CHAPTER I: E-LEARNING AND STEM EDUCATION IN DIGITAL SOCIETY

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ROBOTS AS FRIENDS, CO-WORKERS, TEACHERS AND LEARNING MACHINES – METAPHORICAL ANALYSES AND ETHICAL CONSIDERATIONS

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Abstract: *In the wake of digital networks and the penetration of private and public realms by algorithmic dynamics and robots, new claims and tech promises as related to A.I., robotics and machine learning have been increasingly gaining currency. On the one hand, new opportunities for individuals, groups, societies and transnational developments are being emphasized. On the other hand, there is a need of differentiated and critical analysis in view of grandiose promises, naive visions of robocracy and obvious examples of A.S. ("Artificial Stupidity"). The paper presents a selection of metaphorical descriptions of robots and human-robot relations, followed by an analysis of the key metaphor "artificial companion". On this basis, the relevance of the results for issues of accountability and responsibility is being presented. Finally, the contribution aims at reflecting ethical consequences for future-oriented ideas of responsible robotics.*

Keywords: educational robotics, artificial companions, metaphor analysis, robot ethics, machine learning

INTRODUCTION

From ancient music machines and wind-powered organs designed by Hero of Alexandria (ca. 10-70 C.E.) to Vaucanson's automatic duck, and from Čapek's (2004) play *Rossum's Universal Robots (RUR)* to autonomous robots, chatbots

and molecular machines that act flexibly, metaphors play an important role in the history of human-machine interaction. Throughout history, a wide range of imaginary worlds regarding automated interaction, imagination of mediated communication and technological "wish worlds" (*Wunschwelten*) (Stadelmann et al., 2000) have been described. However, the idea of robots as "machine humans" or autonomous machine beings that are created by humans and by means of science and technology did not develop until modern times (Gendolla, 1980).

In cultural theory, social sciences and philosophy, various media-cultural, socio-technical and ethical aspects at the interfaces of technological, cultural, economic, social and political developments are being researched, usually starting from the assumption that complex entanglements of these developments are setting the direction and pace of societal developments rather than robotics, information technology or A.I. itself. In technological discourses, on the other hand, distinctions between different robot types, technical aspects and application contexts are of primary importance. The classification of robots, for example, is often made by distinguishing between environments and mechanisms of interaction and especially by application fields (Ben-Ari & Mondada, 2018, p. 2f). Typically, industrial robots, social humanoid robots, social bots, chatbots and nanorobots or molecular machines are regarded as parts of different worlds based on different technologies.

However, these complex worlds are conceptualized, there is the problem of how they are connected and communicated in cultural and societal contexts. Among the connecting elements, binding forces and mediating structures we can find scientific achievements including mathematical constructions, technological and cultural developments enabling the production and programming of different types of robots, constellations of hegemonic or leadership interests, hopes and technological promises regarding future developments, discursive relations and narration patterns, and last but not least, metaphors.

The research questions of the study include:

- What are typical examples of metaphorical descriptions of robots and human-robot relations?
- How can the key metaphor of the "artificial companion" be analyzed?

Furthermore, the paper explores the relevance of the results for corresponding issues of accountability and responsibility. Finally, the contribution aims at reflecting ethical consequences for future-oriented ideas of responsible robotics.

1. METHODOLOGY OF METAPHOR ANALYSIS

Even though methodological approaches in metaphor analysis do not yet play a central role in research in the humanities, cultural studies and social sciences, their importance should not be underestimated. The relevance of methods

of metaphor analysis goes far beyond the textual interpretation of metaphorical phrases and investigation of underlying patterns of imagination and perception. The spectrum ranges from the analysis of practical uses of metaphors in everyday life to philosophical investigations of ways of constructing realities.

1.1. From Ancient Traditions to Recent Developments

Metaphor is as old as historical records. As for European traditions, there is a variety of forms dealing with metaphorical expressions including Homer's *similes,* Isocrates' *metaphora* and Plato's *metapherein* ("transfer") and *onomata* ("transferring words") (Kirby, 1997). To this day, countless contributions to philosophy and the methodology of metaphor analysis refer to Aristotle, who defined metaphor as "the application of a strange (alien, *allotrios*) term either transferred (displaced, *epiphora*) from the genus and applied to the species or from the species and applied to the genus, or from one species to another, or else by analogy" (Aristotle, 1982, 1447b; italics in orig.). Aristotle's four possibilities of creating a metaphor – genus to species, species to genus, species to species, and by analogy or proportion and resemblance – show a social and political dimension in so far as the major goal of rhetorical speech is persuasion, which is of importance in many present-day contexts of digital communication, too.

