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ROBOT TEACHERS AS A NEXT STEP IN ALGORITHMIC EDUCATION? ETHICAL CONSIDERATIONS AT THE INTERFACES BETWEEN HUMANISM, DIGITAL HUMANISM AND CRITICAL POSTHUMANISM

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Abstract

This paper explores the ethical considerations surrounding the use of robots as teachers and personalized learning companions in education. While AI and robotics are increasingly integrated into educational settings, the deployment of humanoid robots as educators remains rare but raises important questions. The article asks to what extent concepts of moral agency in machines, ethical design, and artificial morality are applicable in educational contexts and how these technologies affect pedagogical autonomy, relational quality in human-robot interactions, and the distribution of responsibility. By examining these issues through the lenses of humanism, digital humanism, and critical posthumanism, the study situates contemporary developments within a longer historical trajectory of educational automation and algorithmic thinking. Finally, the analysis illuminates how emerging intelligent technologies reshape the promises and perils of future schooling, offering nuanced insight into the ethical tensions at the intersections of humanism and posthumanism.

Keywords

Algorithmic Education, AI In Education, Robots in Education, Robot Ethics, Educational Technologies

Introduction

Among the various technologies that are relevant in many discussions about the future of education, developments in AI and robotics are playing an increasingly important role. This applies not only to computational thinking, AI literacy or educational robotics in STEAM contexts, but also to diverse claims of the utilization of AI and robotics in education in general. To understand these developments and the recent upheaval in a nuanced way, we must consider historical and systematic aspects of the topic. The introductory explanations aim to shed light on the contested nature of education and its ever-changing definitions, contextualizing them within historical, philosophical, and socio-political frameworks. It begins by outlining traditional and contemporary understandings of education, from Johann Friedrich Herbart's (1776-1841) pedagogical theories to the current proliferation of compound terms such as "inclusive education" and "digital education." In so doing, the analysis traces the historical development of educational aims and legitimization processes, drawing on Hermann Veith's concept of "educationalization formulas." As for the contemporary context, the text highlights "algorithmic education" as a unifying concept that encompasses digitalization, automation, artificial intelligence (AI), and platformization. The conceptual considerations provide a basis for critically examining ongoing debates about digital pedagogical agents and applications of robots in education.

Education has been a contested term throughout history. Accordingly, we can find a variety of complementary and conflicting concepts and related practices including upbringing and preparing for adult life, personal development and *Bildung*, teaching, learning and training, as well as qualification, competence development and skilling. Moreover, quite in contrast to Herbart (1841, p. 1), who advocated for "educability" (*Bildsamkeit*) as the basic concept for the study of pedagogy, researchers, practitioners, administrators, developers and politicians use countless compound terms including inclusive education, digital education and algorithmic education, today. Furthermore, even a cursory examination of current educational discourses shows that key issues often revolve around different learning or teaching concepts and a variety of sets of competences, literacies or

skills. And quite in contrast to Herbart's ideas of pedagogy as academic scholarship and discipline, based on its "native" or "domestic" (*einheimisch*) concepts and without the risk of being "governed as a distant conquered province by a foreigner" (Herbart 1806, p. 8), educational research is anything but associated with only one established scientific discipline. Depending on the context and preferred key terms, educational research is situated differently within the tensions between art, design, academic studies, technology, and science. Depending on the fundamental understanding of education—for example, as a meaningful relationship, moral communication, a public good, a commodity, a means to an end, or an end in itself—related disciplines are given different levels of importance. Thus, the spectrum of related disciplines is no longer limited to philosophy, psychology, and sociology. More recently, it has expanded to include communications, media studies, gender studies, learning sciences, political science, cybernetics, information science, computer science, cognitive science, medical science, biology, robotics, and neuroscience. Consequently, problem descriptions, research approaches, and proposed solutions vary regarding questions of contemporary and future-oriented education and claims of primary responsibility.

The diversity of different ways of thinking and talking about education does not mean that these ways are negotiated solely in the academic sphere. They are negotiated in diverse societal and cultural contexts in which different pedagogical orientations and respective ethical principles are considered anything but equally relevant by the actors involved. From a historical perspective, we can reconstruct normative focuses that function as centrally relevant educational objectives or orientation marks for a certain period of time. These focuses result from internal and external legitimization processes and power dynamics in the respective formations of society. Hermann Veith (2003) has provided a historical overview of reproduction problems and corresponding "educationalization formulas" (*Pädagogisierungsformeln*) for the German-speaking world. His historical overview begins with the Lutheran call for the establishment of Christian schools as a response to the crisis of orientation in the Holy Roman Empire of the German Nation in the early 16th century, with the aims of a secular and confessional reorganization being linked under the guiding formula of "instruction" (*Schulunterricht)*; and it ends with an argument for competence development and self-organization in view of unbounded globalization dynamics, medialization of lifeworlds, and challenges of increased complexity and for a life of contingency at the end of the 20th century (Veith 2003, pp. 183-201).

