

## Ideas on digitally supported individualization of teaching and learning for evolving competency requirements

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### **Abstract**

*The world is changing rapidly, mainly due to the digitalization of all areas of living. A huge amount of information is accessible via the Internet, and since it is no longer possible for individual humans to keep track of it, artificial intelligence (AI) is analyzing this data. In this rapidly changing world, students have to be educated for a successful career during their whole working life. These boundary conditions lead to completely new challenges for the education of students that are unprecedented in this form. Digitalization in education can help to cope with these challenges but can only be a means, not a goal. Personal interaction with students remains the most important task in education to address individual weaknesses and further develop strengths and talents. With the increasing amount of openly available information and the consequently increasing diversity of experiences within the group of students, differentiation is advancing to become the key to successful education. Digitization can help with this challenging task and support communication between students and their experienced instructors. But computers cannot replace human interaction and attempts to improve teaching efficiency by replacing this communication with electronic means endangers the learning success for complex concepts. This article analyzes education demands and possibilities for digitally supported teaching and learning.*

**Keywords:** *Digitalization; higher education; student competencies; differentiation.*

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## **1. Introduction and Motivation**

More and more information is being generated and is accumulating as common accessible and searchable knowledge. In all fields of professional working life, topics are becoming more and more complex. Experts are concentrated on smaller and smaller fields of knowledge. This exponential growth of information and the apparent availability of nearly all information on the Internet leads to a completely new scope of teaching and learning.

The idea and motivation for this article arose during personal discussions about the demands for teaching and learning in this fast-changing world with an exponentially increasing amount of information. This article postulates the need for a fundamental change in higher education as the consequence of the described change in information availability. The authors postulate:

**Theorem 1** *There is enough information on any subject available: A plethora of books, internet pages, online videos, scientific papers, blogs and podcasts are out there for any teaching topic – easily accessible and not too difficult to find.*

The conclusion is that the traditional role of a lecturer has no benefit for future learning:

**Corollary 1** *The benefit of lecturers in the modern learning process is not to provide additional material or repeat facts.*

The goal of this article is to think about new teaching scenarios with benefits for learners and new roles for lecturers. The next Section 2 explains how the modern information society changed the diversity of students. Section 3 describes expected shifts in graduates' competencies that are necessary for their later working life and Section 4 explains the resulting changes in study goals for students. Section 5 describes the impacts of digitalization on students' education and Section 6 shows a way toward a digitally supported individual teaching and learning. The last Section 7 gives a summary and a conclusion.

## **2. Change in Diversity of Students**

The diversity discussion is focusing on differences in talent, social background, and personal living situation. Due to the information society, the diversity discussion needs to enter a new scale: In former times a few books and school education were the main sources of information for students. There was a mainstream of competencies induced by the standardized teaching at school. Pupils received the same information, had the same learning goals and passed the same tests. Some, from today's point of view, small differences between students originating from diverse social backgrounds have been discussed (Ahmadaliev et al., 2022; Ugras, 2018). However, in the modern information society, things are changing fundamentally. The school has lost its effect of standardizing the competencies. The contribution of schools to the information supply has become less and less important, as even very young children can learn

from the internet. Every individual has consumed a different set of information, developed different competencies and built a different world model. In consequence, students are not only having social diversity, but they have developed an individually unique set of knowledge, competencies and an individual way of thinking. This is the main source of diversity and makes conventional teaching approaches less effective.

**Theorem 2** *The main source of future student diversity will result from information diversity.*

### **3. Shift of Graduates' Competencies in Working Life**

The working environment of professional life is changing rapidly. Berger and Frey (2015) write that “Jobs that are not at risk of computerization have something in common: they require an understanding of human heuristics or involve the creation of novel ideas - that is, they require social or creative skills.” and “Over the next decade, the computerization of middle-income jobs will shift to mainly substituting for low-income workers, while the demand for problem-solving, creative and social skills is likely to increase further.”

Dondi et al. (2021) write that citizens benefit from a set of fundamental skills:

- add value beyond what can be done by automated systems and intelligent machines
- operate in a digital environment
- continually adapt to new ways of working and new occupations

They state that the two major factors of proficiency with a higher likelihood of employment are “Adaptability” and “Coping with uncertainty”.

