New approaches to educational technology has given rise to both quality and equity concerns as "… the process of integrating an international, intercultural or global dimension into the purpose, functions or delivery of higher education at the institutional and national levels" (Knight, 2008, p. 21). This is in line with the claim made by Arias-Oliva et al. (2004) that a higher education institution and its stakeholders should consider the advantages and disadvantages of educational technology as a way to ensure openness, equity and international understanding and to avoid the digital divide, cultural ignorance or insensitivity.

According to Dunn and Marinetti (2007), if e-Learning ignores cultural factors it will inevitably lead to frustrating and ultimately ineffective learning experiences. Nevertheless, much of the literature concerned with cultural and cross-cultural issues relied on the classic works of Hall and Hofstede (Myers & Tan, 2002), and sometimes revealed there to be inadequate attention given to the dynamic nature of culture (Krishna, Sahay, & Walsham, 2004). Therefore, it is essential that cross-cultural issues in online learning be more critically examined (Rogers, Graham, & Mayes, 2007); students' cultural attributes affect how they perceive an online learning setting and how they present themselves online, cognitively, socially, and emotively (Wang, 2007). In addition, the ability to accommodate culturally-based learning differences is becoming an increasingly critical skill in this time of rapid globalisation and technology-influenced cross-cultural interactions (Parrish & Linder-VanBerschot, 2010, p. 15).

2.6. Equity

In an inter-organisational environment, the main ethical dilemma emerges from the fair allocation of resources and distributive justice whose judgements regarding fairness "represent the degree of equity or equality across parties' payoffs that are considered normatively acceptable or desirable within a situation" (Bazerman, Loewenstein, & White, 1992, p. 221). In this regard, the implementation of e-Learning technology can provide an equitable and equalising environment (Kanuka & Rourke, 2008). John Rawls' (1971) theory of justice and fairness enlightened the dilemmas of resource distribution. According to Roberts (2002), it is vital to extend the narrow learning environment of campus-based education to wider resources, for instance: learning experiences, digital libraries, availability and liability. Nevertheless, distributive fairness is a complex concept that depends much on cultural values, precedents, and the context of the problem (Wierzbicki, 2010). However, literature in theories for cross-national equity in the sense of e-learning implementation is scarce.

2.7. Glocality

To debate XXI century high education is essential to investigate connectivity and interactivity as key features of the learning society (Webster, 2006a). For that reason, it is logical that governments or educational institutions, do not plan to mislay this prospect bounded to information society (Lallana, 2004), since e-learning is globally accepted as a prerequisite for future social and economic development, providing a new essential style, as a base level for accessible education (Richards, 2004). Moreover, the internationalization of campus and community is simultaneously a chance and a challenge that higher education institutions ought to deal today. Although, chronological data as regards to knowledge transfer in higher education institutions exhibits a wide array of unequal results, when it concerns cultural restrictions (Altbach, 2004). According to Hammond (2003) higher education institutions exist within political, cultural and social contexts which shape policy and practice. Even, information systems development and adoption efforts should involve participatory design, user satisfaction, and human relations (Kling & Scacchi 1980), if the objective is shifting paradigms for the university (Duderstadt, 1997) and change in the very structures of educational thinking (Andersson, 2008).

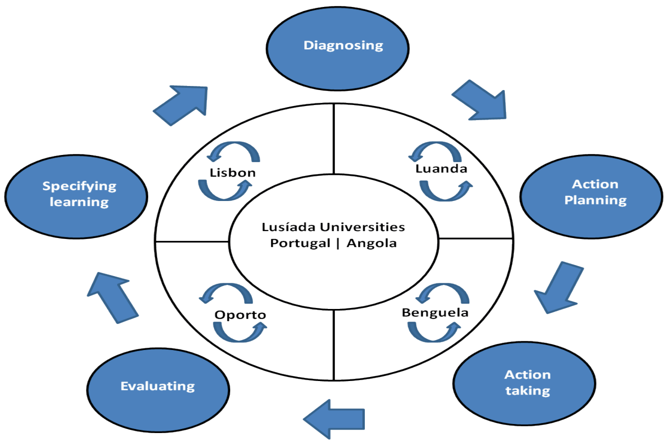
Even so, it is crucial to develop international normative rules for ethical education knowledge distribution, which is in line with Olsen's (2009) political glocalism: putting humanity's collective requirements ahead of vested interests' short term desires, humanity's collective priorities ahead of politicians' short term ambitions, and humanity's local needs and priorities equally balanced with global ones. The globalisation of education may necessitate further partnerships and collaboration. These partnerships can exist to ensure local support for e-Learning, and to address accreditation and certification issues (Uys 2000). The emergence of a global education marketplace can be understood as a consequence of informational society and globalisation (Friedman, 2005). Despite this global awareness, education is inevitably expressed within local dimensions (Altbach, 2004).

3. METHODOLOGY

The study of culture is very complex and ethics practice needs intervention. In that sense, the action-case approach (Braa & Vidgen, 1999) is the option that balance interpretation with intervention. However, it is vital to debate the concept of "hybrid", which the researcher defines as a concept with two sorts of components: case study and action research. This research assumes a qualitative analysis as a way to grasp and describe social phenomena and cultural milieus in which people live.

3.1. Research approach

The distinctive organisational setting of the Institution under study, provide an environment to investigate the ethical and cultural impact in an e-learning project. Understanding the trade-off between planning and current ethical and cultural practices is vital to promote an effective e-learning project, despite its multiple geographical locations. This contextual milieu is enclosed through an ICT joint implementation. Figure 2 represents the intertwining of the whole as the central Institution brand, the four localizations, and the action research cycles both in the "whole" and in the parts "local interventions":



F i g u r e 2. Research design in action-case method
S o u r c e: Author, 2017.

4. EMPIRICAL RESULT

The empirical evidence emerged within the context of the Institution under study, where the implementation levels of ICT embedded in within a e-university organisational climate (e.g. portal, videoconferencing, webstorage, webmail, messaging, etc.). The homogeneity of the Institution under study leads to an ethical dilemma, as what is proper and correct in one culture may be ineffective in another. Globalisation and technological development have simultaneously pressured local cultures and global ethics, moving between push and pull strategies, as this research's findings exemplify in the following figure.

4.1. E-learning strategy

From a research point of view all the technical problems encountered were already stated in the literature. However, ethical and cultural overlaps are far more specific and complex in the cross-cultural environment of the University under study. For example the perceived value of an equitable e-Learning project (different stages of implementation) due to different cultural settings needs an ethicultural evaluation if it persists the intent to share the same brand.

4.2. Technological infrastructures and services

Through data analysis it is possible to recognise several ethical issues and social dilemmas. The core for all linkages is ICT infrastructure liability and adoption, leading to a necessary comparison of Angola and Portugal. The differences were easily perceived throughout the field work as the following problems demonstrated: lack of equipment maintenance, software piracy, electricity power outage, limited network and bandwidth infrastructure, unsatisfactory performance and high internet service cost. Nevertheless, the campuses in Portugal possess a proprietary academic management system which Angola has been using, although the system design does not report any ethical and cultural sensitivity. In fact, the majority of system modules are not applied in Angola and the system design simply neglects requirements for equity (Kanuka & Rourke, 2008). In addition, in regard to the existing government funding in Portugal (e-Europe Action Plan) all network infrastructure was updated with most modern technology, where global vendors were engaged. In Angola no funding was available, so more one equity problem emerged. Meanwhile, the free e-Learning platform (Moodle) was chosen for the whole Institution in Portugal and Angola, which confirms that the high cost of commercial e-Learning platforms limits their use in education (Vrasidas, 2004). However, the implementation plan remains to be completed in Angola, not because the opportunity costs but as a result of different strategies and organisational cultures (evidence based on the leadership environment).

Several other problems were found relating to licensing software even for administrative or academic use. For instance, the Microsoft campus agreements signed in Portugal are not valid for the campuses in Angola, because the localisation comes under other geographic reseller (usually in South Africa). Furthermore, several participants commented that in the Angolan society software piracy is widespread. Perhaps African Ubuntu ethics influence this scenario (Capurro, 2008a), but from the point of view of western ethics it might be said that in terms of deontological theory the act of copying software is always wrong, whilst in utilitarian theory it is justified if it has a beneficial effect on a society as a whole.

4.3. Knowledge/Content management

In Angola, pre-Bologna curricula are still utilised and have been since 2001 despite the existing negotiations to adopt the current ones. In fact, the intended consequence of the Bologna Process in Europe, which is not being pursued in Angola, creates a remarkable social dilemma: the current curricula and programs require a resynchronisation in order to truly allow knowledge sharing and distribution.