In the 21st century, new key terms have been widely promoted to determine orientation in educational policy and research, teacher education and schooling as well as institutional development. The most prominent terms here include digitalization, datafication, automation and "learnification" (Knox / Williamson / Bayne 2020). Even if other key concepts such as sustainability, inclusion and globalization continue to play an important role in dealing with the current multiple crises in many countries, it is easy to see from the activities of the global education industries and AI investments where the focus lies.

Most recently, the term algorithmic education has been introduced as an umbrella term referring to "the increasing importance of data-driven educational technologies in all processes of teaching and learning, and educational governance" (Cobo / Rivera-Vargas 2024, p. 211). This description should not distract from the many implicit meanings of "algorithmic education" throughout history, some of which still play a role today.[1] Today, algorithmic education is a new educationalization formula that encompasses related phenomena such as digitalization, datafication, automation, artificial intelligence (AI), platformization, and privatization. Different approaches and definitions are used in this context. Ongoing research includes thematic priorities like learning in the age of algorithmic cultures (Jandrić et al. 2017), the critical analysis of algorithmic assemblages of Learning Analytics (Perrotta / Williamson 2018) and benefits and challenges of algorithms and AI-enabled robots in "Education 4.0" (Seldon et al. 2020). Among the further prioritizations are algorithmic bias in education (Baker / Hwan 2022), synthetic governance as "an emergent form that combines old and new political rationalities, methods, and technologies" (Gulson / Sellar / Webb 2022, p. 15), the qualitative analysis of "formation algorithms" (Böder / Böhme 2023), and "new capacities that educational organizations […] need to strategically and responsibly develop in an era of data-intensive education" (Cobo / Rivera-Vargas 2024, p. 211). For my argument, I am using the following definition: *Algorithmic education refers to a variety of forms of designing, executing, assessing, evaluating, managing and controlling learning processes in educational institutions by means of digital infrastructures, networked data architectures, numerically processable models and algorithmic methods.* This definition includes current developments that are associated with keywords such as intelligent tutoring systems, adaptive learning and pedagogical agents, too. Although these topics have been discussed for years, they are gaining new significance at the intersection of digitalization, datafication, automation, and monetization of digital interfaces. Among the forms of digital pedagogical agents with the strongest claims to educational innovation and transformation are undoubtedly humanoid robots that are used as teachers or educational assistants.

On the one hand, I agree with Neil Selwyn when he writes:

[1] Examples of "algorithmic education" *avant la lettre* include practical pedagogical guidelines, didactic concepts for teaching routines, and prescriptive instructions for addressing disciplinary issues.

> "While the deployment of human-looking robots in classrooms remains more of a publicity stunt than a serious educational trend, many other forms of digital automation are being implemented across schools and universities around the world." (Selwyn 2019, p. 5)

Who would expect that teachers are being replaced by social humanoid robots in the near future? Who would want to replace teachers with robots anyway? On the other hand, we should not forget about the long history of imagination of automated applications and "machine humans" (Witting 1997; La Mettrie 2023 [1748]) and the fact that processes of automation, measurement and evaluation already played a prominent role in educational systems long before the Internet and contemporary AI developments. However, ongoing developments at the intersection of machine learning, learning machines, and human education are not only about computational thinking, AI literacy, or educational robotics in STEAM contexts. They are also about the various ways AI and robotics can be used in education in general. Accordingly, these discourses are as well about robots as teachers, personalized learning companions and assistive educational technologies. In so doing, they are part of discourses about the future of education and (educational) politics of the future. Along with the corresponding ideas of disruption and the new educational horizons for the future, ethical debates are ongoing (Sharkey 2016; Selwyn 2019; Regan / Jesse 2019; Peters 2020).

This article contributes to these debates as follows: First, I will summarize crucial reasons for a differentiated discussion, particularly of the ethical dimensions of the topic. Then, I provide some examples for concepts and applications of robots as teachers, companions and assistants in education from different world regions to illustrate the phenomena involved here. Furthermore, key points of ongoing ethical debates are examined, followed by additional considerations of ethical arguments at the interfaces between humanism, digital humanism and critical posthumanism. Additionally, some of the misleading metaphors frequently used in this field are examined, as well as the ambivalences and paradoxes relevant to a theoretically and practically motivated in-depth study of AI and robotics in education. Lastly, solutionist approaches are problematized, and the importance of a diversity of innovation paths and forms of knowledge is emphasized.

Humanoid Robots as Educators?

The use of robots in education that goes beyond their application as objects of computer science education and as tools for imparting technical knowledge is not yet widespread. It is by no means a foregone conclusion whether and to what extent humanoid robots for education should be seen as playthings for advanced learning technologies, service robots for the benefit of educational bureaucracies and control, flexible tools of the global education industry, or social actors with pedagogically relevant functions. Imaginations of a "take-over" by robots in the field of education are rather rare and, on closer inspection, they have more to do with developments in the entertainment industry and science fiction than with ongoing dynamics of datafication and digital automation in education. Nevertheless, I believe it is important that these robotics developments in the field of education are not only considered as a niche phenomenon from a computer science, learning technology, pedagogical or economic perspective, but also from an ethical point of view, for the following reasons in particular:

- Descriptions of robots as teachers, companions and assistants in education are part of a tradition of influential ICT rhetoric (Haugsbakk / Nordkvelle 2007; Shanks 2020; Zulaica y Mugica / Zehbe 2022) that keeps coming up with new technology promises without seriously engaging in history and theory of education and appropriately differentiated discourses and evaluations. The role of metaphors in these descriptions is rather utilized for project funding and expanding social acceptance of robot technologies than critically analyzed in terms of accountability, educational justice or the role of bonding in education in respective descriptions (Hashimoto / Kato / Kobayashi 2011; Bosede / Cheok 2018).
- These descriptions are kept in a spirit of optimization and optimism, combined with the claim of a forward-looking milestone on the way to realizing old dreams of automation in education, following up widely established routines of measurement and control in educational governance, and overcoming pedagogical technology deficits, too (Luhmann / Schorr 1979; Osterwalder 2002; Hollstein 2011; Töpper 2023). In this atmosphere of departure, ambivalences and critical assessments dealing with problematic aspects of datafication, digitalization, automation, economization or trivialization of education are underestimated if not ignored.
- In contrast to the intricate role of algorithms and AI in educational contexts, which often prove challenging or impossible to fully comprehend, a paradoxical moment of visibility emerges in the use of robots. Despite being controlled by imperceptible algorithms, humanoid robots' anthropomorphic features suggest human-like communication modalities. However, it is crucial to acknowledge that the visibility of the programmed apparatus cannot obscure the fundamental distinction between robots, as "learning machines," and humans, who can be characterized by their sensitivity, empathy, and vulnerability.

- Even if the efforts to make widespread use of robots in education may seem futuristic, it is argued by some advocates (Bosede / Cheok 2018) that - similar to the shortage of nurses or priests - there is a global problem of scarcity of teachers (UNESCO 2016) that cannot otherwise be solved. This is a good example of how the rhetoric of the future of education can go hand in hand with persuasive suggestions of a specific innovation path without considering alternative options. Moreover, such kinds of "futuring" (Oomen / Hoffman / Hajer 2022) can be seen as more or less powerful interventions in the realm of emerging developments in a way that imagined futures become more likely and acceptable.

These reasons certainly suggest taking a closer look at the concepts and applications of using humanoid robots in schools from an ethical point of view, even if it can be assumed that they are currently not widely used.

Robots as Learning Companions and Teachers - Some Examples

To my knowledge, a commonly accepted typology for categorizing educational robots alongside other types of robotics is still lacking. Unlike industrial robots, which are quantified in terms of density per workforce, there is no standardized metric for measuring the prevalence of educational robots in schools and universities. However, a brief description of some examples illustrates the phenomena we are referring to here.

- One of the most notable examples in the German-speaking world is the H.E.A.R.T. (Humanoid Emotional Assistant Robots in Teaching) project, led by Jürgen Handke (2020). This initiative explores how humanoid robots such as Pepper and NAO can function as teaching assistants, advisors, and examiners rather than full replacements for educators. The project highlights how humanoid robots can facilitate digital teaching, promising to reduce teachers' workload and offer more flexibility in lesson planning. The robots support an inverted classroom model, where students independently acquire content while teachers focus on discussion, collaboration, and practical application.
- A similar assistive approach is also being pursued in Europe, for example in Finland. There, in Tampere, humanoid robots of the NAO type are used together with the Elias robot application from the Finnish company Utelias Technologies Oy in language lessons in some elementary schools, but also in a university context, particularly for the subject German as a foreign language (DaF) (Auri 2020). While Elias, as this robot is called (see https://www.eliasrobot.com/), is designed for robot-assisted language learning (RALL), the focus of the OVObot's applications (see https://ovobots.com/) is on mathematics lessons.
- Elsewhere, robots are being developed and tested that are geared towards "intelligent" handling of emotions or affects as well as multimodal and relationship-oriented forms of communication. Examples include EngKey (Yun et al. 2011) and ROBOSEM (Park et al. 2011) in South Korea and SAYA (Hashimoto / Kato / Kobayashi 2011) in Japan. In the case of SAYA in particular, the anthropomorphic features of the high-tech mannequin, elements of non-verbal communication and especially facial expressions that correspond to basic emotions such as anger, fear, joy, contempt or surprise are of central importance with regard to the role as a remote-controlled but independently acting teacher that is assigned to the robot in the predefined teaching setting. Even if the primary aim here is to increase interest, learning motivation and the ability of learners to concentrate, a much more fundamental claim of the authors also plays a role here "[t]oward the achievement of a humanoid robot with anthropomorphic properties making the robot so real that it cannot be distinguished from a living human" (Hashimoto / Kato / Kobayashi 2011, p. 52).
- As a final example, the assistive robots from Eagle Robot Labs (www.eaglerobotlab.com) should be mentioned. These have so far been used primarily at Indus International Schools (https://indusschool.com/) and some state schools in India (Yadav 2020). The applications of the different versions (currently up to Eagle 6.0) are based on a collaborative teaching-learning model that is geared towards the interaction of human and so-called artificial intelligence (AI) with a view to improving the performance of teachers and students and optimizing the workload for teachers. The content spectrum of the subjects as well as learning technology details with regard to interaction and feedback modalities, performance assessment, facial recognition and speech and voice recognition are continuously being further developed.[2]