ChatGPT was asked “Which competencies are needed for future work?” with the answer:

“There are several competencies that are likely to be important for future work, including:

1. Technical skills, such as programming and data analysis.
2. Interpersonal and communication skills, such as the ability to work effectively in teams and to communicate complex information clearly.
3. Problem-solving and critical thinking skills.
4. Creativity and the ability to adapt to change.
5. Emotional intelligence, including the ability to manage stress and navigate emotional dynamics in the workplace.
6. Digital literacy, including proficiency with technology and understanding of how it is used in various industries.
7. Cultural competency, including the ability to work effectively with people from diverse backgrounds and cultures.
8. Continuous learning, the ability to learn new skills and technologies quickly and adapt to new situations.”

This answer by ChatGPT is not generated by its own research and ChatGPT doesn't understand the real meaning of this question; this answer is produced by using a huge data set implemented inside an artificial neural network. ChatGPT can't generate new knowledge, but it helps to extract and summarize existing knowledge.

**Theorem 3** *As AI programs gain more and more skills for finding, summarizing and analyzing knowledge and competencies of graduates for a successful career will change fundamentally.*

Where AI can achieve acceptable and reliable results, it will do so faster and cheaper than humans. Remaining tasks for humans will be those where AIs can't deliver sufficient quality.

## **4. Resulting Changes in Study Goals**

### ***4.1. Information Selection and Evaluation, not Information Gathering***

The amount of information is increasing exponentially and the Internet gives access to a large part of mankind's knowledge. Search machines show all available information on the internet on request and ChatGPT from OpenAI (2023) is the next level. This reverses the teaching paradigm of the past where a lecturer had to generate new content with information specifically prepared and arranged for the students. The capacity that was used to achieve this is now free for other activities in teaching that have gained importance: Focusing on topics that are essential in a digital world with overwhelming information flows.

**Theorem 4** *The job of lecturers will be to teach students how to gather valuable information, how to evaluate and connect these to find solutions. Lecturers need to assist in building up mental working models by setting up connections between gathered pieces of information for gaining competencies.*

Guiding students will consist of enabling them to find the required facts for a given challenge, evaluate the correctness of the information, and discard misinformation. From this information, a creative process of problem-solving should be started.

### ***4.2. Information Selection and Evaluation, not Information Gathering***

It is expected that most routine work of academic professionals can be done by AI. Real social interaction, self-reflected and critical thinking, and creativity can not be performed by today's AI. They are trained on a data-set and can manipulate the output according to trained rules and user interaction. But they can not reflect on their work based on a world model and so the systems are limited in their ability to create novel ideas (Boden, 1998). Mazzone and Elgammal (2019) write that "clearly, machine learning and AI cannot replicate the lived experience of a human being; therefore, AI is not able to create art in the same way that human artists do." This says that AI and humans act principally different.

Shneiderman (2020) “endorses a Human-Centered AI approach for designing and developing systems that support human self-efficacy, encourage creativity, clarify responsibility, and facilitate social participation.” Real social interactions, critical thinking, and creativity as well as responsibility are not possible with current AI approaches. But AI programs can help humans to do a better job when human-AI cooperation is done in an appropriate way.

**Theorem 5** *Social interaction, critical thinking, and true creativity will be future key competencies and gain in importance. These will be complemented by the competencies to work in the digital domain and to interact with AI computer programs.*

Humans will be needed in these important areas and consequently there will be an increased need to develop the competencies required to perform such tasks during their education.

## 5. Impacts of Digitalization on Education

### 5.1. Increase of Efficiency

Routine jobs in teaching can be performed well by AI and thus the efficiency of knowledge transfer can be increased. Barbosa et al. (2022) predict in the future working trends for 2050 that it will be possible to train a large number of students using MOOCs. These teaching programs that mainly focus on knowledge can be automated. Examples are trainings for jobs where special knowledge is important and learners have acquired the competencies for self-organized learning as well as the domain-specific thinking models before. Asimov (1957) described in his science fiction novel “Profession” that knowledge is easy to transfer to humans but to learn how to gain competencies is a long and individual process.

**Theorem 6** *Many approaches introducing digital elements into teaching and learning focus on increasing ‘efficiency’, i.e. educating more students with the same amount of resources and in consequence reducing the direct contact between lecturers and students. This can be only done when teaching knowledge, not competencies.*

### 5.2. Shift of Focus in Education

As the transfer of knowledge will become an increasingly self-driven, and media and tool-supported process, there will be a shift of focus for the human-driven teaching towards skills and competencies like critical and creative thinking as well as social interaction. This part of teaching can not be handed over to AI and builds up indispensable competencies to further develop the state of the art of any discipline. One important factor driving human activity is to ‘do things in the right way’. The definition of ‘right’ however, is based on a complex rule set based on the observation of nature and social interaction.