Other inconveniences have been reported regarding linguistic understanding, since lecturers are mostly non-African natives. The most frequently occurring nationalities are Portuguese, Brazilian, Cuban, Russian, and Eastern Europeans. This is furthered by the 42 different native dialects that exist in Angola (Lewis, 2009), and in spite of the fact that Portuguese is the official language, student's communication is based on their own dialects. This quandary is increased because Portuguese content development happens only in Portuguese and replicates the Bologna Process; therefore ignoring local needs (absence of cultural sensitivity). Moreover, the absence of specialists (teachers) compels the University of Angola to hire those from abroad, and so these teachers are extremely well paid: their wages is five times that of the Angolan minimum wage. This scenario raises another quandary (equity): education is restricted to the wealthy social classes. This dilemma is clearly made greater because the bureaucratic procedures necessary to get a visa are extremely costly, difficult and slow, as are travelling arrangements (consistent with Britz & Ponelis, 2010). These problems enable the teachers to demand even higher wages. Moreover, these teachers are clearly less culturally knowledgeable because the previous requirements (visa and travelling costs) often prevent them from having travelled previously to Angola in order to understand local culture.

4.4. Computer-mediated communication

The importance of videoconferencing to this e-Learning environment was a key piece of evidence of efforts to minimize inequity problems on collaborative communications. In fact, the Polycom technology implementation in the whole Institution solved the lack of interactive communication systems for sharing content and perform good teaching with low internet bandwidth in Angola and enabled an educational environment equity. Nevertheless, it has been used most regularly between the campuses of Lisbon and Oporto (in Portugal) for management meetings, and was for a while largely ignored for lessons. Several political and cultural impacts led to different implementation outcomes, namely between the campuses in Portugal and Angola, and local initiatives must be identified and supported, for example, the formal inauguration day in Angola, or the privacy complaints in auto-attendant configuration. Furthermore, since its use becomes more effective, emerging issues must be considered to enhance cultural understanding of how collaboration happens. Indeed, as how bandwidth updates make feasible the use of internet to access to certain kinds of multimedia content, also the use of videoconferencing methods of contact between students and lecturers may change, and new pedagogical insights generate impacts on the traditional academic culture.

4.5. Value added

The ICT implementation enabled value added services as a competitive advantage to help attract new students, namely having better access to information. The objective of the e-U Virtual Campus (www.e-u.pt) was to encourage the production, access and sharing of knowledge through a wireless network, and access to lessons, articles, papers, notes, and service anytime and from anywhere through the internet. However, the physical distribution of facilities among all the campuses of the Institution could benefit from a solution with components of blended approach.

The use of the e-Learning platform Moodle for placing online content of the traditional classes showed only an added value related to access, privacy and security, since lecturers can make content available only for students who must take the respective access rights for course units, while the use of the shared folder allows content to be accessible to read by all lecturers and students. Regarding the educational outcomes, existing practice places little interest in the use of e-Learning tools, but the aspects of funding, quality, reputation, image and modernity justified the investment. This value-added service improved the market position by international accreditation of the Universities.

4.6. Equity dilemmas

The Institution under study, Lusíada Universities, is a Portuguese brand of private universities, with academic co-operation agreements leading to internationalisation, namely in Portugal (Europe) and Angola (Africa). The shared common organisational culture follows the vision of the founder of Lusíada Universities, as is clear from the motto (although it is slightly altered in Angola), the newsletters and the social events. This way has achieved a very positive reputation around the Portuguese speaking world!

Regarding technological infrastructures and services, all necessary components were installed in Lisbon and Oporto (network, internet, portal, single sign-on, videoconference, etc) and all features integrated with the existing legacy system, in particular the SIGUL (academic management software). E-Learning has been developed in-house based on an open source culture, and has been implemented in Portugal since 2008 (Oporto), and 2010 (Lisbon). In Luanda and Benguela (Angola), not all necessary components were installed (only a restricted network, low bandwidth internet, and videoconference), and e-Learning platform has been implemented only in 2012 (Benguela), despite no features or functionalities are integrated. However, the e-Learning platform is not yet in Luanda (year of 2017), leading to a different organisational environments. So, at this level emerges an inequality dilemma between the resources available for students and lectures in each campus.

The leadership drives an organisational culture and cultural awareness designed to avoid failure and reconcile the inconsistencies between different local policies and different quality proposals. For example, the curricula equity and the uncompromising defence of quality in teaching assume special relevance in terms of the moral and ethical stance. With eventual differences, the problem raises questions related to the reputation of the University brand, given its globality. One of the most critical needs for establishing effective quality in Angola is human capacity for development, *"technology starts at the moment that is installed, the human factor has to play its role, so they can use it… it only lacks the human upgrade"* (informant comment in Luanda, Angola). On the other hand, Academic integrity in Angola is very problematic.

Additionally, the importance of diversity is recognised in the Declaration of Principles of the World Summit on the Information Society (2003), and by UNESCO's Universal Declaration on Cultural Diversity (2001). Therefore, diversity in higher education relies on the trade-off between homogeneity and heterogeneity between educational contexts, leading to the concept of glocality.

Equality and equity are utilitarian perspectives which focus on the consequences or ends (utilitarian case for global equality), often ignoring the means by which these ends are achieved.

4.7. Glocality

The emergence of a global education marketplace can be understood as a consequence of informational society and globalisation (Friedman, 2005). Despite this global awareness, education is inevitably expressed within local dimensions (Altbach, 2004), or at least focusing on a certain global region (the European Bologna Process is an example), in which it is feasible to distinguish different local perspectives regarding the process itself (Rogerson, 2004b), as well as concerning the main issues around education in that region: cultural diversity, ethics and values, mobility, intercultural communication, organisational cooperation, economical value, and the government's education policy. Following Meyrowitz (2005), "glocality" (global dimension with multiple local dimensions) engages a whole new range of ethical and social issues in education.

This quandary is increased because Portuguese content development is only created in Portuguese and replicates the Bologna Process, therefore ignoring local needs (absence of cultural sensitivity). In addition, this social dilemma is amplified because local managers consider it a minor question, which is the main reason for sharing curricula and programmes. Beyond these claims, lecturers are confronted with an ethical issue in the choice between the use of global references (even digital) over a combination of global and local didactical references.

This is concurrent with the claim made by Arias-Oliva et al. (2004) that higher education institutions and their stakeholders should consider the advantages and disadvantages of ICT, pertaining to educational practices, as a way to ensure openness, equity and international understanding.

CONCLUSION

This research study began with an initial "ethicultural" concern for the introduction of e-learning technologies in Lusíada Universities in Portugal and Angola. The curricula equity and the uncompromising defence of quality in teaching assume special relevance in the moral and ethical stance of an educational institution and the role of leadership in creating that culture of values.

The curricula equity and the uncompromising defence of quality in teaching assume special relevance in the moral and ethical stance of an educational institution and the role of leadership in creating that culture of values.

From the educational point of view, language is the main problem in knowledge transfer, both because of the local dialects in Angola and the influence of Portuguese Language variations in Angola (in particular the Brazilian variation).

The research aims and objectives were based on a practical exploration and resolution of current ethical and cultural problems involving in such endeavours and international research. The research design structure appears to respond optimistically in special innovative data collection and analysis methods, as well as the conceptual framework which was developed. In fact, the empirical outcomes reveal a considerable number of ethical issues and cultural dilemmas that substantiate the research aims and objectives. Given the nature of the research problem, as well as the insights introduced throughout the action case longitudinal approach, it is imperative to recognise two significant claims: (i) there is a lack of e-Learning literature in the cultural contexts of study; and (ii) the evolution of e-Learning implementation enhances ethical dilemmas, both individual and organisational.

The analysis, based on implementation levels according to the conceptual framework, successfully differentiated the stages of e-Learning, and the specific ethical and cultural impacts regarding each one of the project components. Interventions were made acknowledging e-Learning methodologies practice in order to promote problem solving and mutual agreement between all stakeholders, as well as to reply positively to ethical and cultural needs for successful implementation. In relation to the practical elements of collaboration, the evidence shows that a more holistic and longitudinal approach is justified. In fact, the use of research to improve learning and lecturers' professional practice highlighted several problems repeated over short periods of time, usually single academic semesters. Also unfortunately, the rate of technological change does not necessarily imply the same rate of implementation and equity. Acknowledging different organisational cultures in Portugal and Angola is to point out differing perceptions concerning IT management for equality.

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STUDY OF AUGMENTED AND VIRTUAL REALITY TECHNOLOGY IN THE EDUCATIONAL DIGITAL ENVIRONMENT OF THE PEDAGOGICAL UNIVERSITY

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Abstract: *This article offers the didactics of studying augmented and virtual reality technology in the educational digital environment of the pedagogical university. The basic concepts and practical content of the course on the study of augmented and virtual reality technologies are highlighted. The peculiarities of studying augmented and virtual reality technology by students majoring in Informatics at Ternopil Volodymyr Hnatiuk National Pedagogical University are highlighted.*
The study and use of virtual reality equipment and software for 360 video is proposed. Two types of virtual reality video are considered: virtual reality 360 Video and virtual reality based on models. The expediency of using mobile devices in conducting research in STEM projects using virtual reality/augmented reality technologies and creating augmented reality objects using various tools is substantiated. The stages of creation of virtual reality objects are singled out. An example of tasks for the development of virtual reality projects is given. We look at how different augmented reality applications can help improve understanding of the objects being studied.
The proposed innovative approach to the study of augmented and virtual reality technology can be used as a basis for the development of digital didactic courses for students, pupils and teachers.

Keywords: augmented reality; virtual reality; STEM projects; augmented reality development tools; pedagogical university.

