

DIRECTIONS OF THE EVOLUTION OF HIGHER EDUCATION

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***Abstract:** Technological progress has irreversibly changed the approach to education, including higher education. New generations of students have different educational needs and requirements, which usually do not meet up to the level of university infrastructures and IT preparation of teaching staff. Currently, universities and lecturers can choose from a wide range of possibilities that change the way students are educated. There are many options available, such as mobile learning, multimedia-learning, Web 2.0-based learning, and teaching using extended and virtual reality. A move towards a smarter, technology-rich educational environment has been initiated by a number of top universities across the world, paving the way for new regional and national initiatives, and higher education institutions which face ongoing funding challenges. The paper presents an analysis of global trends in technology-enhanced academic education and indicates the potential of new teaching and learning environments to meet the needs of generation Z. It also discusses barriers to the implementation of innovative technologies in education provided by Polish universities.*

Keywords: higher education, mobile learning, multimedia learning, Web 2.0-based learning, virtual and augmented reality

INTRODUCTION

Generation X (generation of people born in the second half of the 20th century) is still an important core of university staff. These are currently professors, associate professors and senior lecturers. They remember times when the transfer of knowledge at the academic level was based on instructivist lectures, supported by available literature, that is, textbooks and scientific articles. A change in the approach to teaching methods and techniques requires generation X to overcome resistance and acquire necessary ICT competences. Young academics and PhD students representing generation Y have a much better opportunity to evolve as innovative professionals. They are familiar with digital technologies and are more open to changes in their approach to students.

Who are the current students? This is generation Z, also known as the online generation. They grew up in the world of modern technologies, which they consider indispensable tools for expanding knowledge and personal development. Their characteristic features are openness to other people and desire to build social relations. They are not afraid to independently search for knowledge on the Internet and share it with others. Because they are considered to be entrepreneurial and creative, they need education that satisfies their specific needs. An important, stimulating factor for generation Z is contact with peers both on the level of cooperation and competitiveness. When learning, they focus on a fast message and data, preferably in electronic and pictorial form (Rickes 2016). Generation Z is the force that shapes the approach to education. New delivery modes and new educational environments are being researched, and changes in curricula are a necessary response. With new technological possibilities, these changes will become even more pronounced (Mynbayeva, Sadvakassova, Akshalova 2018:9).

Free access to a huge amount of information and a quick jumping from topic to topic, characteristic of hypertext, triggers a reflexive superficial assessment of ideas. Images, visual associations and verbal minimalism are the attributes of modern times. A transition to symbols and pictograms is a natural result of communicating using digital communicators, where a compact form is required. Everyday encounters with digital media (computer and video games) cause quick fatigue and a loss of concentration during a traditional lesson. "Clip thinking", i.e., the inability to verbalize thoughts and a move away from the culture of the written word towards schemes, drawings and symbols as well as the incapability to concentrate on a subject for long time, is a characteristic feature of present day students (Berezovskaya and Shipunova 2015). The clash of the digital world and traditional university teaching causes discomfort in both lecturers and learners. That is why, it is so important to promote modern educational methods and the tools that technological progress offers.

The literature review presented in this paper and the authors' research conducted over the last three years aim to:

- analyse global trends in technology-enhanced academic education,
- understand the potential of new educational, technology-rich environments to teach the present and future generations of students,
- identify barriers to the implementation of technological advances in higher education.

The paper targets university and college staff who would like to make a move towards student-centred teaching enhanced by innovative technologies. The decision-making process may be difficult, time-consuming and costly because there are a vast number of online tools and advanced equipment. For teachers whose ICT skills are not well developed it will be overwhelming and affected by non-availability of sufficient knowledge and experience, which can discourage them from introducing novelty into their teaching. Moreover, universities are usually cautious when it comes to implementing new solutions and investing in technological innovations. The data collected during the research are meant to help decide how to build a technology-enhanced learning and teaching environment.

1. TECHNOLOGIES IN EDUCATION

Modern technologies have been changing every aspect of human life. Education is no exception and it should be paving the way for other areas. There are many possible ways to enhance academic education, but one thing is certain, each change must be structured around technological support. Any path entails specific costs and usually encounters impediments in the implementation phase. In addition, each technology has its advantages and disadvantages to consider in the decision making process.