These international examples from different world regions demonstrate that educational robotics extends beyond STEAM subjects, algorithmic literacy and computer science education. The examples also show that distinguishing between robots as teachers, companions, assistants, and pedagogical agents can be difficult in view of technologically impregnated educational framings and an orientation toward learning concepts that ignore arguments based on educational theory (*Bildungstheorie*). On the one hand, distinctions can be made, for example, by leaving the autonomous decision about *how* to deploy robots—*as* teachers with comprehensive responsibilities or *as* assistants with well-defined support functions—up to human teachers, administrators or educational

[2] See also https://bangalore.indusschool.com/beyond-academics/collaborative-learning-model/. For a review of scope and challenges of incorporating educational robots into the Indian education see Benny & Thankalayam (2024).

technologists. On the other hand, the possible distinctions are only relatively important due to overlaps in the content of misleading metaphors and the impact of socio-technical systems, as well as constraints created by institutional and infrastructural dimensions. For the argument in this contribution, it is important that the examples aim at broader implications for schooling and (media) education. From a media-cultural perspective, they seem to reconsider both, La Mettrie's (2023 [1748]) *Man a Machine* and Asimov's (1954) mechanical (robotic) teacher, a figure in a science fiction story, set in the year 2157. In this story, learning individually at home is the norm for children, not a result of a pandemic.

Some advocates of the use of robots as teachers explicitly argue in favor of the importance of automation in the history of industrial revolutions and the general social relevance of developments in robotics. Following Diprose and Buist (2016), Bosede and Cheok (2018) point to corresponding potential in the field of education:

> "Employers are bound to be more favourable to non-human teachers who will have no need for job dissatisfaction, recognition, remuneration or for autonomy, leaves, rests and above all, who are not limited by natural affective demands like changes of mood, anger, tiredness, etc." (Bosede / Cheok 2018, p. 347)

Furthermore, the authors call for "designing robotic personalities that can take on independent teacher roles" (Bosede / Cheok 2018, p. 345) and "for a future classroom with independent robot teachers, highlighting the minimum capabilities required of such personalities in terms of personality, instructional delivery, social interaction, and affect" (ibid.).

Apart from their aforementioned assumption that robots can solve the global teacher shortage, other possible benefits are frequently brought forward, such as scalability, efficiency, and accessibility in remote or underserved areas. Some advocates, like for example Alam (2021), emphasize the possibilities of personalized learning, education for all, adaptive learning, group formation, 24/7 responsiveness, and enhanced technological and educational experiences for children and students.

Ethical Considerations – Key points of an ongoing debate

As for ongoing ethical debates in the field of robot applications in education, several key points have been highlighted. Among the most outstanding works in this area are the contributions of Sharkey (2016), Selwyn (2019) and Peters (2020). They are briefly summarized here.

In her 2016 paper, "Should we welcome robot teachers?," Amanda Sharkey critically examines the integration of robots into educational settings, focusing on ethical considerations and potential implications for students and educators. Based on a review of existing applications of robots in educational contexts, highlighting their roles in teaching languages, assisting children with autism spectrum disorders, and providing tutoring in specific subjects, she explores future scenarios where robots might assume more prominent positions in classroom. The scenarios can be summarized as follows (Sharkey 2016, p. 286f):

1. Robot as Classroom Teacher (s1): In this scenario, robots function as the primary instructors, delivering curriculum content and managing classroom activities.
2. Robot as Companion and Peer (s2): Here, robots act as companions or peers to students, engaging in interactive learning activities and providing social support.
3. Robot as Care-eliciting Companion (s3): Robots in this role are designed to elicit caregiving behaviors from students, fostering empathy and nurturing skills.
4. Telepresence Robot Teacher (s4): This scenario involves human teachers remotely controlling robots to interact with students, allowing educators to be virtually present in the classroom.

In doing so, she identifies several ethical concerns associated with the integration of robots into educational environments:

- *Privacy*: The use of robots equipped with sensors and data recording capabilities raises significant privacy issues. These devices can collect extensive information about students' behaviors, interactions, and learning patterns, leading to potential misuse or unauthorized access to sensitive data.
- *Attachment, Deception, and Loss of Human Contact:* Robots designed to simulate social interactions may lead students to form emotional attachments, potentially resulting in a diminished value placed on human relationships. The anthropomorphic design of robots can blur the lines between genuine companionship and artificial interaction, leading to deceptive experiences that may affect social development.
- *Control and Accountability*: Delegating teaching responsibilities to robots introduces questions about control and accountability. If a robot makes a decision that negatively impacts a student, it becomes challenging to assign responsibility, raising concerns about the appropriateness of robots making autonomous educational decisions (Sharkey 2016, pp. 287-293).