INTRODUCTION

Virtual and augmented reality (VR and AR) are new tools for education. These technologies can qualitatively complement learning, make it more accessible, simpler and more interesting. Therefore, the interest in these technologies in the field of education and the field of visualization of scientific data is justified (Akcayir & Akcayir, 2017). Scientific data visualization, as opposed to information visualization, involves the use of computer graphics to analyse and present simulated or real data. Scientific data are collected or generated from various scientific fields, such as meteorology, biology, medicine, etc. A common feature of scientific data is that they are usually very big. In other words, they are best displayed in 3D. AR and VR allow users to view and interact with this data in 3D. This is very useful in terms of education and training, as students can really understand and memorize data by immersing themselves in the virtual world and gaining an interactive experience easier than from texts describing.
Research in the field of innovative educational technologies, tools and methods for e-learning is considered in the works of (Smyrnova-Trybulska et al., 2017; Balyk & Shmyger, 2017; Smyrnova-Trybulska, 2018; Hug, 2019). Research on the impact of virtual reality on human focuses on the study of VR / AR equipment impact and work with it, as well as the impact of computer games on the feelings, thoughts and actions of the individual (Bacca et al., 2014; Chavan, 2016; Goedert & Rokooei, 2016).
A study (Merged reality) of merged reality has shown that 70% of users expect VR/ AR technology to drastically change six areas: media, education, work, social communication, travel and retail. Also, 50% of users believe that VR/AR technology will be integrated into a single device, combining AR glasses and built-in VR features. 5G technologies will play a key role in merging virtual and augmented reality with the physical world, providing mobility, improving social communication and solving the problems a number of VR applications.
In our study, we will adhere to the following definitions of VR / AR.
VR is best described as an illusion of reality created by a computer system (Virtual Reality).
AR is an enhanced version of reality where the physical world is augmented with superimposed computer-generated content (What is Augmented Reality (AR)?).
The article (Virtual and augmented reality: how new technologies inspire learning) highlights the following characteristics of the virtual didactic environment:
Clearness. In the virtual space, you can easily look at any process or object in detail, which is much more interesting than looking at the pictures in the textbook.
Concentration. In a virtual environment, people are not distracted by external stimuli, which allows them to focus fully on the material.
Maximum involvement. Immersive technologies provide the ability to fully control and change the scenario of events.
Safety and effectiveness. With the help of VR and AR technologies, you can conduct training, perform complex operations in various fields.
The *objectives of this article* are:

- to explore the features of the study of augmented and virtual reality technology by students majoring in Informatics in the digital educational environment of the pedagogical university;
- to analyze the technological aspects of using different techniques and tools for development VR and AR mobile applications;
- to propose the innovative approach to the study of augmented and virtual reality technology and to develop a digital didactic course for students, pupils and teachers;
- to formulate the didactic recommendations on using augmented and virtual reality technologies in student training in the pedagogical university.

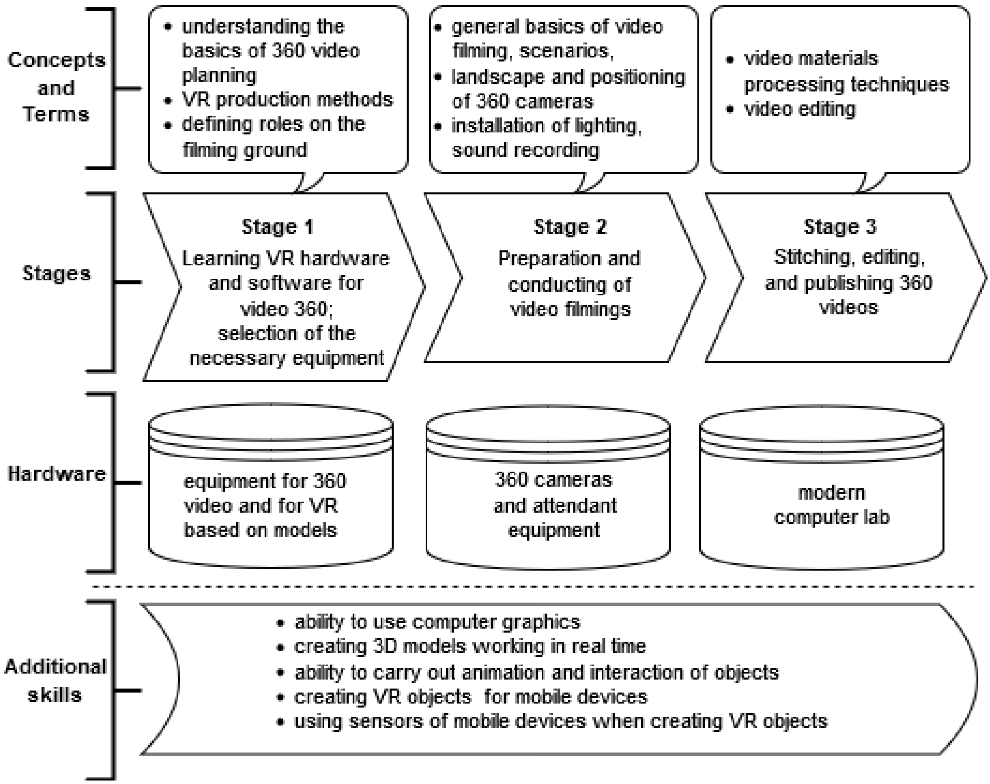
In order to achieve the objectives, the following *research methods* have been used:

- functional, structural, comparative analysis of literary and informational sources;
- analysis of VR and AR technologies and tools of mobile application development in order to determine the state of solving the problem of research and selection of tools for the development of virtual and augmented reality systems;
- synthesis of didactic requirements and technological possibilities at creation of a digital course on studying of VR and AR technologies;
- methods of pedagogical design to achieve the overall goal of the research.

Main results

In 2018, the educational programme for students majoring in Informatics was updated in Ternopil Volodymyr Hnatiuk National Pedagogical University. This programme involved a course on the study and use of augmented and virtual reality technologies.
During this course, students will get acquainted with AR / VR programs and gain practical experience in 360 video production. This course introduces them to virtual reality and 360 video production, with a step-by-step process of creating VR content (Figure 1).
In the first stage, students study the software and technical aspects of 360 video production, tools and processes, VR production methods needed to write, plan, create VR products, using modern equipment and software.
Basic concepts studied: understanding the basics of writing and planning 360 videos, knowledge of preparation for the development of 360 video products, defining roles on the filming ground and selection of the necessary equipment.
In the learning process, we first learn to use VR hardware and software for video 360. Students learn two different types: VR 360 Video and VR based models.
Video content is filmed in the real world with real people using a digital camera. This creates a realistic type of content. Most news, TV series and movies are produced this way or using a combination of video content and computer-generated content.
Based on VR models, computer-generated 3D graphics are used. So in this case, the VR content is based on 3D models, which are files that store mathematical descriptions of shapes and materials. The VR content also contains descriptions of the animation lighting of these models. With model-based VR models, participants can be able to control a virtual camera in real time and watch from any angle. In other words, users can move closer to the object to observe from a shorter distance. 360 videos and

360 VR images are based on pre-made images. They limit the user's point of view to one specific position or, in some videos, to a dynamic point of view chosen by the director rather than the user. From this fixed point of view, users can look left and right, up and down, but they cannot control their movements freely and they cannot observe objects from any position or place.



F i g u r e 1. Stages of creating VR content

S o u r c e: Own work.

Basic concepts studied: structure and features of 360 cameras, choosing the right 360 camera needed for your VR production, knowledge of the basics of video recording, understanding the basics of installed lighting, sound recording and camera positioning, creating your own 360 video.

At the final stage, students learn different options for stitching, editing and publishing 360 videos.

Basic skills: understanding the workflow editing for 360 videos, the ability to insert metadata and add text and titles to 360 videos, the ability to publish and share your 360 videos.

In addition to 360 video production, in the process of studying augmented and virtual reality technologies, students are also working on tasks to develop their own concepts of VR programs.

Students know the basic methods, functions of computer graphics and animation, the interactions used in the project, as well as the requirements for hardware VR tools. The most important thing they need to explain is how the design developed can benefit from the use of VR equipment, how the designed program uses the unique functions of VR. Students must describe the motivation to develop the program, describe what they want to achieve with the VR program.

Like existing VR programs, the created VR program should be designed to solve a problem, share experiences or learn new ways of self-expression.

Also in the task, students must indicate the technical specification of VR, give detailed information about their own VR application on the following aspects: VR display, VR content, and VR interaction.

In this case, students are proposed to familiarize themselves with two existing VR programs, which are either similar to those they create, or contain certain elements that can be borrowed for their own program.

Particular attention is paid to target users on whom the developed program can be focused. Focusing on a specific audience allows you to concentrate on choosing the right VR hardware and software.

The key moment in the project task is the ability to assess the risks of the VR project, to determine why the developed program needs to use VR as opposed to the standard on-screen interface, why the target audience can easily access the necessary VR equipment.

Currently, the Faculty of Physics and Mathematics of Ternopil Volodymyr Hnatiuk National Pedagogical University implements an educational programme involving Game study, in which students create images of 3D models for computer games on a computer.