However, goals and characteristics of metaphorical analysis depend on what is seen as a metaphor, how they are conceptualized and as what metaphors are being seen or taken. According to Niedermair (2001, p. 144), a metaphor can be a "linguistic expression, a concept, an image, a software surface, an affect, an emotion, a scheme – or anything and everything". Then again, metaphors can be seen as "jewellery and ornament, as improper manner of speaking, as falsification of truth, as subversive disruptive factor, as Trojan horse, as profound manipulation, as sign of creativity, as strategy of change – or as principle of the construction of reality in general" (Niedermair, 2001, p. 144).

From a conceptual perspective, an enormous variety of characterizations and conceptualizations can be distinguished. Among all of those numerous options and relevant distinctions, the following are especially important from a systematic perspective:

- Blumenberg's philosophy of metaphors and his take on the use of metaphors
  as a "narrow special case of non-conception [*Unbegrifflichkeit*]" in the "fore-field of concept formation" (Blumenberg, 1993, p. 77).
- Goodman's (1968) distinction of literal and metaphorical exemplifications.
- "The essence of metaphor is understanding and experiencing one kind of thing in terms of another" (Lakoff & Johnson, 1980, p. 5) and further developments in cognitive linguistics from experientialism to embodied realism (Lakoff & Johnson, 1999).

- Glaserfeld's (2005) take on metaphors as indirect descriptions.
- Krippendorff's definition of metaphors as "linguistic vehicles through which something new is constructed" (Krippendorff, 2009, p. 51).
- The importance of contexts, the role of context-induced creativity and further extensions of conceptual metaphor theory as outlined by Kövecses (2009).
- The relevance of context disruptions and contextual entanglements regarding epistemological dimensions as argued by Gehring (2010).

The list could easily be continued. The methodology used in this study is outlined below.

1.2. From Philosophical and Linguistic Analysis to Qualitative Research

Among the manifold conceptual and methodological developments in metaphor analysis, we find strands of development from semantics to pragmatics in linguistics as well as further developments in social sciences (Niedermair, 2001, p. 147-155). In educational research, too, there are examples of theoretical studies of metaphors (see, for example de Haan, 1991; Drerup, 2016) as well as of empirical studies (see, for example Guski, 2007; Gansen, 2010).

On the assumption that constructivist perspectives of methodology (Moser, 2011) open up fruitful ways of connecting theoretical and empirical concerns in a non-fundamentalist manner, metaphors are taken hereafter as situated products of interaction in social and media-cultural contexts. As for the methodical procedure, the explorative study combines elements of Niedermair's (2001) approach to metaphor analysis with the qualitative research methodology elaborated by Schmitt (2011, 2017) and Schmitt et al. (2018).

As far as details are concerned, the following steps are intended:

- Specification of the material.
- Explication of research questions.
- Collection and reformulation of metaphorical expressions.
- Bundling metaphorical concepts and central motifs.
- Interpretation and integration in argumentation context.

The third step deals with the collection and reformulation of the metaphorical expressions occurring in the selected corpus of material, as well as the corresponding indication of focus and frame (Black, 1954). In doing so, metaphorical concepts in the sense of "prototypes" (Buchholz, 1996), "root metaphors" (Schmitt et al., 2018, p. 31) or "key metaphors" (Schachtner, 1999) can be reconstructed (see also Niedermair, 2001, p. 159). Furthermore, questions of enlightening and obscuring perspectives are of importance.

In this explorative study, a selection of typical examples of metaphorical descriptions of robots and human-robot relations as well as an analysis of the key metaphor of "artificial companion" are presented for discussion.