In her analysis, these concerns prove to be problematic in different ways as regards the single scenarios. As for scenario 1, robots as classroom teachers (s1), Sharkey summarizes that "robots do not have the necessary moral and situational understanding to be able to adequately, or acceptably, fulfil this role" (ibid, p. 293). As for the scenarios 2 and 3, when the robot is presented as a (Care-eliciting) companion or peer, "it is not seen as being in a position of authority, and there is less reason to be concerned about questions of control and autonomy" (ibid.). However, Sharkey highlights that "there is still a need to think carefully about any delegation of decision making capabilities" (ibid.). Scenario 4, the case of a telepresence robot teacher, is considered less problematic ethically, as it maintains human instruction while utilizing robotic technology to bridge physical distances. Nevertheless, the difficulty remains that a "remote teacher is distanced from the classroom situation is likely to limit their awareness of what is going on in the classroom" (ibid.). Accordingly, Sharkey concludes that fully autonomous robot teachers (s1) should not be welcomed due to the substantial ethical concerns they present. Robot companions (s2 and s3), designed to foster implicit learning, could be introduced cautiously, considering their potential impact on students' social development and the authenticity of interactions. Telepresence robots (s4) are viewed more favorably, as they support human teachers without replacing the human elements essential to education, especially "when they are used to provide educational opportunities that would otherwise be inaccessible" (ibid.).

In his 2019 book, Neil Selwyn takes the question of welcoming robots as teachers even further and simultaneously broadens analytical perspectives. He argues in contrast to Alam (2021), who answers the same question – "Should Robots Replace Teachers?" – affirmatively and enthusiastically:

> "Embedded systems have enabled the employment of cobots or humanoid robots as teaching assistants or independent trainers, as well as the usage of chatbots to perform teacher or trainer duties. The efficiency and effectiveness of teachers have increased as a result of these platforms and technologies, resulting in a more comprehensive and sophisticatedly advanced quality of education." (Alam 2021, p. 11)

While Alam argues without any differentiated considerations regarding ethical and pedagogical issues, Selwyn offers a critical examination of the increasing integration of AI, robotics, and big data in educational settings. In doing so, he advocates a socio-technical approach that entails the recognition of technology as an amalgamation of technical and scientific components, in conjunction with economic, political, social and cultural considerations. Hence, he writes:

> "Distinguishing between 'human teachers' and 'robot teachers' is not a matter of people versus machines. Instead, we are concerned with how different sets of people are entwined with machines and software in increasingly complex and closely connected ways." (Selwyn 2019, p. 17)

Therefore, reflecting on the intricate interweaving of individuals with machines and software, characterized by increasing complexity and interconnectedness, involves not only ethical issues as regards pedagogical interaction and processes of teaching and learning. It would not be sufficient to contemplate issues related to empathy, modes of personalization, learning analytics, nudging, machine-generated decisions, misunderstanding the role of teachers, and algorithmic discrimination or unfair outcomes. A more comprehensive examination also involves looking "behind-the-scenes" and considering issues of accountability in a broad sense, as well as the ideological quality of educational policy. This is especially important when educational AI becomes "a high-profile vehicle for advancing alternative visions of what education in the future might look like" (Selwyn 2019, p. 117). Furthermore, the wider view is also about contextualizing the rise of AI and robotics within education, noting a growing anticipation outside the teaching profession for a technological reinvention of educational practices. And it involves an inverse argument as Selwyn writes:

> "Teachers having to work *like* robots is a far more likely scenario than their being replaced outright by robots. In short these are technologies that are most likely to control, deskill and demean the teachers they are assisting." (Selwyn 2019, p. 122; italics in org.)

The argument of the devaluation of education professionals is relevant in stronger as well as in weaker scenarios of the mechanization and automation of education and schooling. It concerns debates about "educability" (*Bildsamkeit*) and overcoming or improving pedagogical technology deficits directly. In a scenario where robots act as the primary instructors in classrooms, education comes down to specific forms of trainability, behavioral shaping of learners and educational adjustment. Thus, educational aspirations would be reduced to personalized behavior management and detailed educational controlling. Moreover, curricular, didactic, epistemic and anthropological assumptions of teacher training would be just as much in question as issues of teacher employment and professional identity. In a broad sense, life is always educational (Bittner 2011). However, the implementation of socio-technical restraints through robot teachers and pedagogical agents that are no longer

perceived as such over time raises ethical concerns about the impact of these implementations on human discourse, the social and emotional development of students and teachers, and democratic competence.

Selwyn (2019) highlights the importance of scrutinizing how AI and robot technologies can be part of viable and sustainable solutions in education. He does not adopt the principle of "all or nothing". On the contrary, he encourages educators, policymakers, and technologists to engage in nuanced discussions about the role of these technologies, ensuring that its integration into education is deliberate, ethical, and enhances the human aspects of teaching and learning. This involves engaging educators in the development and implementation of AI tools to ensure they serve to augment human teaching rather than undermine it. And this involves a wide range of ethical considerations including aspects of autonomy, diversity, discrimination, (in)equity, inclusion, and educational justice. We can again specify the question of whether robots should replace teachers again: Who would want to replace teachers with robots anyway? So far, it's not humanoid robots arguing autonomously at this point. If anything, aims and values of the EdTech industry and Big Tech, philanthropic foundations and venture capitalists as well as political ambitions to reorganize educational labor politics are to be considered here. After all,