When creating 3D content on a computer, students first develop and animate the desired three-dimensional models, then capture and animate them with virtual cameras. In this way, you can get not only computer-generated images that are captured by a virtual camera, but also 3D scenario that contain all the models and animations created and can be reused. Thanks to 3D content created by a computer, you can go beyond real life. If a 3D scenario was created, it can be visualized and animated in different ways.

This is very important for VR, because you can program 3D models to be interactive in real time. That's what 3D computer games do. Most of them are based on computer 3D models, where users can interact with animated objects in real time.

Understanding what type of VR content students are dealing with helps them make choices about the VR equipment they need. The model-based VR model is best viewed on high-performance VR displays with not only rotation but also with position tracking. In this way, you can benefit from being able to approach the object, to observe it from different positions. Position tracking allows users to use their body for natural observation of the object and thus use the full power of the equipment for viewing of model-based VR. On the other hand, 360 videos can be viewed via **mobile VR**. In this case, the image or VR content based on the video limits the way it is displayed. The user's point of view is limited by a certain tracking point and the position that comes with high-class VR displays doesn't really add anything. Because 360 VR content is stored as images rather than 3D objects, 360 videos are usually not interactive. The bound between 360 video and VR-based model may be blurred in the near future due to new technologies in the field of computer vision.

A practical step in the study and use of virtual and augmented reality technologies is to maximize the use of modern gadgets of students, pupils and teachers and ready-made VR software to create STEM projects (Balyk & Shmyger, 2018).

Modern mobile devices have many different sensors, which can be divided into the following categories: motion sensors (accelerometer and gyroscope), position sensors (magnetometer, GPS, proximity sensor), ambient sensors (light sensor, temperature sensor, etc.). They can assist in conducting research in STEM projects using VR / AR technologies. Augmented reality applications can help focus attention on certain elements of the image obtained from the camera; improve understanding of the objects of the surrounding world by providing the necessary information that is superimposed on the image in the form of a text message or visual image.

Augmented reality programs belong to the class of complex platforms. To create educational STEM-projects using VR and AR, it is advisable to use the most common platforms Google *ARCore* (on a base of Android 7.0 and higher) and Apple *ARkit* (on a base of iOS 11 and higher).

The primary capabilities of ARCore platform are: motion tracking, environmental understanding, light estimation, user interaction, anchoring objects. The primary capabilities of ARKit platform are: position tracking, lightning perception and landscape understanding, rendering. Table 1 contains the results of a comparison of three capabilities of ARCore and ARKit platforms.

Both AR platforms have similar capabilities and only developers will see their differences. Although the number of Android users is significantly higher than the number of iOS users (approximately 5 times), the market for Android devices is significantly fragmented into numerous devices that rarely use the latest operating system, which can lead to compatibility issues. Although all Apple devices have included the same basic sensor systems for years, the sensors on Android devices change significantly. ARCore requires a device with a back-facing camera, accelerometer and gyroscope. Although almost all phones have the required camera and accelerometer, the gyroscope requirement removes compatibility with most low-end Android devices.

The basis of the ARCore platform was the Project Tango project. Using an accelerometer and a conventional camera, ARCore recognizes surfaces, tracks movement and assesses lighting levels. This allows virtual objects to "respond" to changes in the environment.

The ARKit platform has the same features, but stores less data on previous locations than ARCore. Mobile devices make it possible not only to measure various environmental parameters, but also to analyse and statistically process the results using special applications.

Let's analyse mobile applications that can be used in various STEM-projects in combination with VR and AR technologies.

Table 1

Comparison of Google ARCore and Apple ARKit possibilities

Possibilities	ARCore	ARKit	Remark
Calibration	+	+	Both AR platforms can accurately calibrate the position of virtual object in the real surroundings.
Lighting	+	+	Both platforms provide a simple estimate of the essential lighting. But ARKit provides colour temperature and intensity, while ARCore offers a shader through the Unity API or a value of the pixel intensity through Android Studio API.
Simultaneous localization and mapping	+	±	On any of these two AR platforms, the tracker checks whether there is a map available or creates a new map. ARCore maintains larger maps, which makes the system more reliable. If the user's device loses tracking, ARCore will better recover a map.

Source: Own work.

The mobile application *Ruler* is useful in the implementation of the STEM project, it remembers the dimensions and allows you to show the length, width and depth at the same time. Using Apple's new ARKit technology, MeasureKit includes the following AR measuring tools:

- ruler (measuring straight lines on any surface),
- magnetometer (measuring the magnetic field around a mobile phone),
- marker pin (measuring the distance from the device's camera to fixed points in space),
- measuring the area of the room, etc.

The *Physics Toolbox Sensor Suite* application is useful for students and teachers in the field of STEM. It uses the sensor inputs of the device to collect, record and export data. Data can be displayed both graphically and digitally. Users can export the data for further analysis to a spreadsheet or any charting tool. The application menu allows the user to use more than twenty sensors in STEM projects: linear accelerometer, gyroscope, barometer, hygrometer, thermometer, proximeter, timer, ruler, magnetometer, compass, GPS, inclinometer, light meter, colour detector, sound meter, tone detector oscilloscope, etc. Information about each sensor can be obtained by clicking on its icon (name, manufacturer, data collection speed, principles of its physical operation, links to additional resources, etc.). All sensor data can be stored in a folder or on the SD card of the device. You can also export, email, or share on Google Drive or Dropbox. The *Atom Visualizer* application (Android ARCore platform) makes it possible to move a 3D model of a nucleus with electrons into space. This is the first AR application for ARCore on Google Play. Atom Visualizer allows you to see and explore atomic models in augmented reality. Atom Visualizer is an interesting educational tool that helps to visualize well-known scientific models: Bohr model and the quantum mechanical model. The application uses AR technology to create 3D-animated visualization of both of these models in the real world using only a camera. AR Expeditions is an application that presents virtual tours with virtual and augmented reality. The Google Expeditions app has more than 800 expeditions that can be carried out for educational purposes: to explore the underwater world, to visit the most remote corners of the universe, and to visit museums, etc.

STEM projects developed by students show that mobile technologies help to create an educational environment for the use of mobile devices with support for VR and AR technologies and the formation of modern digital competencies. In the process of implementing educational STEM projects, you can use mobile devices that support AR technology and are equipped with various sensors: motion sensors, position sensors and ambient sensors. STEM projects and products of project activities can be used in the process of teaching computer science, physics, mathematics, chemistry, biology, geography, etc. It is worth noting the need not only to learn using AR and VR technologies, but also to learn competencies to create products that use these technologies.

CONCLUSION

Currently, the conditions and way of life differ in the new characteristics of the information society. Young people, who are the "main consumers" of educational services, feel these differences very sharply, and therefore they increasingly demand a change in the content, level and quality of educational programmes.

The peculiarities of the study of augmented and virtual reality technology by students majoring in Informatics in the educational digital environment of the pedagogical university are a combination of VR/AR technologies, mobile technologies, and project technologies involved in the creation of educational STEM projects.

One of the innovative methods in the educational digital environment of the pedagogical university is the educational STEM project. Modern mobile devices help to conduct educational research in STEM projects using VR/AR technologies. Augmented reality applications can help focus attention on certain elements of the image obtained from the camera; improve understanding of the objects of the surrounding world by providing the necessary information that is superimposed on the image in the form of a text message or visual image.

Augmented and virtual reality technologies improve the flexibility and manageability of educational programs, individualize curricula, open access to educational digital resources, increase communication between students and teachers in the project activity process.

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E-LEARNING SYSTEM DEVELOPMENT AND IMPLEMENTATION: UNIVERSITY EXPERIENCE

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Abstract: *The results of the design, development and implementation of the non-commercial e-learning system at Dniprovsk State Technical University (Ukraine) are presented in the paper. The developed system made it possible to organize the transition from face-to-face to on-line distance learning within the shortest possible time. For the successful system creation, the following stages had been performed: the data domain requirements analysis, system design, software construction, testing, implementation and maintenance. The university blended-learning model, which operated before the introduction of quarantine, and the developed e-learning system information model are presented in the paper. The models display the functional and structural data domain features, determine the roles, functions and available actions for the system users. The proposed e-learning system model consists of five components: e-content, discussion board, evaluation, collaboration and reflection. The constituent models parts implementation through the system user interface made it possible to provide the functions of asynchronous communication, collective and personal interaction, distribution of educational e-content, assessment of learning outcomes, statistical data accumulation and processing.*

Keywords: e-learning system, distance learning, higher institution, design, implementation experience.