2. ANALYSIS OF ROBOT METAPHORS

Today, we find a variety of metaphorical descriptions of robots in contexts of industrial production, generic and mobile applications, entertainment and science fiction as well as research and development. The spectrum extends from slaves to friends, and from autonomous devices to learning machines. Inversely, the term 'robot' is sometimes used as a metaphor, too, for example for 'the inhuman', 'the other', 'the alien', 'the strange' or 'the rational'. The examples outlined below refer to fields of education and learning as well as social work and care.

2.1. Exemplary Robot Metaphors in Education and Care

In the course of the preliminary study, material has been specified and selected as related to the fields of education and care that provides prototypical robot metaphors. Typical examples of metaphorical descriptions of robots and human-robot relations refer to robots as teachers, coaches, tutors, friends, co-workers, companions, nurses, conversation partners, comforters and guardians. Technically speaking, most of these kinds of robots fall into the category of "service robots."

From the perspective of metaphor analysis, frame and focus (or source and target) can be explicitly described as shown in Table 1.

Table 1.

Exemplary robot metaphors

Selected Quotations	Focus	Frame
"It looks just like an ordinary NAO robot, but the heart and brain of Elias is the robot behavior developed by Utelias. It can understand students' needs and help them practice their speaking skills in a fun and save [sic] environment, without fear of making mistakes. Combined with Elias application, the robot can turn your classroom into a positive learning experience, filled with engaging content and happy students. Get ready to take learning to a whole new dimension with Elias!" (Utelias Technologies, 2019)	NAO-robot (Elias)	language coach, help, understand needs, promote positive learning experiences in classrooms
"A robot can make a shy kid talk, motivate the child who is not interested about studying, or having any conversations… A robot can be a teacher when there	NAO-robot (Elias)	have conversa-tions, motivate uninterested

are not enough qualified teachers; a robot never gets tired, just keeps on repeating or listening, whatever you need. It understands your needs and makes the learning miracle possible. Is it a science fiction dream, or something we are now starting to understand and accept as a reality? The robot revolution has started. That has happened for sure. There already are hotels that are driven by humanoid robots, elderly homes where NAO robots help stimulate patients with dementia, and dentist receptions where NAO robots talk with kids so that they forget to be scared. **This is reality in modern era: Robots are integrating with our everyday life.**" (Pääkkönen, 2018; bold in orig.)		children, teacher, help, talk, understand needs, enable learning miracles
"Our mid-term vision is to purposefully and responsibly promote this new generation of *robonatives* with suitable educational concepts. The main goal is to enable them to use and further develop state-of-the-art robotic technology, create benefits for their own lives and careers and in turn help to shape our future society." (Haddadin et al., 2019, p. 4, italics in orig.)	current generation of children	digital natives, robotic natives, create benefits, shape future society
"Like a good nurse, the robot can continuously observe and monitor the activities of the user. In a long-term view, this allows to provide valuable data for a long-term assessment and to detect changes in behaviour that might indicate a decline in the overall health state, e.g. reduced mobility. On a daily basis, the robot can be the personal coach of the user, detecting e.g. that there have been only pretty limited physical activities this day and encouraging to do some training." (Meyer et al., 2009, p. 4)	robot (Florence)	observe and monitor, provide data for long-term assessment and to detect behavioral changes, personal coach, detector, encouragement
"In the GUARDIAN ANGELS project the functionality is not incorporated in a robot but in a series of wearable devices. The main function of these devices is to monitor physical and physiological parameters of the user and his or her environment (e.g. blood pressure, hydration level, stress, air quality, information for blind persons). These computational devices are permanently in operation but remain invisible in the background, hence guardian angels. GUARDIAN ANGELS are companions in the broad metaphorical sense as 'invisible helpers' continuously accompanying the user." (Böhle & Bopp, 2014, p. 163)	computational wearable devices	invisible helpers, monitors, companions, guardian angels