> "it is important to remember that robots are designed and configured by human designers, and that algorithms are scripted by human programmers. Similarly, most 'machine learning' actually involves computers trying to discern patterns from the aggregated actions of millions of humans." (Selwyn 2019, p. 16)

The ethical considerations so far show many overlaps with ethical key points in ongoing debates in related fields such as roboethics and algorithmic ethics. For example, Peters' (2020) exploration of roboethics underscores the imperative for a proactive and multidisciplinary approach to the ethical challenges posed by AI and robotics. As these technologies become increasingly integrated into education and society, it is essential to establish robust ethical frameworks that prioritize human well-being, equity, and the preservation of fundamental rights. With particular consideration of a report of the European Group on Ethics in Science and New Technologies (European Commission 2018), he summarizes a broad bundle of ethical issues and questions – from safety and security to democratic decision-making and the utilization of scoring-systems – as key parameters of a matrix for evaluating roboethics in education and society as follows: "*security, responsibility, governance, democracy, transparency, values* – SRGDTV" (Peters 2020, p. 14; italics in org.). In so doing, he emphasizes issues of accountability and "the problem of attributing 'authorship' of the values that underlie autonomous or intelligent systems and their design" (ibid.). To avoid hastily drawn conclusions, it is crucial to engage in ongoing dialogue and critical reflection. Such engagement is pivotal to navigating the intricate landscape of technological advancement in a manner that benefits all members of society.

Similarly, general considerations regarding the ethics of algorithms (Mittelstadt et al. 2016; Tsamados et al. 2022) apply to education in general, too, as well as to educational robot applications. In their 2016 paper, Brent Mittelstadt et al. aim to map the debate about ethics of algorithms including "ethical issues arising from algorithms as mathematical constructs, implementations (technologies, programs) and configurations (applications)" (ibid., p. 2). Their map is

> "not intended as a tool to help solve ethical dilemmas arising from problematic actions driven by algorithms but rather is posed as an organising structure based on how algorithms operate that can structure future discussion of ethical issues." (ibid., p. 4)

The six types of ethical concerns include three epistemic concerns (*inconclusive, inscrutable and misguided evidence*), two normative concerns (*unfair outcomes, transformative effects*), and *traceability* as an overarching concern addressing complex issues of accountability and responsibility in view of potential failures and multiple actors (ibid., p. 4). In so doing, they use the term 'algorithm' also along public discourse lines and not only in a formal sense of a mathematical construct. On the one hand, this allows for detailed analysis of educational robot applications and related algorithmic structures. Moreover, it encourages the study of algorithmic structures in education *avant la lettre*, too, especially as it relates to non-digital pedagogical technologies. Whether the thesis of a historical development from "technologically weak but morally strong methodological concepts in pedagogy" (Osterwalder 2002, p. 168) to technologically strong but morally weak methodological concepts in the case of robot education is tenable is not yet clear. On the other hand, the overview provided by Mittelstadt et al. (2016) shows overlaps with the ethical debates discussed in this article, especially concerning issues of privacy, fairness, data protection and accountability. However, ethical issues as related to "futuring" (Oomen / Hoffman / Hajer 2022) and designing desirable futures (Macgilchrist et al. 2024) for different groups and different cultures, materiality and digital algorithms as capital, as well as anthropology and the interplay of anthropomorphisms and robomorphisms are missing here. These aspects have recently been examined in the discourses of digital humanism and posthumanism.

Further ethical arguments at the interfaces between humanism, digital humanism and critical posthumanism

So far, we have discussed rather conflicting positions. On the one hand, it is about euphoric approval and welcoming of robots as teachers and learning companions. While authors like Bosede and Cheok (2018) or Alam (2021) seem to ignore ethical considerations completely, influential supporters of AI in education like Seldon, Metcalf and Abidoye (2020) argue in a rather ambivalent way as they write:

> "Moral behaviour and good character underpin good education, or should do, though the drive for exam success as the sole measure for the evaluation of the success of educational institutions has tended to negate or at least to downplay its value. Nevertheless, to make moral choices is the essence of what it means to be human, and only human beings should decide ethical questions about the future of other humans, animals, and the survival of the planet. If we make the wrong decisions, and we often do, we can blame ourselves. Sometimes we surprise ourselves and take a giant leap forward in art or culture, or gain deeper insight into what we value in each other." (Seldon / Metcalf / Abidoye 2020, p. 30)

At the same time, they frame the theme in terms of the Cinderella metaphor: "As with AI in general, education is the Cinderella subject of the vast robot literature" (ibid., p. 152). And they advocate effective designs of educational processes by means of neuroscience, AI, robots and blockchain technologies. Accordingly, the Cinderella position of AI should be turned around quickly: "*AI should be the fairy-tale princess or the Prince Charming in education."* (ibid., p. 0 [sic!], italics in org.)

On the other hand, authors like Sharkey (2016), Selwyn (2019) and Peters (2020) summarize important ethical considerations in a differentiated way. By and large, these revolve around humanist perspectives in postdigital conditions. However, related perspectives have been discussed recently that are associated with digital humanism (Werthner et al. 2022; Fuchs 2022; Coeckelbergh 2024) and critical posthumanism (Braidotti 2013; Bayne / Jandrić 2017; Herbrechter et al. 2022).