INTRODUCTION

The rapid development of information technologies, means of communications and the Internet gave impetus to the development of new ways of the distance learning (DL) organizing. DL is a form of learning whereby the source and recipient of knowledge are at a physical distance from each other, and ≥ 80% of educational content is delivered by post and / or other tools for bridging the distance (Gorska, 2016; Sadeghi, 2019). The Internet using has made it possible to transform the methods of remote interaction between participants of the educational process: from sending educational materials by mail to organizing virtual classrooms. The learning for which ≥ 80% of the content is delivered only via Internet and specialized software is called online or e-learning (*Distance Education in European Higher Education*, 2015; Fryan et al., 2013). The pandemic caused by the disease COVID-19 has created a number of challenges not only for government and health care system, but also for educational institutions of all types. According to the Resolution of the Ukrainian Cabinet of Ministers dd. 11.03.2020 № 211, all educational institutions have been transferred to DL to prevent the spread of COVID-19. Dniprovsk State Technical University (DSTU), Ukraine is a fourth-degree accredited higher education institution (HEI) that provides educational services for applicants of the bachelor' and master's level, trains PhD and postdoctoral programs (Friedman & Trines, 2019). The quarantine was introduced in DSTU by the Decree № 176 dd. 12.03.2020 and it has been still continuing. The introduction of quarantine restrictions implied a transition to 100% online interaction in the educational process. In this connection, the question arose about choosing methods and technologies for organizing DL to ensure the implementation of the educational process schedule in accordance with the approved class schedule and curricula of specialties. This work presents the results of the design, development and implementation of the e-learning system (ELS) in DSTU.
The research objectives were as follows:

1. Analysis of methods in, and international experience of, transition from face-to-face to distance online learning.
2. Building a blended-learning model describing features of the university education system, which had been functioning before the quarantine restrictions introduction.
3. Development of the ELS information model for DSTU, which forms the basis for its software implementation and distance online learning (DOL) organisation.
4. Description of the ELS implementation features.

1. INTERNATIONAL EXPERIENCE IN DISTANCE ONLINE LEARNING ORGANIZING

Universities around the world are launching and promoting various types of online learning, and the topic of information and communication technologies effective use remains relevant and leading scientific and practical task.
In general terms, it is expedient to describe two main ways of DOL launching in HEIs, namely:

1. Use of commercial and non-commercial software products. The national researches on e-learning launching were describe in numerous works of the scientists such as: Alkhalaf, Drew, AlGhamadi, Alfarraj, Gorska, Al-adwan, Smedley, Thowfeek, Jaafar, Benta, Bologa, Dzitac, Dzitac. The works of scientists teams describe the results of complex studies and comparative characteristics of the learning manager systems (LMS) implementation results in various countries: African countries (Kituyi & Tusubira, 2013); countries of the Middle East (Azawei, Parslow, & Lundqvist, 2016); European countries (Vasilevska et al., 2017; Fidalgo et al., 2020; Zormanova, 2016; Kommers et al., 2014; Falfushynska et al., 2019). In Ukraine, such scientists as: Morze, Buhaichuk, Korotun, Kademiia, Koziar, Kukharenko, and many others are engaged in the process of the effective DOL organizing. Most of the works, describing experience of DOL launching and usage in universities, are devoted to the results of LMS Moodle launching (Shcherbyna, 2020).
2. Development and launching of its own university software products. Kituyi and Tusubira (2013) in their work describe the framework for the e-learning integration in HEIs. The results of the successful development and implementation of its own ELS into Hashemite University educational process in Kingdom of Saudi Arabia are presented in the work of Dutta, Mosley and Akhtar (2011). One of the most famous and successful examples of own university software product, implementing DOL, is the MOOC EdX platform, developed in 2012 by Harvard University in cooperation with the Massachusetts Institute of Technology (USA) (Baran, Baraniuk, Oppenheim, Prandoni, & Vetterli, 2016).

At the time of the quarantine introduction, DSTU was implementing one of the types of DL – blended learning that provides a combination of e-learning and traditional face-to-face learning (Oliinyk, Filipova, & Shelestova, 2019). Distribution of e-content was carried out through the university informational portal – the non-commercial software of its own production.

In the 2019–2020 academic year more than 2000 students had been studying at DSTU. The training had been carried out in 21 bachelor specialties, 19 master specialties and 10 specialties of PhD training at 25 university departments. About 90% of students are full-time students, therefore, the task of providing uninterrupted learning, a quick and effective transition to a DOL, ensuring the development of general and special competencies, is a difficult and extremely urgent task.

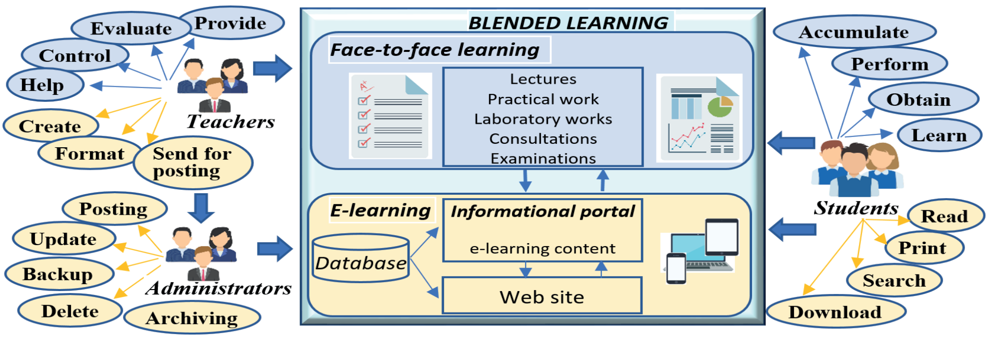
2. E-LEARNING SYSTEM MODELLING

According to software engineering standards, the life cycle of the ELS consists of five mandatory stages: requirements and data domain (DD) analysis, design, software implementation, testing and operation. The purpose of the ELS requirements analysis was: to obtain maximum information about the methodological and technical requirements, to define an expected effect from the ELS implementation.

It is advisable to present the results of the DD analysis in the form of its models, which allow displaying the system from the functional and structural sides.

2.1. Blended-learning information model before the e-learning system implementing

One of the ELS requirement was the necessity to preserve and ensure the further functioning of the available software tools that had been already used to organize remote interaction of participants in the educational process. DSTU informational portal (URL: http://www.dstu.dp.ua/Portal/WWW). The informational portal has been functioning at DSTU since 2011. The purpose of its creation was to organize a structured repository of educational e-content, created by DSTU teachers, with the possibility of sharing, viewing and downloading. During the transition to DL, it could be used as a knowledge base, but it was not able to independently perform all the functions of DOL. Figure 1 illustrates the fragment of graphical model presentation, describing DD features before the ELS introduction.



F i g u r e 1. Module Introduction of Distance Courses

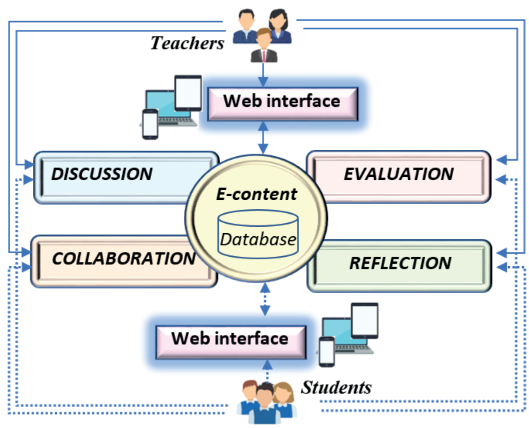
S o u r c e: Own work.

The blended learning information model development provided an opportunity to present the existing structure of the site and informational portal. The purpose of model creation is to determine the points of data flows input and output, data sources and receivers; to form specifications of missing functions for the effective DOL implementation. The detailed description of the informational portal functions, its structure and modalities of operation are presented in the work (Yalova, Zavgorodnii, Romaniukha, Capay, & Drlik, 2014).

2.2. Developed e-learning system information model

Before developing own ELS model, the online learning models created by various scientists were analyzed. Anderson's Online Learning Model (Anderson, 2011) describes the DD as the combination of three main objects: student, teacher, and educational structured content delivered through a specialized software framework. Bosh (2016) proposed to transform Anderson's model into a Blending with Pedagogical Purpose Model, it expanded the mandatory actions, which ensure the effectiveness of DOL. Multimodal Model for Online Education by Picciano (2017) represents DD as a community with the following functions: e-content, social communication, independent study, dialectic, evaluation, student generated content, reflection.

The development of the ELS information model for DSTU was carried out on the basis of requirements and the blended-learning model mentioned above. In the process of developing the features and characteristics of Anderson's, Bosh's and Picciano's models were taken into account. The readiness and prospects of launching DOL at DSTU have been studied within the framework of the international project IRNET by conducting a survey for students and teachers (Yalova, Zavgorodnii, Romaniukha, & Sorokina, 2016). The proposed ELS model is presented graphically in Figure 2.



F i g u r e 2. DSTU E-learning System Information Model

S o u r c e: Own work.

The created ELS information model contains five components that ensure the organization of DOL for educational process participants, namely:

1. E-content is a component responsible for the creation, storage and distribution of the educational literature electronic version. During the existence of blended learning at DSTU, the array of electronic educational literature was formed:
   - guidelines for practical, laboratory, coursework, independent, qualification work, students' internship;
   - lecture notes;
   - study guides and textbooks.

   Access to the available ELS e-content to be provided through the appropriate links to resources posted on the university informational portal. The access mode is asynchronous. Viewing the contents of files is available after downloading them. Educational materials can be added in various formats: text, presentations and videos.
2. Discussion Board is a component that organises message exchange between all educational process participants, where a teacher can publish his general guidelines, advice, and wishes. There are two modes of using the discussion board:
   - public correspondence for viewing by all authorized users;
   - personal correspondence for communication between a specific student and a teacher.

