
IMPACT OF AI APPLICATION ON DIGITAL EDUCATION FOCUSED ON STE(A)M

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Abstract

Digitization is omnipresent and digital transformations are thus constantly taking place in all areas of society. Of course, education is also subject to these changes. Since it is an absolute prerequisite for both the future security of society and the development of the individual, it must be innovated continuously in order to guarantee the future opportunities of future generations. To ensure that these developments can be planned and shaped systematically, there are varieties of initiatives by education stakeholders. Current studies emphasize that the further digitisation of education is a very complex and demanding process, although successful theories, concepts and models already exist.

Although the key role of the digitisation of education is taken into account, the new challenge of the interplay between human and artificial intelligence is emerging. Artificial intelligence has been researched and taught for many years, especially in the context of knowledge-based systems], but with digitisation it is gaining a completely new status and an exploding range of applications. The individual field of artificial intelligence is increasingly linked with other scientific fields in an interdisciplinary way, resulting in new methodological, technological, social and ethical challenges.

Existing target systems in research and teaching are not to be replaced completely, but should rather be questioned and further developed in a very comprehensive way. For this reason, the proven problem-solving processes are being made more dynamic and agile. They will be optimised with the methods and means of digitisation as well as artificial intelligence. Due to the omnipresence of digitization and artificial intelligence, all processes, structures and functions must also be reviewed and adapted in education.

A prerequisite for this is a renaissance of the interaction of science, technology, engineering, mathematics, and their combination with areas of humanities,

economics and social sciences. Applications of artificial intelligence are finding their way into all the above-mentioned scientific fields and promote their networking. These developments are already becoming visible in complex research and education projects, making it possible to demonstrate the sustainability of the new approaches in an exemplary manner.

However, the rapid development of digitalisation in general and of artificial intelligence in particular is generating distortions in the systems. Seeking solutions for them is also on the agenda of research and teaching. This paper contributes to this debate by applying a systemic approach to develop a new understanding of the relationships between digitalisation and artificial intelligence.

First, an overview of digitalisation in education as well as of smart systems based on human and artificial intelligence will be presented. The next section of this paper explains the theoretical basis of this research before discussing a specific example of STEAM influence on education. Finally, ethical borders of digitalisation and AI in education are highlighted.

Digitalisation in Education

Digitisation is the basis for the transformation and presentation of information and communication as well as for the more complex design of objects and services and thus for the digital transformation of complex systems of the entire society. Therefore, digitisation is not sufficient for education as a complex application. It is rather simply the basis for their digitalisation. For the users and thus also for the developers, it is much more relevant how digitalisation can generate innovations, improve processes and optimise operations. Digitalisation takes place within the framework of digital transformations.

In order to ensure the success of digital transformations, they should always be related to the processes of society, living, professional and working environments, because, on the one hand, they are initiated in this context and, on the other hand, they lead to fundamental changes in these areas. Education should therefore not only be subject to general digitization, but rather be education for digital transformations. First, this includes raising awareness of social acceptance and change. If this is given, then education for digital transformation includes new forms of teaching and learning as well as new teaching content. Digitalised teaching will therefore have a growing share in all educational processes.

Digitalised teaching and learning in a globalised world promote open education, lead to greater individualisation of education and life planning, require better coordination of all interfaces of initial and further education in lifelong learning and demand new skills in areas such as social networking, connected learning, knowledge and information literacy.

The daily interaction of the digital natives with digital information and communication media does not necessarily lead to the development of a deeper understanding of digital transformations. In addition to technical-informal skills, an understanding of, for example, new digital models, data security and protection as well as other social implications must be present in order to be sufficiently educated for digital transformations. (Gallenkämper et al., 2018)

A study of the Association of German Engineers (VDI) on engineering education for digital transformation in 2019 determined the current state of education in Germany and served to identify supportive and inhibitory framework conditions. It led to a comprehensive and constructively critical discussion in educationally oriented areas of society. Due to the change in the fields of life, learning and activity, inter- and transdisciplinary approaches, soft skills, the combination of theory and practice, and ethical aspects are becoming increasingly important. The accelerated change through digital transformations requires agile models for curriculum development. Digital transformations become a strategic goal for educational institutions. Across all groups surveyed, the willingness to undergo digital transformation was rated higher than their own ability to do so.

Students would like more interdisciplinarity in teaching content according digital subject. Largely, they are in favour of adapting their own study foci in the course of digital transformations. Teachers who are hostile to new content and formats are also seen as an obstacle to the digitalisation of education. In contrast, cooperation with partners in practice and particularly active teachers were highlighted as drivers of digitalisation in education.