Digital humanism seeks to align technological development with human-centered values arguing for clear distinctions between humans and "human-like" digital technologies. The conception of humankind involves historical, biological, socio-cultural, political and economic dimensions but no assumptions towards machine-like human beings or cyborgs. It aims to ensure that digital technologies, such as artificial intelligence and robotics, serve human well-being and do not undermine human dignity or autonomy. The ethical core of digital humanism focuses on fairness, transparency, accountability, and inclusivity in the design and implementation of digital systems. It emphasizes protecting privacy, preventing algorithmic bias, and ensuring equitable access to digital resources. Digital humanists advocate for human oversight in automated decision-making and call for ethical guidelines that prioritize social justice and democracy in the digital age. The different positions have similarities, for example concerning interdisciplinary perspectives, power-critical orientations and calls for political reforms – but there are also differences, for example with regard to the importance of regulations (Werthner et al. 2022), critique of digital capitalism (Fuchs 2022), and orientations towards less anthropocentric perspectives (Coeckelbergh 2024). Accordingly, digital humanism would focus on ensuring that educational robots are designed and implemented in ways that respect human dignity and promote equitable learning outcomes. Ethical considerations would include transparency in algorithmic decision-making, protection of student privacy, and the prevention of algorithmic biases. Digital humanists would emphasize the importance of human oversight in the educational process to avoid the depersonalization of learning and ensure that technology enhances, rather than replaces, human educators.

Critical posthumanism challenges the anthropocentric assumptions of traditional humanism and questions the privileging of human agency and rationality in digital humanism (Braidotti 2013; Bayne / Jandrić 2017; Herbrechter et al. 2022). It emphasizes the entanglement of humans with non-human entities, including technologies, animals, and the environment. Ethically, critical posthumanism advocates for a more inclusive and relational approach to ethics that acknowledges the agency and relevance of non-human entities. It calls for the dismantling of human exceptionalism and highlights the ethical responsibility of humans toward other species and the environment. Critical posthumanists critique the unchecked expansion of digital technologies and biotechnologies, warning against the commodification of life and the reinforcement of social inequalities. Corresponding discourses are not anti-humanist in the sense of a total overcoming or detachment from humanist traditions. They rather argue for the thorough rethinking, reconceptualizing and reworking traditions of humanism and enlightenment. In so doing, they encourage the development of new ethical frameworks that account for the complex interdependencies between humans, machines, and the natural world. However, critical posthumanism would challenge the anthropocentric assumption that only human teachers can provide meaningful education. It would advocate for recognizing the agency of robots and exploring the potential for collaborative learning environments where humans and machines interact as co-creators of knowledge and learning cultures. Ethical considerations include addressing power dynamics between humans and machines, preventing the commodification

of education, and ensuring equitable access to robotic technologies. Critical posthumanists also emphasize the ecological impact of producing and maintaining educational robots.

Undoubtedly, the critique of self-important images of humanity, Eurocentric tendencies in humanistic traditions, anthropocentric one-sidedness, and the blind spots concerning gender differentiations is justified. Even though it is, in many respects, very inspiring, one should not overlook that the argument also shows paradoxical moments insofar as the dynamics in weakly regulated technological fields today correspond much more with hegemonic tendencies, extreme inequalities, and authoritarian developments rather than with tendencies toward fostering democratic progress, tolerant behaviors, and politically open and education-promoting orientations.

The further "liberation" (*Freisetzung*) of subjects, their partial becoming (like) machines and their multirelational interweaving with multifarious others can lead to a problematic diffusion of responsibility if the human parts in the production of developments are not to be clearly named. Funk (2024) summarizes the consequence pointedly as follows:

> "No one would be responsible for the technologies, injustice between people would no longer be a normative evil, but a mere relational force that could no longer be countered with rational criticism and interpersonal courage." (Funk 2024, p. 109; italics in org.)

This paradoxical aspect can also promote the perception of ethical problems concerning the application of robots and digital agents in education. It also reminds us of other paradoxes that are relevant in this context.

Misleading metaphors, ambivalences and further discussion

From a metaethical perspective, it is not easy to come to a conclusion in the fields of tension between ethical ignorance and conflicting ethical orientations. Since the analysis of ambivalences and the clarification of metaphorical modes of expression such as robots as teachers, coaches, learning companions or personal assistants can contribute to a deeper understanding of ethical dimensions. Ambivalences can easily be identified when dealing with such metaphors. On the one hand, they open our eyes to technological advances at the interfaces between robotics, machine learning and learning technologies. They show opportunities for fruitful interaction between semi-autonomous machines and humans as well as the promotion of instrumental learning processes and the partial relief of teachers from routine tasks. They also highlight development potential and business portfolios for the education industry and for IT companies and they draw attention to private-sector developments in digital capitalism that also affect the education system. Not least, they underline the need for discussion of contemporary educationalization formulas and their effectiveness.