   Discussion Board is the organization of feedback from the teacher.

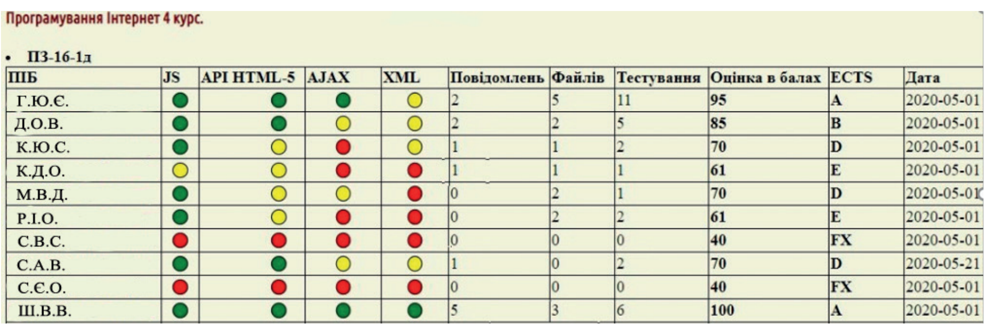
3. Evaluation is a component that organises control and evaluation of the students' obtained knowledge. This component is organized in two forms:
   - checking/evaluating practical task;
   - testing. Tests are formed online through special forms.

   It is possible for a teacher to create and send:
   - a personal task to the selected student.
   - a collective task for the student group

   Ready-made tasks are sent by students in text, video or presentation format. For each student interacting with the teacher, a history of assignments is created, indicating the type of actions, date and time.

   There are two modes for each test:
   - control mode to receive a mark for its completion;
   - learning mode to provide students' self-control.
4. Collaboration is a component that provides a platform for collective discussion on a certain problematic topic chosen by the teacher through a forum. The main difference with the Discussion Board component is that the questions/ answers and comments of the discussion participants are grouped by topic and are available only to authorized users identified by the teacher as the target audience.
5. Reflection is a component that provides the educational process participants with the reporting information. The ELS reporting information is formed on the basis of accumulated statistical data about: students' and teachers' activity; received intermediate and resulting grades.

   Displaying student progress data is provided to:
   - each teacher in the form of the Study Report Card for each group and discipline. Its graphical Ukrainian language web interface is shown in Figure 3;
   - each student in their virtual dashboard;
   - system administrators and university management, it contains statistical information about the daily, weekly, monthly activity of the educational process participants' interaction with the ELS and among themselves.


Програмування Інтернет 4 курс.

- ПЗ-16-1д

ПІБ	JS	API HTML-5	AJAX	XML	Повідомлень	Файлів	Тестування	Оцінка в балах	ECTS	Дата
Г.Ю.Є.	🟢	🟢	🟢	🟡	2	5	11	95	A	2020-05-01
Д.О.В.	🟢	🟢	🟡	🟡	2	2	5	85	B	2020-05-01
К.Ю.С.	🟢	🟡	🔴	🟡	1	1	2	70	D	2020-05-01
К.Д.О.	🟡	🟡	🔴	🔴	1	1	1	61	E	2020-05-01
М.В.Д.	🟢	🟡	🟡	🔴	0	2	1	70	D	2020-05-01
Р.І.О.	🟢	🟡	🔴	🔴	0	2	2	61	E	2020-05-01
С.В.С.	🔴	🔴	🔴	🔴	0	0	0	40	FX	2020-05-01
С.А.В.	🟢	🟢	🟡	🟡	1	0	2	70	D	2020-05-21
С.Є.О.	🔴	🔴	🔴	🔴	0	0	0	40	FX	2020-05-01
Ш.В.В.	🟢	🟢	🟢	🟢	5	3	6	100	A	2020-05-01

F i g u r e 3. Web Interface of the Study Report Card: Teacher's View

S o u r c e: Own work.

Table 1 presents a generalised specification of the ELS main functions and the valid users actions.

Table 1

Valid actions and ELS users' roles functions

User role	System function	Valid actions
Administrator	Authorization	Gaining access to distributed functions and ELS data
	System database administration	Creating a database backup copy Data recovery Supporting a trouble-free operation of the ELS database
	Program code administration	Adding, replacing, removing, commenting, testing program code System software trouble-free operation support
	Data operation	Data operation with database tables
	Virtual dashboard	Forming requests input parameters Results data sampling obtaining Analysis of statistical data
Teacher	Authorization	Gaining access to distributed functions and ELS data
	Stored data modification	Adding, editing database data through the web interface Posting text, video files and presentations Removing previously posted own e-content
	Collaboration and feedback	Moderation of public and personal messages in the discussion board Adding new forum topics, deleting, editing existing ones, receiving questions, sending answers
	Students evaluation	Posting general and personal tasks Downloading files received from students Returning tasks after correction Changing the status of the task progress Grading based on the results of completed tasks Getting notifications about passing the tests Putting down the resulting grades Keeping Study Report Card
	Virtual dashboard	Obtaining statistical information about students educational process progress
Student	Authorization	Gaining access to distributed functions and ELS data
	Independent study	Viewing, downloading, searching for e-content
	Interaction with teacher	Sending messages, questions, comments Collaboration in the discussion of forum topics Participation in Discussion Board correspondence
	Evaluation of obtained knowledge	Adding, sending completed tasks Passing tests in different modes
	Virtual dashboard	Obtaining statistical information

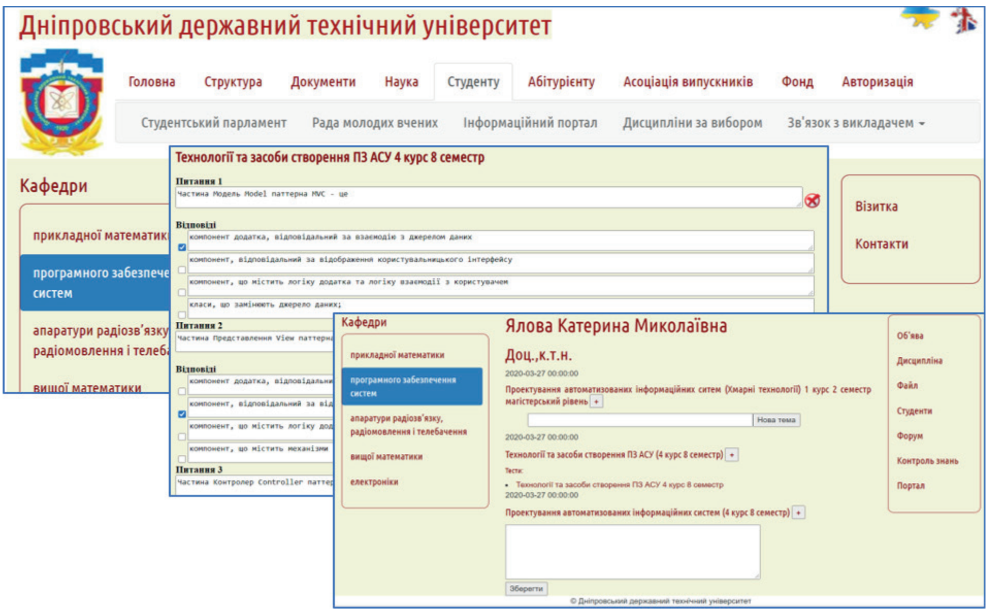
Source: Own work.

3. FEATURES OF SOFTWARE IMPLEMENTATION AND APPLICATION IN THE EDUCATIONAL PROCESS

On the basis of the developed ELS information model, its software implementation and application in the architecture of the existing university website and informational portal were organized. The principles of flexible Agile methodology for software development were used to develop the ELS. The process of software implementation had many features of extreme programming:

- constant adjustment of system requirements;
- frequent updating of software product versions;
- close interaction with end users;
- extremely short implementation timeframes;
- maximum release speed.

There are no possibilities to present all ELS web forms in the paper, nevertheless Figure 4 demonstrates some of them. A complete set of ELS web forms is available throw the link URL: https://www.dstu.dp.ua/uni/index.html#student.



F i g u r e 4. E-learning System Web Interface: Ukrainian Language

S o u r c e: Own work.

One of the main document regulating the educational process organization under quarantine conditions was the DSTU's Decree dated 01.04.2020, in which the developed ELS was put into operation. ELS application was established as an obligatory and integral part of the DOL organization, considering nationwide quarantine restrictions. In addition, a number of organizational and administrative measures related to the ELS implementation in the educational process were taken. The main organizational tasks included:

- implementation of a quick and comprehensive distribution of the ELS user manual and background information about the system;
- formation of user access log, which stores information about problems and errors that have arisen during the ELS use. Accumulated data was used to make changes to the ELS program code through program scripts injections;

The purpose of the administrative measures was to regulate the teachers work with the ELS, which included:

- amendments entering into the regulatory documents describing the educational process at DSTU;
- decree and directives creation regulating the place, role, tasks, functions, expected results, reporting forms, rights and obligations of DOL participants through the developed ELS.

Deans, heads of departments and curators of academic groups were entrusted to inform the students about the transition to DOL. All teachers and students of all education forms and specialties were involved in the DOL organization. Access to the ELS is provided via the Internet and various devices, the only requirement for the user's software is the browser availability.