Overall, several fields of action were identified that are relevant for remedying the deficits in digitalised education between the content and quality of studies and the actual and future requirements of the professional and living worlds. They are supported by concrete recommendations for activities. It is demanded that strategic goals be set, drivers and obstacles identified, target systems operationalised, ethically responsible action generated, competence profiles further developed and academic continuing education systematically expanded (Wernz et al., 2019).

Smart Systems Based on Human and Artificial Intelligence

Smartness is a characteristic that is posited positively in many ways. It expresses that intelligence exists or an appearance acts intelligently. In the face of the overwhelming flood of information, the barely controllable explosion of data, the omnipresent streams of communication and the constant influence of the media, the question arises, how smart can respond to these influences and challenges by appropriate education. Digital transformations intensify these scenarios, but they also offer the opportunity to design

education systems and processes in such a way that the new conditions are not only a burden but also an opportunity for better education and thus better living conditions.

However, smart education also means that data, information, communication and media in all social, professional and personal areas are used intelligently, in order to generate more quality of life, better career opportunities and personal happiness. (Schumann & Kauper, 2018) Smart systems are therefore at the same time intelligent systems, which can also form a framework for the symbiosis of human and artificial intelligence. Holistic recognition and understanding of complex interrelationships as an essential part of human intelligence is combined with the possibility of artificial supplements.

As soon as all areas of society, including education, is permeated by digitalisation, all facets of digitalised education will be influenced by artificial intelligence. The formation of collective intelligence requires that natural and artificial intelligence influence each other in their development without making each other obsolete. Through artificial intelligence, problems can be solved holistically and human consciousness can be expanded. (Pagel, Portmann, & Vey, 2018)

That is why; artificial intelligence is an indispensable component of the methodology and content of digitalised education and offers a wide range of methods and numerous areas of application to support human intelligence, expansion of consciousness, support of awareness and creativity (Figure 1).

Methods	Neural Networks	
	Machine Learning	
	Deep Learning	
	Cognitive Computing	
	Natural Language Processing	
Applications	"Frugal" Artificial Intelligence	Image Recognition
		Speech Recognition
		Navigation Systems
	"Complex" Artificial Intelligence	Autonomous Systems
		Self-training Systems
		?

Figure 1. Essential methods and application areas of AI

Artificial intelligence is the ability of artificial systems or objects to plan and execute tasks independently and efficiently in an analogous way to humans by means of creative and intellectual activities and by learning to adapt to new conditions. Since methods of AI are in different, partly still very early stages of development and complex systems of AI still show a rather low degree of maturity, they can of course only be part of educational content and drivers of educational methodology according to the current state of knowledge.

Problem Orientation, STE(A)M and Digitalised Education

According to activity theory (Leontjew, 1987), a human as a social being is motivated to perform activities that lead to purposeful actions based on operations. This statement is also valid for mental actions based on mental operations and is not relativized by artificial intelligence. Therefore, the activity theory has a direct relation to the action theory (Parsons, 1937) and, due to the knowledge gain associated with it, to the learning theory (Harasim, 2017). Because, however, in all goal-oriented activities that are the subject of the theories mentioned, it is assumed that people recognize, describe, discuss and, if they have the necessary knowledge, partially or completely solve problems. Therefore, problem orientation as well as the actions and operations associated with it remain the central task of human activities and the associated learning processes from the human point of view. Artificial intelligence will only promote or inhibit this sphere of human existence, since its processes are relatively independent and can at least temporarily run independently of human activities, actions and operations.

In an increasingly digitalised world, science, technology, engineering and mathematics (STEM) are particularly relevant and useful disciplines for recognising, describing and, if necessary, solving complex problems by means of complex actions and operations. They are seen as the key to structured, systematic, constructive-critical thinking and systematic understanding of the human environment and thus serve to shape meaningful approaches in school and university education. It is interesting to look at the STEM-bearing disciplines in comparison to those that are characteristic of the AI (Figure 2).