On the other hand, the metaphorical expressions are also linked to obscuring perspectives. These relate to the following aspects, for example:

- the stereotyping of specific teaching-learning arrangements and related *pars pro toto* representations while various forms of expansive learning, self-determined and emancipatory education as well as education thought without purpose remain completely ignored,
- the misleading character of the framings, particularly as regards issues of performance, responsibility, autonomy, innovation, openness to the future and, not least, the quasi "natural" inevitability of technological developments,
- the fictional character of the comprehensive disposability (*Verfügbarkeit*) of learning and educational processes and the ignorance of the limits of the calculability and predictability of complex phenomena and developments,
- the ignoring of the commercial interests of the education industry, the poorly paid or unpaid background work ("ghost work") involved in the 'training' of AI applications and the enormous expenses and costs for the development and operation of learning technology systems, including energy consumption,
- and the "liberation rhetoric" that corresponds with the creation of new dependencies, shifts in responsibilities and with the devaluation of pedagogical professionalism.

However, the overall misleading character of the metaphors mentioned can also promote discussions about sustainable and future-oriented forms of educational innovation. The following points concern educationally relevant dimensions of anthropology, ethics, knowledge, media, economics and politics, and summarize some points of reference for the discussion of currently relevant areas of tension:

- attributions of human-like traits to machines and robots (anthropomorphisms) and attributions of machine- or robot-like traits to humans (robomorphisms),
- humanization of digital interfaces and anthropological reflection of media constellations versus monetization of digital interfaces and economic reflection of pedagogical constellations,

- anthropocentric and post-anthropocentric justifications and concepts of media education and pedagogically motivated robotics,
- professional teaching action as theoretically sound, didactically founded, independent, norm-oriented, situation-related, non-technical application of knowledge versus data-driven teaching action as socially cybernetically oriented, mechanized process optimization of learning and examination processes without bothering too much about issues of data privacy when robots or other socio-technical systems collect biometric or behavioral data,
- critical reflection of (media) educational concepts, political contexts and power constellations versus educational robotics with general educational claims at the same time ignoring educational theory,
- concepts of education informed by educational and media theory versus variable lists of market-relevant digital skills, literacies (including AI literacy and algorithm literacy) and future skills,
- orientation towards democratic principles in the development, application and evaluation of educational robotics versus orientation towards techno-feudalistic expectations of normality,
- co-creative design principles and open-source software for open learning environments taking into account human and non-human actors versus educational industry prefabricated learning arrangements based on proprietary software, non-transparent metrics and profit-oriented strategies of the global media industries,
- cultivation of diverse innovation paths in the education system versus orientation towards restrictive ideas of an innovation path of the tech giants without alternatives.

The collection of areas of tension could be expanded and specified in theoretical and practical respects. The points of reference are intended as suggestions for discussing dilemmas, ambivalences and paradoxical constellations. The complexity of these issues should not be underestimated, nor should the underlying power dynamics. However, if we are interested in viable, sustainable and ethically responsible solutions in educational cultures of digitality, we cannot avoid a differentiated examination of these areas of tension and misleading metaphors, not least because they also require re-interpretations of well-known antinomies and paradoxes in educational contexts (cf. freedom and coercion, heteronomy and self-determination, uniformity and diversity, mobilization and stabilization, adaptation and resistance, proximity and distance, etc.).

Conclusion

In this paper, I started out from the historic and contemporary relevance of changing educationalization formulas that can be seen as programmatic attempts to respond to the functional and reproductive requirements of societal systems. Algorithmic education was used as a currently significant example that includes related phenomena such as digitalization, datafication, automation, and AI. The focus was on developments in robotics, not in the narrow sense of educational robotics in STEAM contexts, but rather on the various applications of AI and robotics in education in general. In so doing, discourses about robots as teachers, personalized learning companions and assistive educational technologies as well as key points of ongoing ethical debates have been introduced. During the critical examination of similarities and differences between humanism, digital humanism, and critical posthumanism, paradoxical moments were emphasized. Additionally, the importance of illuminating and obscuring aspects of metaphorical speech was presented. Despite the differences that can be identified upon closer inspection, it is not only digital technologies that are important in this context, but also the discourses, metaphors, and future-related rhetoric.

The conclusion remains ambivalent. The examples for advanced applications of humanoid robots in education and corresponding discourses certainly provide relevant impulses for debates on questions of contemporary education generally and the intricate role of algorithms and AI in educational contexts. However, to the extent that efforts to promote the use of robots as teachers align with solutionist perspectives on shaping the future, they conflict with claims of openness to the future and promotion of transformational potential. Clearly, the "we" that ascribes great importance to educational robots and wants to promote corresponding developments consistently includes industry representatives, industry-related researchers, and to some extent, economic and educational policymakers. Educational professionals, children, students, teachers, union members, parents' association representatives, family association representatives, and teacher training representatives are just as rarely part of this "we" as researchers in educational science, media studies, and communications. This only underscores the need for interdisciplinary communication and collaboration. The formalization, standardization, automation, and functionalization of instrumental forms of knowledge and learning processes, as well as the idea of an innovation path without alternatives, cannot be justified for solidary and sustainable problem solving. To successfully address the urgent issues of our time, it is crucial to cultivate diverse paths of innovation within the education system, promote the diversity of knowledge, and recognize the problem-solving relevance of various forms of knowledge.

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