CONCLUSION

The results research into the design, development and implementation of an ELS in the educational process at DSTU were presented in the paper. The proposed ELS is a non-commercial software application. Its main purpose is to ensure the effective acquisition of general and professional competencies by students of all specialties, during the transition from face-to-face to 100% DOL. At the time of quarantine restrictions announcement, a blended learning was applied at DSTU. The use of the developed ELS made it possible in the shortest possible time to organize a full-fledged DOL, with the implementation of functions: asynchronous communication, organization of collective interaction through the discussion board and forum, educational e-content sharing, learning outcomes evaluation, accumulation and processing of statistical data. Learning has been carried out online through the ELS web interface, that made it possible to complete the academic year successfully in accordance with the curricula of all university specialties. The assessment of the ELS use results and feedback from users allows to claim that the developed ELS adequately takes into account the incoming requirements.
Analysis of accumulated statistical data about students and teachers' activity, making a survey on satisfaction and expectations regarding the implemented ELS, specifications formation for the expansion and ELS functionality improvement are the topics of the further scientific work.

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DIGITAL TRANSFORMATION OF THE LEARNING ENVIRONMENT AT UNIVERSITY

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Abstract: *One of the ways to develop the digital competence of future teachers is to create a digital learning environment at university. The article substantiates the essence of the concept of "digital educational environment", defines its structural components and outlines strategies for its implementation. The article analyses foreign experience in the creation and implementation of digital learning environment, which is a critical component of the model of the development of future teachers' digital competence. An important precondition for creating a digital learning environment of a university is the availability of modern IT infrastructure, technologies and means of electronic communication of all the participants of educational process, the creation of digital educational content. In this context, the experience of Volodymyr Hnatiuk Ternopil National Pedagogical University on the digital transformation of the educational process is shared. The article describes the principles of projecting digital learning environment. It analyses possibilities of the organisation of the digital learning environment of a university with the use of cloud technologies and their possible application in various fields, which provides a range of opportunities for the digitalization of educational process.*

Keywords: digital transformation; digital competence; digital technologies; digital learning environment; communication, collaboration.

INTRODUCTION

Nowadays, digital transformation is a popular trend which influences all spheres of public life. Modern higher educational institutions seek to provide training for highly qualified professionals with developed professional competencies that are in demand on the labour market. Modern young generation Z requires non-standard approaches to the organization of educational process. One of the possible ways of achieving these goals is digital transformation of the educational environment of a higher educational institution which is a platform for the development of modern methods and innovations. The digital transformation of educational environment means its modernisation and reformation with the help of digital technologies. The digital learning environment of a higher educational institution should ensure the development of the digital competence of future professionals through the widespread use of digital technologies and the introduction of new innovative methods and solutions.

Methods

To achieve the goal, a set of methods was used:

- theoretical: methods of the comparative analysis of scientific sources for understanding the state of the research problem, for determining the conceptual apparatus of the research, synthesis, generalization, systematization for theoretical justification of the principles of designing a digital learning environment of a higher educational institution;
- empirical: the study of strategies, regulations for designing a digital learning environment.

1. BACKGROUND RESEARCH

The digital transformation of education and the rapid development of digital technologies require higher educational institutions to change their approaches to the organisation of the educational process. Today, a higher educational institution must train competitive specialists for the labour market, who must be able to demonstrate professional competencies.

Today, the digitalisation of education in accordance with national and European programmes and frameworks occurs in Ukraine: "Ukraine's Digital Agenda – 2020", which includes initiatives, projects, basic principles of the digitalization in Ukraine until 2020, the European Digital Competence Framework (DigCompOrg, 2015), European Digital Competence Framework for Educators (DigCompEdu, 2017). In 2019, by the order of the Ministry of Education and Science of Ukraine, a working group developed a description of teachers' digital competence, which contains requirements for the structure and the levels of digital competence necessary for teachers' successful professional activity in the conditions of digital society development. In 2020, the Ministry of Education and Science of Ukraine developed a professional standard for teachers of general secondary educational institutions, which sets requirements for teachers in accordance with the qualification category. The standard describes the professional competencies of a specialist. Information and digital competence is one of the key competencies of a teacher.

Various aspects of education informatization have been the subject of research of many Ukrainian scientists. Thus, Morze and Spivak substantiated the ICT competencies of students and their ability to use information and communication technologies to carry out information activities in their professional field (Morze, Spivak, 2017). The scientists have considered the features of the formation of a modern cloud-based personalized learning environment, taking into account students' ICT competence. Henseruk substantiated the essence of the concept of *digital competence* and identified the components of *digital competence* of future teachers, outlined the directions of its development in the conditions of the digital transformation of the educational environment of an educational institution (Henseruk, 2019). Panchenko has developed a theoretical and methodological basis for the development of the information and educational environment of a university (Panchenko, 2010). Vakaliuk proposed a model of a cloud-based support system for teaching bachelors in Computer Science, in which students, teachers and administrators are the subjects of interaction (Vakaliuk, 2016). Many researchers state that the creation of information and educational environment in educational institutions involves: prompt updating of educational information; qualitative change of methods and forms of educational activity; obtaining information about the level of academic achievement of each student, making adjustments to teaching methods; students' ability to control the quality of the knowledge they acquired (Smyrnova-Trybulska, 2018; Morze, Kocharyan, 2014; Bykov & Shyshkina, 2016; Spirin, 2009; Balyk & Shmyger, 2017; 2018).

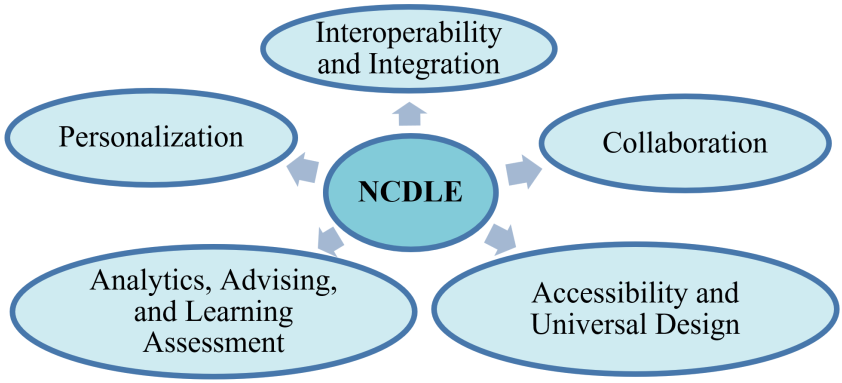
Despite various studies existing, the problem of the digital transformation of the educational environment of higher educational institutions, which will ensure the development of future teachers' digital competence, requires a more detailed study.

2. FOREIGN EXPERIENCE

The problem of designing and creating a digital learning environment is studied by many foreign scientists. In 2014, the Bill & Melinda Gates Foundation, with the support of EDUCAUSE, began exploring modern learning management tools and creating a digital learning environment that can meet the changing needs in higher education. As part of these studies, EDUCAUSE conducted a series of interviews with experts in order to get the idea of the possibilities of existing tools and to find the idea of designing new learning environments.

According to scientists, the next generation digital learning environment (NGDLE), which will become an ecosystem and a digital learning platform for all the participants of the educational process, should be designed in educational institutions. This environment contains a wide range of training programs and digital educational services, quality management tools for education as well as enables communication, data exchange and digital content. For users, it is a cloud storage for identifying and connecting content and features, similarly to a smartphone, where users modify their environment directly with the help of applications selected by them. All the software and educational resources must be located in one place and should implement all the functions of a digital university.

NGDLE has to provide support for the educational process and perform the following functions (cf. Figure 1) (Brown, 2017):



F i g u r e 1. Functions of the digital learning environment of the future generation
S o u r c e: Own work.

All of these functions are NGDLE dimensions which are interconnected. The design and the development of the next generation digital learning environment is possible only if all the functions are implemented.

Scientists have developed a model of the next generation digital learning environment which includes 13 components that are interconnected and aimed at implementing the functions mentioned above:

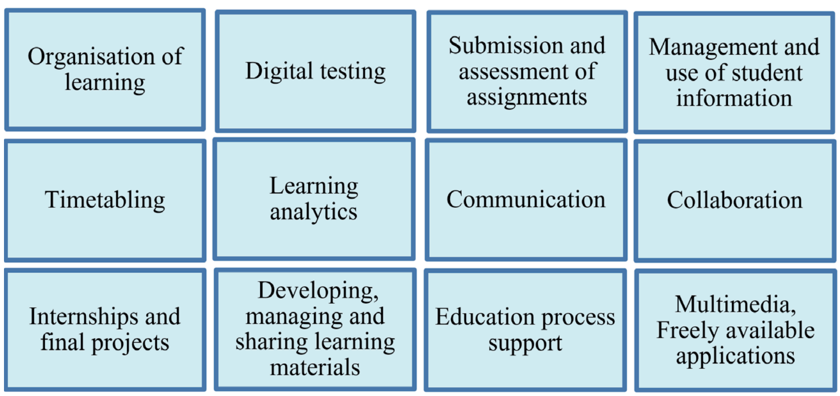
The proposed NGDLE is an ecosystem that contains a wide range of programs and digital services. One of the key tasks in the implementation of the next generation digital learning environment is full compliance with standards and support of the educational process.