The overview of modern technologies and tools presented in this article can support higher academic education and significantly influence its effectiveness. The authors focus on the opportunities for academic education offered by each option and indicate the barriers to its implementation in Polish universities.

1.1 Mobile learning (m-learning)

Mobile devices play an increasingly important role in education, especially in university education. Notebooks, smartphones, tablets and e-books offer quick access to information and interaction with other users. Applications for these devices allow their users not only to read content, but also to search for it and create it, which in turn influences students' learning styles and educational preferences. The convenience, flexibility, multimedia possibilities and interactivity of mobile devices make learning very attractive. This global trend has also reached Poland and has impacted education, including higher education. Many universities

have created mobile versions of their websites and prepared teaching materials for mobile devices.

Although students still prefer laptops, the popularity of tablets, smartphones and e-book readers is constantly growing, and students are increasingly using them to have access to educational resources. There is little research in Poland on how students use mobile devices and applications for academic purposes (Leszczyński, Charuta, Gotlib, Kołodziejczak, Roszak, Zacharuk 2017; Bajorek, Gawroński 2018). Considering the results of research in more technologically advanced countries, it can be said that the popularity of mobile devices for educational purposes is growing very fast. According to EDUCAUSE Center for Analysis and Research (ECAR) many students prefer small and portable devices such as smartphones and tablets, and the number of such devices used for educational purposes has doubled in just one year (EDUCAUSE 2012). More than half of US students participating in the survey (N=1082) used mobile devices for academic purposes – 82% of tablet device owners said they used the device for academic purposes, while only 58% of small mobile device owners and 64 percent of e-book reader owners reported doing so (2013). The research results indicate that tablets are the most efficient mobile devices in the academic environment and mobile learning often takes place outside the traditional classroom.

Barriers: Because technological progress is much faster than changes in education systems, especially in teaching and learning strategies, the implementation of mobile devices for everyday academic education seems quite a challenge. If you add to this the need to provide support to students using such equipment and the need to constantly improve teacher competencies, such projects come at a high cost.

1.2 Multimedia learning

In today's world, no one denies the power of images – 65% of the population is visual (Bradford 2011), and the time of image processing by the human brain is only 13 milliseconds (Trafton 2014). In addition, about 30% of the population are audio learners and the remaining 5% of the population are so-called experiential learners – they learn by doing. Becoming aware of diversity in learning styles is the first step to the proper selection of educational means and methods. Basing teaching solely on the text, whether in written or oral form, leads to a rapid weariness of the recipient. The most appropriate approach is to provide materials in a variety of forms (e.g. online textbooks, video lectures, interactive exercises, simulations, animations) to support different student preferences (NMC Horizon Report 2015:16; Roszak, Kołodziejczak, Ren-Kurc, Kowalewski 2013).

According to research (Leszczyński, Charuta, Łaziuk, Gałązkowski, Wejnarski, Roszak, Kołodziejczak 2018; Scheiter, Wiebe, Holsanova 2009), multimedia learning benefits from the brain's ability to make connections between the verbal and the visual. The understanding thus achieved supports learning. This is important in today's and future classrooms, which should prepare

students for challenges in the work context, where soft skills such as higher-level thinking, problem solving and collaborative ones are required. A large percentage of the human brain is dedicated to visual processing. Thus incorporating images, video and animations into a text helps increase its activity. This means that in a multimedia learning environment, students should process information more easily and more quickly identify and solve problems than in textbook-based classes. Moreover, learning through multimedia impacts students' moods. If they have a positive attitude towards such an environment, they learn better and tend to be more active. Student attention and retention increase.

Barriers: Nevertheless, it should be remembered that the preparation of multimedia materials is time-consuming and requires from the teacher an appropriate level of IT competencies (Kowalewski, Kołodziejczak, Roszak, Ren-Kurc 2013; Kołodziejczak, Roszak, Kowalewski, Ren-Kurc 2014; Roszak, Kołodziejczak 2017). In order for the resource to fulfil its educational role, it must also be structured around student-centred pedagogies (Andresen, Brink 2013). Therefore, the development of valuable multimedia materials, although very desirable, is a long-term process, requiring commitment, necessary substantive knowledge and the ability to use modern technologies. Due to the complexity and time-consuming nature of the undertaking, an interdisciplinary team responsible for substantive, pedagogical and technological aspects should be involved in developing new educational materials (Roszak, Kołodziejczak 2017).