"Assistants are helpers providing *personal assistive services*. In contrast to Guardians the user is enabled by an Assistant to fulfil tasks, which she or he would otherwise be unable to perform. The emphasis of these companions is not on supervision but on enabling. [...] 'The robot is not only considered as a ready-made device but as an artificial creature, which improves its capabilities in a continuous process of acquiring new knowledge and skills' (COGNIRON Appendix III)." (Böhle & Bopp, 2014, p. 163; italics in orig.)	robot	assistant, companion, enabler, learning creature able to acquire new knowledge and skills
"The social robot is imperfect by design and behaves more like a clumsy dog than a perfect butler or servant. With this approach the acceptance of robot assistances shall be increased. The concept of co-learning assumes that the robot and the user are providing mutual assistance. The user shall not be dominated by the technology, but empowered, physically, cognitively and socially (ACCOMPANY Appendix III)." (Böhle & Bopp, 2014, p. 164)	social robot	clumsy dog vs. perfect butler or servant, co-learning, mutual care, empowerment
"This creates the hope and, at the same time, the fear that robots will be integrated into our society as full-fledged actors in the future." (Weiss, 2012, p. 430, translation by T.H.)	animal(like) robot	socially integrated, full-fledged actor

Source: Own work

This collection already shows that the metaphorical ways of describing activities, potentials and features of robots and human-robot relations are consistently accompanied by far-reaching announcements, claims and more or less cautious assertions. An in-depth analysis of an integrative metaphorical concept will show that such forms of such descriptions not only support bridging technical and cultural codes but also have misleading features.

2.2. "Artificial Companion" – Analyzing a Metaphorical Concept

2.2.1. Ambivalent Perspectives

"Artificial companion" has been chosen for this in-depth analysis because the metaphor functions as a meta-metaphor and as an integrative metaphorical concept. It can be used on its own and also as including or related to other metaphors. In both respects, it shows orienting as well as disorienting characteristics.

Table 2.

"Artificial Companion" as an integrative metaphorical concept

"Artificial Companion"	Focus	Frame

as an Integrative Metaphorical Concept		
"Companions, comrades, helpers in need, consultants, protectors, guardians, guardian angels, support in everyday life, good friend, best mate, counselor, other half, lover, buddy ... - Artificial Companions are not only for us, but also in the interdisciplinary field of Service Robotics, Artificial Intelligence and Human Computer Interaction a metaphor rich in associations, even more so: The metaphor is a guiding vision for all those working here in research and development." (Pfadenhauer, 2018, p. 57; translation by T.H.)	robots	accompany, monitor, protect, advise, good friend, guardian angel, lover, guiding vision, etc.

Source: Own work

Bundling metaphorical concepts and the analysis of central motifs reveals some relevant points. "Artificial companion" as a widespread integrative concept refers to:

- fulfilment long-lasting dreams of technologies serving humans,
- suggestions of professional support as well as reliable companionship,
- viable and meaningful human-machine relations,
- notions of machines "learning" and "acting" as trustworthy and rational assistants,
- accounts of crucial relevance for multiple functions in various social and cultural respects,
- flexibility towards "common sense" and research contexts generally,
- mediation of positive moods as well as positive attitudes towards emotional
  ties and affective bonds with machines, at the same time mollifying gestures towards "automation anxiety",
- enhanced embodiment of automated routines and external objects,
- a vision of technological solutions for psycho-social and educational issues.

Furthermore, perspectives that are highlighted or opened can be summarized as follows:

- technological advancements in relation to personalized, adaptive, "learning" systems,
- functional responsibility of various interdisciplinary IT fields for fields like education, nursing and social care,

- claims to leadership as regards primarily relevant approaches to dealing with problems in caring, assisting, welfare, education, relationship dynamics, etc.,
- humanly adequate structuring of relationships and modes of companionship with prospects of both sustainable solutions and large profits,
- new potentials for IT businesses in view of emerging technologies and changing media-cultural constellations,
- possibilities of fruitful interactions of semi-autonomous humans and machines,
- solution-oriented working and acting open to inter- and transdisciplinary approaches,
- demands for the promotion of computational thinking,
- alternatives to former welfare-state measures in terms of technological and market-economy reforms over the medium term.

On the other hand, there are also perspectives that are concealed or obscured. Among them we find:

- *pars pro toto* descriptions, restricted wordings and tunnel visions,
- misleading rhetoric, especially regarding issues of responsibility and accountability,
- primacy of industrial and political interests in rich countries,
- huge research funding, business models and commercial exploitation of data,
- limitations of voluntary participation when making use of services provided
  by artificial companions,
- leeway for multiple forms of empowerment and fostering self-responsibility,
- interplay of (partially unconscious) drivers for excessive and constant monitoring, control, surveillance, compliance and enforcement,
- path dependency of developments – alternative options for development,
- limitations of computability and predictability of complex phenomena and respective developments.