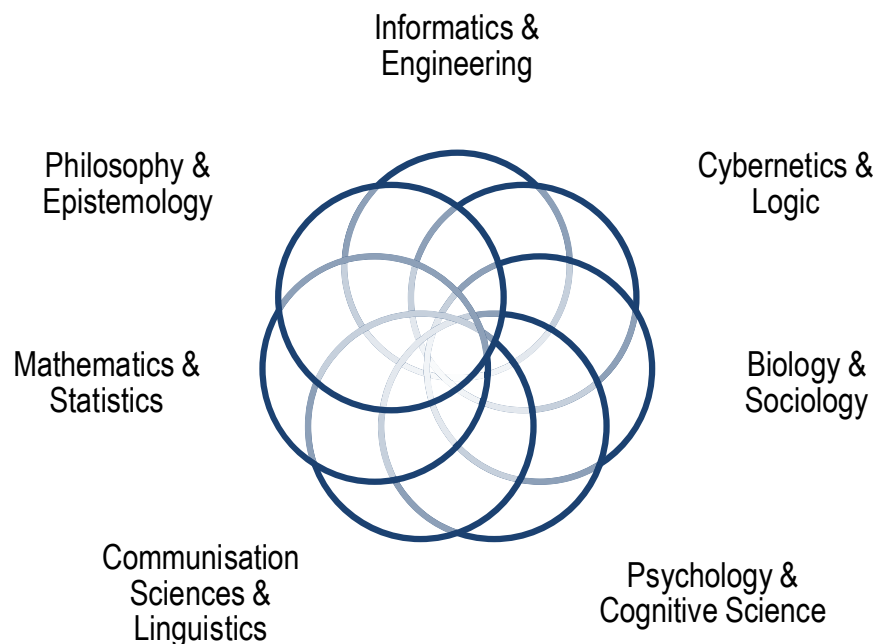


Figure 2. AI-supporting disciplines

With the increased spread and growing influence of AI, a renaissance of STEM will therefore inevitably have to occur. It will have a decisive influence on educational potentials and outcomes and thus on the development capacity of society (Figure 3).

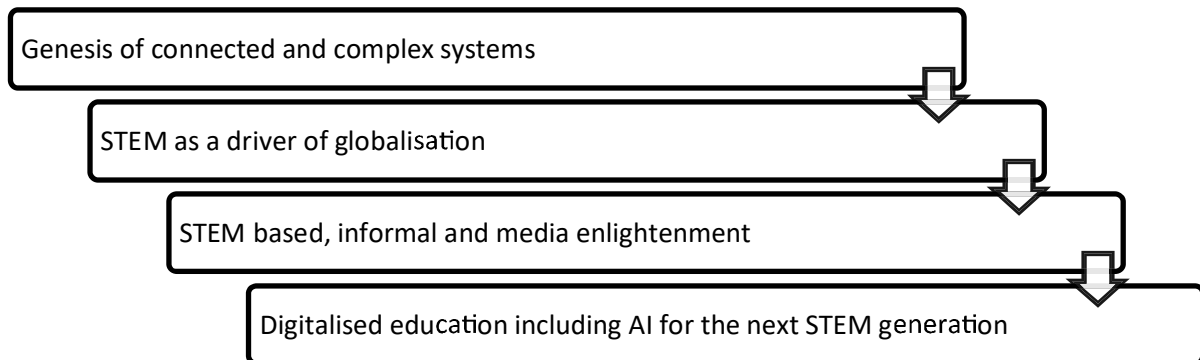


Figure 3. Educational change through globalisation, digitization and AI

Since creativity and innovative ability beyond STEM are essential for the development of individuals, it is expanded by arts to STEAM. This process is duplicated in the transition from classical computing to cognitive computing in the field of artificial intelligence, which in turn promotes STEAM.

Problem Orientation, STE(A)M and Digitalised Education

Proven educational formats should be further developed in the application and teaching of digitised education. Therefore, a complex project in an interdisciplinary field with a high degree of digitization and selective application possibilities for AI was selected to exemplify the associated challenges and opportunities. The selected project takes place within the framework of a so-called junior research group and serves the further education of young researchers and students.

The goal of the research project is the development of a digital assistance system for measuring and evaluating individual work demands. Therefore, empirical studies are conducted based on systemic developments. This project is highly suitable to demonstrate how digitization and artificial intelligence massively influence digitized education in the high technology sector, both methodically and in terms of content, and why STEAM is the basis for successful teamwork. The interdisciplinary team went through several project phases in an agile manner, which were structured in work packages as demonstrated in Table 1.