1.3 E-textbooks

An e-textbook is a well-structured interactive multimedia learning material that meets different requirements. Besides being an educational resource, it provides various functionalities that allow students to verify their level of understanding, search for content and add notes. Moreover, it is available in many formats and for various devices, and it is published on educational portals. It is fully or partly printable, easy to expand and reorganize (Ren-Kurc, Kołodziejczak, Roszak and Kowalewski 2013). Its multimedia format substantially facilitates the development of knowledge (Szułc 2018).

In Poland, the governmental program "Digital school" has contributed to the development of e-educational resources such as free of charge e-textbooks. The first electronic textbooks were presented in September 2013, and in 2018 teachers could use 67 free e-textbooks available on www.epodreczniki.pl and other educational resources accessible on the textbook publishers' websites.

Unfortunately, in the case of academic textbooks, the changes are not so spectacular. First of all, an electronic version of a traditional textbook is often not an e-textbook. But if a university develops a kind of e-textbook, it is usually made available to their students on their portal or intranet. Moreover, commercial publications are not free and access to content is often temporary. Technologically

and pedagogically, these textbooks are still closer to traditional books than to real e-textbooks.

An e-textbook, which, according to the authors, is worth disseminating, is the textbook “e-Physics. Basics of physics” by prof. Zbigniew Kąkol and dr. Jan Żukrowski (2017), available under the Creative Commons Poland license, Attribution-Non-commercial use - On the same conditions 4.0 (CC BY NC SA). It meets most of the requirements set for e-textbooks and is pedagogically sound.

In highly developed countries, especially in the USA, access to e-textbooks and other open license resources is easier. This is due to government and private sponsorship. Students can not only use e-textbooks (Jisc 2018), but also other educational resources accessible on portals (Lecturio 2018) such as: video lectures and images (MEDtube 2018), interactive materials and simulations (PhET Interactive Simulations 2018, WOLFRAM Demonstrations Project 2018), quizzes, databases, atlases (Kenhub 2018) and encyclopaedias (Scholarpedia 2018). Thanks to Internet access and knowledge of English, Polish students also have the possibility of using these resources.

Barriers: In the authors' opinion, the factors that constitute barriers to the creation of e-textbooks in Poland are: lack of appropriate IT competencies of academic staff (Ren-Kurc, Kołodziejczak, Roszak and Kowalewski 2013), time-consuming handbook preparation, lack of appropriate teacher remuneration, and IT and pedagogical support. The authors' research carried out at medical universities show that the majority of e-textbooks have been created by their staff or have been commissioned. The universities that have their own e-textbooks positively assess their usefulness and highly evaluate e-textbooks offered by commercial publishing houses.

1.4 Web 2.0 tools-based learning

The term Web 2.0 was coined by DiNucci, and then popularized by O'Reilly at the Web 2.0 Conference in San Francisco in 2004 (O'Reilly 2016). It applies to the use of computer-mediated communication and networked digital media. It offers not only a wide range of possibilities for publication, but also encourages and supports digital artefact uploading and sharing. Web 2.0 environments provide different ways for self-representation, self-expression, reflection, collaboration, and knowledge building and sharing (Mokwa-Tarnowska 2017b) through, e.g., content remixing and repurposing, as well as networking and group activities (Crook, Cummings, Fisher, Graber, Harrison, Lewin, Logan, Luckin, Oliver 2008).

A number of factors has contributed to Web 2.0 technology being a breakthrough. These include: advancements in the technological infrastructure, increased Internet and broadband adoption, and user-friendly interfaces for navigating, archiving, communicating and collaborating on the web. There are many different

categorizations of Web 2.0 tools. One of them, according to Crook et al. (2008), divides web-based activities as follows:

- media sharing,
- media manipulation and data/web mash ups,
- instant messaging, chat and conversational platforms,
- online games and virtual worlds,
- social networking,
- blogging,
- social bookmarking,
- recommender systems to aggregate and tag user preferences,
- collaborative editing tools,
- automatic notifications changes or updates.