As we can see, perspectives are ambivalent. Some have enlightening features while others are concealing relevant dimensions and aspects.

2.2.2. "Artificial Companion" – An Interpretation

The instantaneous character of the integrative metaphorical concept may support superficial uses of the term and the concealment of ambivalent perspectives. However, analysis has shown its ambivalent character. Undoubtedly, it features multiple connectivity regarding a variety of metaphors, languages, contexts of application and forms of use in technical, political and socio-cultural spheres. Thereby, the metaphorical concept fosters discursive integrability including affirmative and critical perspectives.

Moreover, "artificial companion" alludes to long-lasting dreams of technologies serving humans in intelligent, sensitive, contextual and responsible ways, now for many if not for "everybody" (right now or in the near future). The metaphor suggests responsibility and agency as well as human-like social, emotional and moral intelligence. It also creates expectations of empathic human-like educational or care processes as well as "warm friendship" and company – in contrast to the previous "cold care" of machines. It involves prospects of uncomplicated relationships and pragmatic solutions regarding human needs and necessities combining humanity, human dignity and versatile functionality.

Finally, it addresses positive views on "digital inclusion" as well as social and socio-technical cohesion in view of a lack of solidarity among humans. From a methodological perspective, "artificial companion" does not only work as "conceptual metaphor" or as "(dis-)orientational metaphor" but also as "visual metaphor" (Kövecses, 2019) and as "transcoding metaphor" (van den Boomen, 2014).

3. BETWEEN THE PRIORITIES OF RESPONSE-ABILITY AND RESPONSIBILITY – DISCUSSION

Further research may show how interactive dimensions related to various contexts of usage of metaphorical concepts like "artificial companion" and similar metaphors deal with the ambivalent characteristics that have been outlined above. However, there are ethical and normative dimensions beyond efforts of bridging empirical research and hermeneutic interpretation or linguistic analysis.

The promotion of metaphors like "artificial companion" and corresponding socio-technical systems tend to ignore paradoxical aspects and complex constellations at the crossroads of increased response-ability and the many dimensions of responsibility (Lenk, 1994; Kirchschläger, 2014; DEDA, 2017; Renda, 2019). In this context, we should not underestimate the emergence of new responsibility gaps in addition to former gaps (Matthias, 2004). This is not only due to the complexity of entangled dimensions and intertwined developments of socio-technical systems, autonomous devices and "smart" interactive systems. This is also due to widespread suggestions of innovation pathways without any alternative (Mansell, 2018) and well-known tendencies

in big industries to privatize economic profits and to collectivize costs for damages and undesirable side effects.

Ways of speaking about autonomy are manifold. They refer to decision-making abilities of subjects and the principle of human autonomy but also, for example, to the autonomy of art, schools, universities, parties, companies and to self-government in view of social, economic or political pressure toward conformity. If robots are described without restriction as intelligent autonomous systems equipped with sensors, then they should be able to pass a Kant test in order to show autonomous decision-making abilities. Leschke (2018) has recently introduced this consideration:

"Kant's notion of the subject, however, goes far beyond both the utilitarian quantification strategy and the Turing test, in that he not only makes the somewhat arbitrary perceptibility as subject a condition, but at the same time formulates the categorical imperative as a kind of test question, on which possible differences and thus the differentiation of prostheses and subjects could prove themselves." (Leschke, 2018, p. 92; translation by T.H.)

Obviously, this not about an *a priori* control system based on normative constructions and programmed decision structures for "moral machines". It is about the *universalizability* of decisions. Accordingly, the relevant distinguishing feature between autonomous and non-autonomous systems is the ability to universalize decisions.

"Only if a person or a system is able to universalize its decisions is it a subject or an autonomous system. The Kant test, which in some measure assesses the rational capacity of the subject or the automatic system, distinguishes between systems that can act autonomously, i.e. without control, and those that in any case require control by an autonomous subject." (Leschke, 2018, p. 93; translation by T.H.)