Dobbin believes that the main focus of NGDLE should be on students (Dobbin, 2016). The next generation digital learning environment will promote the use of new innovative forms of learning, the adaptation of methods and digital tools for the educational process support. According to the author, the key functions of NGDLE are: Communication, Inclusion, Collaboration.

The successful functioning of the digital learning environment depends on the use of special software that makes it possible to integrate various resources, improve their functionality and provides data protection. Researchers from various US universities (Goodrum et al., 2019) propose new standards for the implementation of learning tools – Learning Tools Interoperability (LTI) Advantage.

LTI Advantage is the next generation of learning tools designed to integrate learning applications and tools into the digital learning environment of an educational institution. LTI Advantage contains three extensions that make it possible to quickly set various configurations, improve user functionality, increase security and students' data protection. LTI Advantage contributes to the improvement of the digital ecosystem of the educational institution, the integration of digital resources, programs and educational applications into the course. This software allows the platform to validate credentials and share data in the context of teaching and learning, helps to preserve the data of the educational process participants, makes the process of the enrollment on a course faster and automates the assessment process. LTI Advantage reduces technological barriers for students and teachers, reduces the amount of time needed for a course development. The tools and digital content implemented by LTI Advantage make the content of a course scientific and creative. The use of LTI Advantage expands an educational institution's ability to effectively use digital learning resources, programs and tools implementing the functions of the next generation digital learning environment (NGDLE).

The Dutch National Research and Education Network (NREN) SURFnet represented by researchers from higher educational institutions and research institutions aims at researching opportunities for the education quality improvement by supporting innovations and enhancing the usage of information and communication technologies. One of the issues alike is the design of the digital learning environment for a higher educational institution. Marieke de Wit and Herman van Dompseler outline the components of a modular digital learning environment (cf. Figure 2). Some components are available to all the students and teachers of an educational institution, while others require authorization. The components must be interchangeable and should be constantly improved so that the learning environment will be always adapted to the latest innovations in education and technological innovations.



F i g u r e 2. Components of the digital learning environment of a higher educational institution

S o u r c e: Own work.

Organization of learning is a component which provides clear and simple access of students to the content and applications necessary for their studies, the distribution of students in groups, the authentication of students (groups of students) and access management. Organization of learning is a key aspect of the learning management system in the digital environment.

Digital testing improves the quality of teaching, learning and testing in education. There are four subcomponents of this element: an author environment, a playback environment, an analysis tool and an item bank.

Submission and assessment of assignments. This component provides a link between students and teachers (providing student feedback, grades, notifications about the grades and opportunities for their appeal as well as checking for plagiarism).

The *management and use of student information* involves both managing students' administrative data (e.g., personal data) and the registration of grades, academic progress and attendance.

Timetabling provides an opportunity for time and resource allocation in various directions by teachers and students.

Internships and final projects. Internships and final projects are a part of all the curricula in higher educational institutions in the Netherlands. This component provides a link between the internship institution and the students manages contracts and documentation as well as monitors the quality of the internship programme.

Developing, managing and sharing learning materials. This component provides the implementation of the functional possibilities for the development, management and exchange of educational materials.

Education process support. It involves the use of digital tools for monitoring student performance and learning as well as feedback with the aim of supporting the learning process.

Learning analytics. The learning analytics component refers to the programs that gather and analyse information about students' learning process in order to understand and improve teaching and learning processes.

Communication is one of the key components of the digital learning environment.

Collaboration. The digital learning environment should offer ample opportunities for encouraging collaboration in a variety of ways (interinstitutional collaboration, distant collaboration, feedback assessment, and learning content sharing).

Multimedia, freely available applications. This component provides an opportunity to attend lectures remotely in real time, enables students to create videos for completing their tasks. Programs that are freely available make it possible to constantly add new tools to the digital learning environment.

3. THE DIGITAL LEARNING ENVIRONMENT OF TERNOPIL VOLODYMYR HNATIUK NATIONAL PEDAGOGICAL UNIVERSITY

Digital transformation of the learning environment of an educational institution is a complex, long and laborious process which must be ensured by the coordinated work of all the structural units of a university, highly qualified IT specialists, teachers and students. Digital technologies must be integrated into all the sections of educational infrastructure. An important factor of designing and implementing digital learning environment is the availability of modern IT infrastructure of a higher educational institution.

Ternopil Volodymyr Hnatyuk National Pedagogical University (TNPU) has extensive experience in building a single integrated IT infrastructure, the creation and the operation of which began in 1999. IT infrastructure of TNPU has many levels, which include technical level, program-informational level as well as organizational and methodical level. A modern system of server technologies was created on the basis of Ternopil Volodymyr Hnatyuk National Pedagogical University in order to ensure the functioning of the university, user management, of users' data storage, access to databases, file servers, updates for anti-virus databases, software and mail server. The IT infrastructure of TNPU is the core of SMART-TNPU, which ensures the functioning of all its structural components.

According to the trends that determine the development of modern education system, educational environment of a university should be based on the use of modern IT solutions and digital technologies. Therefore, one of the key components of SMART-TNPU is the digital learning environment, the design and the operation of which is implemented by using a system approach which is based on the approved conception and a single architecture.

For the effective digital transformation of the learning environment, the Centre of the Learning Environment Digital Transformation has been established at the university. The main purpose of the Centre is to study and implement modern strategies for the development of the digital learning environment of the university as one of the key components of SMART-TNPU; the development of the digital competence of teachers and students at the university, organizational and methodological support in the integration of digital technologies into the educational process by the departments of the university.

The design of the digital learning environment of TNPU was carried out in compliance with the following principles.

- the priority of the implementation and the system integration of digital technologies;
- the principle of feedback availability;
- openness, accessibility and innovation;
- systemic structure, the creation of new structural subdivisions for the functioning of the environment components;
- personal access and professional development of all the participants with the help of digital technologies;
- organizational structure variability in accordance with the educational policy of Ukraine in the sphere of higher education;
- the improvement of teaching quality and enhancing the efficiency of the educational process organization.
- In the age of digitalisation, information is an intellectual property. Therefore, information storage and processing systems are subject to increased requirements for reliability, processing speed and storage security. One of the key components of the digital learning environment is the creation of a single database of students and teachers in compliance with these requirements.

Recently, there has been an increased interest of scientists in cloud technologies as a means of making education easily accessible and mobile, ensuring the continuity of the educational process and the shared access of all the participants to digital educational resources. The organisation of the digital learning environment of the university with the use of cloud technologies makes it possible to effectively use online services in order to provide the students with modern educational resources.

The components of the virtual component of the digital learning environment of TNPU are divided into two groups: specialized solutions (LMS) and separate online services, which, when used as a whole, provide solutions to basic problems, including the development of the specialists' digital competence (cf. Figure 3). For the remote interaction of the teachers and the university administration with the students, such solutions as groups, mailings, joint work with documents, the creation of questionnaire forms, results processing, e-journals and interactive whiteboards are used. Access to resources is unified due to a single authentication system implemented at the university. The basis of the authentication is the LDAP directory and the LDAP protocol.

All the electronic courses at Ternopil Volodymyr Hnatiuk National Pedagogical University were created in Moodle. After the first authentication of a user in Moodle, an account is automatically created in its own database. E-courses contain digital content (video lectures, practical tasks, presentations), tests and provide feedback.

In 2016, the university created a corporate Google email with the domain tnpu. A Google account allows each student and teacher to use the G Suite for Education web services for work and interaction.

F i g u r e 3. Virtual component of the digital learning environment of TNPU

S o u r c e: Own work.

TNPU – Ternopil Volodymyr Hnatyuk National Pedagogical University DLE – digital learning environment, CLEDT – Centre of the Learning Environment Digital Transformation.

Teachers and students of TNPU also have access to Microsoft products (Office Web Apps): the opportunity to download, edit directly in the browser and to save as a cloud document files in the following formats: Word, PowerPoint, Excel, OneNote. In addition, there is an opportunity of joint work on the created files.

The digital learning environment of TNPU makes it possible to solve the following tasks:

- integration of the university into the global learning environment;
- extensive use of digital technologies in teaching and learning;
- using quality educational and scientific content in various forms in the learning and teaching processes at the university;
- providing reliable and quick access to various sources of information;
- the development of a platform for e-learning;
- ensuring on-line monitoring of current processes with the help of an electronic accounting system in order to ensure the validity and quality of management decisions;
- the development of the digital competence of teachers and students;
- ensuring the accessibility and openness of education;
- increasing the university ranking on the global education market;
- encouraging student mobility and increasing their competitiveness.

The effective functioning of the digital educational environment of TNPU is ensured due to the connections between its components.

CONCLUSIONS

The digital educational environment of an educational institution makes it possible to implement in the most effective way the services that a university should ensure to provide its students with modern educational resources. For the design and the successful development of the digital learning environment, modern IT infrastructure must be created at the educational institution.

The created digital learning environment of a university will make it possible to combine technology and all the participants of an educational process within a single system, which will improve the quality of education, enable the development of students' digital competence and training of highly qualified specialists who are in demand on the modern labour market.

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