The emergence of Web 2.0 tools has had an impact on education, and according to Steve Hargadon, "Web 2.0 is the future of education" (2008). New opportunities have emerged, especially in terms of cooperation, communication, efficiency and knowledge sharing that can serve many purposes both in traditional classroom teaching and e-learning. Constructivist (Green, Gredler 2002) ideas are gradually becoming more popular in web-based education, and a shift from knowledge being passed on to students towards knowledge being developed by students has been seen over the past ten years. Project-based learning (Mokwa-Tarnowska 2017a) supported by online tools has opened up new educational possibilities. Technologies have been seen as a means of enabling learners to take control of their learning and a means of enhancing the social dimensions of learning (Conole, Alevizou 2010:14). By structuring their own resources to suit their individual preferences, students now have the chance to increase creativity and flexibility within the curriculum.

Social networks enable new forms of communication and cooperation and are considered an important means of knowledge building through the exchange of views and co-creation. Communities in social networks, built initially on the basis of a family relationship or community of interest, have gradually evolved into more formal communities, such as student groups and professional networks. New technologies have facilitated counselling and support for peer groups in many ways and on a scale not seen before. For example, the ability to openly comment and criticize other people's work, a standard practice in the blogosphere, has been adapted for teaching and learning.

Although it is true that many younger learners have grown up in a technology-mediated environment, their skills may not be sufficient and they may not be able to use them effectively for educational purposes. Moreover, there is a

wide spectrum of learners with different learning preferences and different willingness to engage with technologies. Furthermore, according to Edwige Simon (2008) integrating technology into teaching requires the combination of adequate technical skills and sound pedagogical foundations. This needs to be supported by an understanding that technology should never outstrip pedagogy.

There are both advantages and disadvantages of using Web 2.0 technology. The former include e.g. reduction of costs, easier and faster access to information whenever and wherever needed, sharing experiences and resources (blogs, microblogs, wikis, flickr, youtube) and low level of complexity necessary for Internet use.

Barriers: The use of Web 2.0 tools has several disadvantages, e.g., necessity of Internet access (especially a broadband connection), limited security or difficult selection process based on the number of available technologies (Grosbeck 2009). Research shows (Benbunan-Fich, Arbaugh 2006; Cole 2009; Minocha 2009:34–37) that there are many questions and concerns about the implementation of Web 2.0 tools in education. These include: concerns as to whether students and teachers have the necessary skills to use these new technologies, uncertainty about the quality and effectiveness of Web 2.0 environments, and the need for changes in the pedagogical approach to the design, delivery and evaluation of curricula.

1.5 Virtual and augmented reality

1.5.1 Virtual Reality (VR)

The concept of *Virtual Reality* was created by Jaron Zepel Lanier, an American computer scientist, writer and composer. The most commonly quoted definition of VR is by Steve Bryson and Jaron Lanier (NASA):

“Virtual reality is the use of computer technology to create the effect of an interactive three-dimensional world in which the objects have a sense of spatial presence.”

Thanks to the high computing power of modern computers it has become possible to create realistic, real-time scenes and events and multi-sensory (audio-visual, tactile and even scent effects) user interaction with the computer in order to reflect realism and the maximum effect of immersion into the world of artificial reality.

Virtual worlds, or three-dimensional immersive environments in which we exist through our avatar, have been present in education since the beginning of their creation. Their popularity peaked around 2010, then it slowly dropped due to the dominance of www-based social networking sites. However, for the education sector VR has never lost its importance, some of the reasons being educators' interest in gamification (Topol, Kołodziejczak, Roszak, Dutkiewicz, Zych, Januszewski, Bręborowicz 2017; Topol 2013) and the possibility of combining VR technology with other technologies, e.g. with mobile technology. This tendency was foreseen by the NMC Horizon Report in 2016, which forecasted the development and growth of virtual and augmented reality educational

applications in the next 2-3 years (2016, pp. 40-41). VR popularity among scientists and educators can be seen in the results obtained by Liu, Bhagat, Gao, Chang and Huang (2017), who compiled an overview of virtual reality research in education. A total of 975 documents were analysed, based on their publication patterns. The research shows that the USA, UK and Chinese Taipei are the top three most productive countries/regions that are involved in virtual reality research in education.