As we can see, a Kant test would go beyond a classic Turing test. If we assume that this kind of self-regulatory capability at the level of universalization is possible, we should also consider abilities of thinking and learning. No matter if we talk about self-learning robots teaching kids or adults, or if we reflect on social bots or chatbots based on A.I. and machine learning features, similar issues require differentiated analysis and prudent discussion. Definitions like the following one call for interdisciplinary approaches, discursive contextualization and the drawing of learning-theoretical distinctions rather than for agreement without further ado:

"Machine Learning is the science of getting computers to learn and act like humans do, and improve their learning over time in autonomous fashion, by feeding them data and information in the form of observations and real-world interactions." (Faggella, 2019)

Whether learning refers to changes of behaviour, attitudes, values, mental abilities, task performance, cognitive structures, emotional reactions, action patterns or social dynamics, in all cases the phrase "like humans do" calls for a closer examination and differentiated analysis. The same applies to different conceptualizations of learning, for example as process of building up and organizing knowledge, as process of transformation based on processes of meaning-making in specific contexts, or as process enabling or leading to relative permanent capacity change beyond "pure" biological maturation or aging. Blurs between programmed forms of domain-specific autonomy and profound forms of trans-contextual autonomy, between determinism and predictability, and between various forms of "automatism" (Bublitz et al., 2010) should also be reflected and not just celebrated.

There is much to suggest that the ascription of anthropomorphic characteristics to robots, like responsibility, autonomy, agency, intentional reasoning, or human-like social, emotional and moral intelligence, is rather in line with business strategists and vague notions of (market) accountability than with differentiated analyses in research on responsibility or robot ethics (Capurro et al., 2006; Lin et al., 2014; Tzafestas, 2016; Heidbrink et al., 2017). In view of many misleading or problematic naming practices in contexts of describing and dealing with robots it seems to be appropriate to consider new names for a "species" with "mind-less morality", "pure" machines and biological-computational hybrids (Floridi & Sanders, 2004).

CONCLUSION

Developments in robotics and A.I. have enormous transformative potential in industrial, socio-cultural, economic and educational contexts as well as in everyday life. However, assessments of its manifold strengths, weaknesses, opportunities and threats (SWOT) fall short if these are based on a technological determinism. It is not digital technologies alone that determine societal, economic, social, cultural and ultimately also digital transformation processes and corresponding trends. Transformative dynamics emerge at the interfaces of technological, societal, media-cultural, economic, political and juridical dynamics.

In the complex web of these r/evolutionary developmental dynamics, metaphors play a significant role among other connecting, binding, (dis-)integrating and sometimes disrupting forces like hegemonic aspirations, economic interests or unconscious desires. Embedded in narrative structures and multimodal forms of communication, they show mediating functions and enable communication across discursive, technical (*fachsprachlich*) and cultural borders.

Translational usability and transdisciplinary "revolving door" effects of metaphors, however, show ambivalent traits. On the one hand, the usage of terms

like ‘teacher’, ‘coach’, ‘tutor’, ‘friend’, ‘companion’ or ‘conversation partner’ as metaphors for robots and human-robot relations sheds light on innovative possibilities for development and design. On the other hand, such forms of use also conceal problematic aspects worthy of discussion. The attribution of human characteristics such as ‘autonomous’, self-learning, ‘creative’, ‘conversational’, ‘intelligent’, ‘moral’ or ‘smart’ to programmed and sensor-equipped automatons is undoubtedly useful for marketing purposes. On closer examination, such attributions turn out to be problematic, especially if ‘intelligent’ systems and autonomously operating machines are attributed ethical reasoning and decision-making abilities, too.

So far, “artificial companions” would not be able to pass a Kant test. Accordingly, we should recognize the limits of technical solution capacities and be skeptical towards grandiose promises of technological salvation. Metaphor analysis can contribute to the exploration of viable development paths between the Scylla of empty robot-promises and the Charybdis of fictions of medial and technological innocence. In addition, systematic evaluation of socio-technical systems, circumspect technology assessment (*Technologiefolgenabschätzung*), thoughtful discourse assessment (*Diskursfolgenabschätzung)* and exploration of various (digital) innovation pathways are indispensable for successful developments considering human responsibility as well as increasing response-ability of robots.

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