Table 1: Impact of digitalisation, AI and STEAM in work packages of a training project

Work Package	Degree of Digitalisation	Possible AI Impact	Existing STEAM Reference
Capture of work content and processes and their digitization	High	Low	High
Selection of vital data for the individual assessment of workloads	Low	Medium	High
Creation and design of the measuring systems close to the body for data acquisition	High	High	Very high
Generation of a data acquisition tool and data analysis	Very high	Very high	Very high
Development of a digital assistance and evaluation system	Very high	High	Very high
Investigation of stress curves for selected applications	High	Very high	Very high
Optimization of specific, digitally supported work content and processes	High	High	High
Evaluation and generalisation of the work results obtained	Medium	Medium	Very high

If young researchers are trained in digitalised research development and application environments by means of interdisciplinary project work, special demands on knowledge and competence development arise with regard to digitisation, AI and STEAM. Through the permanent transfer of knowledge during the joint concept development, implementation and evaluation, those involved in the project are excellently prepared for the requirements of future research and working environments in the age of digitalisation. The project contents are both a direct component of the current training of the team members and the basis for scaling the results by means of digitalised training formats. Due to the excellent results in terms of learning worlds, this form of interdisciplinary project work in digitalised worlds is considered particularly suitable for digital education and training, which is why this form of knowledge and competence development is being rolled out.

Ethical Borders of Digitalisation and AI in Education

Digital transformations and the further spread of artificial intelligence create new challenges for society in general and ethics in particular. Since ethics is related to human action, the connection to the theory of action is immediately apparent. Young people have to be educated in order to be able to recognise the new constraints and act accordingly. STEM has to be expanded to include this view of applied philosophy. Principles and fundamental values of ethics, such as the inviolability of human dignity, are preserved. They have to be supplemented by new demands of moral action, which inevitably arise

from the mass application of digital, autonomous and smart systems and artificial intelligence.

The new values will be incorporated into education, but people's fields of action and decision-making are becoming even more complex and are increasingly influenced by artificial intelligence and systems. In new approaches to ethical rules, it is proclaimed across the board that transparency and human control of machine decisions and, above all, the traceability of decision paths should be given in order to be able to act morally at all. At present, however, the dilemma, and thus the limits of ethics in education and application, is that intelligent systems sometimes make decisions without the required transparency and traceability being completely given. These ethical limits of education and action must be identified and clarified.

Thus, in order to be able to act morally, ethical considerations are needed on how to ensure transparency, influence and traceability in the interaction of natural and artificial intelligence in system control and decision-making. The solution is that, in addition to the necessary STEAM-based professional knowledge and general education, they should be a prerequisite for the use of digitization and artificial intelligence. It is precisely this idea that is being pursued in new concepts for ethical rules in order to give those acting the opportunity for moral behaviour at all. With regard to the design and handling of autonomous AI-based systems, the following specific values are of particular importance with regard to the design of the essential interfaces (man-machine, machine-machine, man-cloud, machine-cloud) in addition to the traditional values: explainability, transparency, accountability, reliability, safety, data privacy, cybersecurity, fairness. A necessary prerequisite for the fulfilment of these values is the traceability of the decision-making processes. (Hubig et al., 2020)

References

- Akerkar, R. A., & Sajja, P. S. (2010). Knowledge Based Systems. London. 1-24.
- Gallenkämper, J., et al. (2018). Smart Germany. INGENIEURAUSSBILDUNG FÜR DIE DIGITALE TRANSFORMATION. Diskussionspapier zum VDI-Qualitätsdialog. VDI-Thesen und Handlungsfelder. VDI Verein Deutscher Ingenieure e.V. Beruf und Gesellschaft. Düsseldorf.
- Harasim, L. (2017). *Learning Theory and Online Technologies* (2nd ed.). New York: Routledge.
- Hubig, C., et al. (2020). *Ethische Grundsätze des Ingenieurberufs*. Draft. Düsseldorf: Verein Deutscher Ingenieure.
- Leontjew, A. (1987). *Tätigkeit, Bewusstsein, Persönlichkeit*. Berlin.

Pagel, P., Portmann, E., & Vey, K. (2018). Cognitive Computing. Editorial. *Informatics Spectrum*, 41(1), 1-4. Springer.

Parsons, T. (1937). *The Structure of Social Action*. New York: McGraw-Hill.

Schumann, C.-A., & Kauper, J. (2018). Smart Education Prototyping for Digital Transformation and Industry 4.0. IN: Geril, Ph. The 2018 International Science Fiction Prototyping Conference SCIFI-IT '2018. Designing your future with science fiction. Proceedings. Bruges. 5-8.

Wernz, J., et al. (2019). INGENIEURAUSBILDUNG FÜR DIE DIGITALE TRANSFORMATION. VDI-Studie. Zukunft durch Veränderung. VDI Verein Deutscher Ingenieure e.V. Beruf und Gesellschaft. Düsseldorf.