For many years, the best example of VR was the *Second Life* (SL) platform, which was made available in 2003 by Linden Research, Inc. Many aspects of human life are reflected in the SL platform, and the educational aspect holds an important place here. Particularly language and medical schools appreciate the educational value of this platform. Learning a foreign language in SL can lead to an increase in different skills, especially in people who cannot travel. Also, for students of emergency medical care and nursing, and doctors of various specialties, the possibility of training, acquiring professional competencies in a safe environment, far from patients, is an extraordinary educational experience. Research shows that learning in a VR environment provides positive stimuli, is attractive, addictive and effective (Nicholson, Chalk, Funnell, Daniel 2006; Skiba 2009; Trangenstein, Weiner, Gordon, McNew 2010). An important Polish application of SL is *Academia Electronica* established in 2007. In 2013 the Academy, highly estimated by the Jagiellonian University authorities, became a non-institutionalized part of the Institute of Philosophy and is a platform where teaching and scientific activities take place (Academia Electronica 2018).

VR offers many unique benefits when used in education. First and foremost, adapting VR into modern education means equipping teachers with a new tool expanding educational possibilities. With VR, they can enhance student experiences, motivate and stimulate them, as well as provide them with a hands-on experience (Bricken 1991).

At the beginning of 2014, a new VR trend (called a second wave of VR) that used the power and popularity of smartphones appeared. Google Cardboard goggles, for Android or iOS phones, could display VR wirelessly. This is how simple, inexpensive and wireless access to virtual worlds was born. The current, improved version of the goggles significantly reduces the risk of motion sickness caused by delayed movement, from which many first users suffered.

VR technology will be useful in a variety of educational fields, e.g., those with a need for a simulation or 3D presentation. They range from interactive environments designed to teach basic science in small labs to advanced higher education courses in, e.g., engineering, architecture and medicine. If it is cheaper and more accessible, it will be a necessary teaching and learning tool in the years to come. The way of building knowledge and skills during a virtual experience is something unique that cannot be found in education today. When used

imaginatively and in a carefully thought-out way, VR can offer a wide variety of advantages for both educators and students (Hussein and Nätterdal 2015).

1.5.2 Augmented Reality (AR)

Augmented reality (AR) refers to a wide spectrum of technologies that project computer generated materials, such as text, images, and video, onto users' perceptions of the real world. Ronald Azuma (1997) mentions its three characteristics:

1. „the combination of real-world and virtual elements,
2. which are interactive in real-time, and which
3. are registered in 3D (i.e., the display of virtual objects or information is intrinsically tied to real-world location and orientation).”

AR technology is widely used in many fields, e.g. aviation, medicine, automotive, museology, training, marketing and tourism. AR is also used in areas that are directly or indirectly related to education, e.g. in medical sciences as a tool for medical training and simulation, in mechanical engineering, in architecture, interior design and science education. Thanks to enormous visualization possibilities, AR can be used to design complex technical devices, observe phenomena otherwise difficult or impossible to see, and it can be helpful in understanding abstract issues, e.g. concepts in mathematics, physics and geometry (Kęsy 2017). In addition, interaction with a virtual object can evoke positive emotions that stimulate curiosity and promote learning. AR books (books that allow displaying three-dimensional characters on each page or offer interactive experience) or AR games (learning by using games set in the real world and augmented with network data or games using marker technology), are just a few examples of the technology's huge educational possibilities.

1.5.3 Mixed Reality (MR)

A completely new quality of three-dimensional visualization is provided by a Microsoft device known as Microsoft *HoloLens*. It is a technology that has the potential to substantially change teaching and learning, research and entertainment. Devices such as Microsoft *HoloLens* have the ability to develop educational programmes in a mixed holographic reality (MR). Students can see, e.g., how human organs work, collaborate with fellow learners and experts regardless of their location, and see with the eyes of others – all in real time. They can learn geography through being immersed in what they are reading about. Because their brain believes that they are there, their response to such an experience is more emotional and they learn more holistically (Workman 2018). The Interactive Commons team is developing *HoloLens* applications for disciplines such as genetics, chemistry, art, dance, engineering, and palaeontology. Students are offered opportunities to see and experience things unavailable before, without leaving their own classrooms.

Barriers: Like with any new technology, there are also different concerns. Despite the unquestionable potential of VR/AM/MR in creating a unique, personalized and efficient educational environment, the greatest concerns are financing the implementation of technological innovations and ensuring a sufficient level of teachers' and students' ICT competences. According to the authors, the three challenges, cost, technological complexity and fear of advanced technology, may constrain their availability for educational purposes.

1.6 Reasons for building technologically-rich educational environments

The implementation of modern technologies in education is faster in countries where strategies for infrastructure investments, use of technology and promotion of e-learning in education are considered to be important factors, e.g. in Great Britain (HEFCE 2009). In the process of implementing innovative teaching methods, the motivation of the universities themselves is important. Usually the driving force behind these changes is competition for a student. By focusing on modern technologies, universities create a more effective teaching and learning environment and build communities of practice. An important initiative is to provide tools for creating academic social networks for students and employees along with a virtual educational environment supporting formal and informal education (Conole, Alevizou 2010:61-62).

Barriers: The use of technology, no matter how attractive it seems, must first and foremost be subordinate to educational goals. Teachers should have an influence on the choice of tools and educational environments. This approach will favourably affect their use in the future. What is also important is motivation behind decisions and reasons, and conviction that new environments will positively affect the learning outcomes.

2. SUMMARY OF RESULTS

To summarize, the analysis of the most interesting and promising technologies to support building smarter learning and teaching environments, enhanced by e-learning and online tools, has shown the likelihood of the following developments.

- The use of mobile devices and free ready-made software to support learning in a university context will increase significantly in the years ahead, which will result from their availability, popularity and affordability. However, overall implementation costs, including training sessions' costs and IT infrastructure costs, especially in the initial phase, can be high. Moreover, universities will have to restructure their course curricula.
- There is a growing interest in developing multimedia educational materials and interactive electronic textbooks to support traditional education in Poland, regardless of how expensive the production process is. The explanation lies in their high effectiveness and flexibility of use. The use of

such innovative resources is understood to improve the university reputation and competitiveness.

- Polish university staff willingly use Web 2.0 tools to enhance their traditional classes. They are perceived to be effective in developing engaging online activities and resources for both e-learning and web-supplemented face-to-face education. In addition, there is a wide variety of tools which are free, user-friendly and easy to implement, even by teachers who lack advanced ITC skills.
- The barrier to the immediate and widespread implementation of virtual and augmented reality in academic education is that they entail substantial implementation costs. Some universities in Poland are looking for the most cost-effective ways of implementing VR and AR to enhance their students learning experiences. Further technological advances may transform academic education in Poland and across the world, but whether VR and AR will define the education process is yet to be seen.
- Every university, college and faculty, depending on their vision, funding, infrastructure and staff competencies, can shape its development and approach to technology-based education. However, changes in delivery modes and course curricula are inevitable. As the developments presented in this article show, incorporating innovation into academic education is a slow and multi-stage process that requires a pedagogical paradigm change. An increase in funding and support for teaching staff will definitely open new opportunities for Polish universities and other higher education institutions if they are on the government's agenda. With their advantages and drawbacks, new technologies pose a challenge for educators, and the analysis provided in this article is believed to help them make rational and sensible decisions.

CONCLUSION

This article addresses technologies and tools that significantly affect or in the near future will affect the shape of academic education. Due to its scope some developments have not been discussed, e.g. the Open Educational Resources initiative.

The development of technology provides tools that irreversibly revolutionize approaches and methods in education. Each change has its advantages and disadvantages, and usually entails problems at the implementation stage. The major limitations to the evolution of academic education addressed in the article are costs, low level of teachers' motivation and their insufficient ICT competences.

If Polish higher education institutions desire to compete with western universities, they must join the wave of change and adjust their educational methods and environments to meet new needs. Funding is a strategic factor in the development

of Polish education. Innovative programmes can be financed by national and European programmes. It is possible to overcome the staff initial resistance to change through raising their knowledge about new technologies, i.e. through training and foreign internships, and by exposing them to interesting solutions and implementations. A positive attitude towards innovative learning environments affects motivation and commitment, and may lead to the improvement of teaching methods and tools. Sceptics of new technologies should be guided by the motto “The world only goes forward because of those who oppose it” (Johann Wolfgang Goethe).

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