**Theorem 7** *The teaching of knowledge can probably be automated by AI, but the teaching of skills and the development of personality i.e. individual thinking models require interaction with the complex world models of experienced humans to be efficient.*

Claxton (2023): “As for ChatGPT, we quickly learned that its greatest skill is lying.” Maybe lying is not the correct wording, as there is no real understanding of the content by the AI model but it selects and synthesizes information from the internet according to algorithms. The AI has no idea if any information is true or not, not speaking of seriously complex concepts. There is also no conscience of the AI; ethical limits are implemented by algorithms and result in mere censorship but there is no understanding of ethics itself. AI systems are largely unable to foresee the consequences of their actions, which leads to overoptimism and as many reports show, blunt lying in case of a lack of information. With this, the AIs will probably increase the amount of misleading information being available on the Internet and thus increasing the risk of misleading other AIs.

**Theorem 8** *The teaching of the future will mainly promote social interaction, critical and creative thinking, reflection about their own work and prediction of consequences.*

### **5.3. Personalization of Learning**

With AI software that helps lecturers with routine work for a high number of students, there will be more time for the personalization of teaching and learning. Barbosa et al. (2022) predict in the future working trends for 2050 that learning will be more personalized with tailored learning plans. This new freedom should be used by lecturers to shape a new era of learning. Lecturers and students can be assisted by AI software, other media, or can do teaching and learning using pure human interaction. The prerequisite for this new era of teaching is a new set of competencies and a new mindset for lecturers and students. The future of competency-oriented learning will require redefining the role of lecturers:

**Theorem 9** *The work where lecturers can't be replaced by AI is the ability to identify individual ways of thinking and to provide specifically adapted guidance towards more competency. This can be done with the assistance of AI software.*

This implies that experienced lecturers must get into an intense academic discussion with the learning individuals to be able to observe their specific thinking models and draw the right conclusions, how to support them:

**Corollary 2** *The job of lecturers will be to guide students to compensate for existing deficits, develop individual strengths, and their personality.*

This makes it clear that while increasing the efficiency of teaching by possibilities of digitalization is very useful, it is extremely important to take care not to reduce the contact between students and lecturers. This would endanger the effectiveness of the unique

competency of human instructors to individually guide students and thus reduce the effect of the teaching work: The construction of a physical and ethical world model to validate the own activities happens in observation of the physical reality and direct social interactions. Also, the systems are largely unable to foresee the consequences of their actions, which leads to over-optimism and as many reports show, blunt lying in case of a lack of information. This will increase the need for humans to be able to verify the validity of the information.

**Corollary 3** *To be didactically useful, digital elements need to be integrated in such a way as to increase and intensify the intellectual contact between lecturers and students.*

Tools that lecturers can use to improve their impact on the learning process are very valuable.

**Corollary 4** *Digitalization in education is an important supporting tool for an effective educational approach but it is not a goal of teaching to integrate as many digital elements as possible.*

The introduction of digital elements might lead to a distraction from the actual teaching goals, or to an increased separation of lecturers and students playing with computers instead of interacting in discussions. Careful didactic design of a learning environment fitting to the intended learning outcomes will therefore become an even more challenging task.

**Theorem 10** *Digitalization should never be the main goal of teaching, but a supporting tool to achieve maximal competencies of students.*

## **6. Digitally Supported Individualization of Teaching and Learning**

Digitalization will give a valuable contribution to education. It releases from routine work and gives more time and freedom for individual coaching of students. Higher education has already undergone an evolution during the last decades as many teaching techniques have been developed and applied that allow for more individualized instruction like project-based learning, or activating concepts as inverted classroom schemes. AI will lead to the next big step in teaching and learning. With the integration of AI software into the learning process, both the efficiency and effectiveness of teaching and learning can be drastically improved. This evolution has to be developed further and their application has to be extended to achieve the goal to intensify the contact of thinking models of lecturers and students to support young people in developing their world models. The authors think that:

1. Gathering knowledge using digital tools with the aid of AI computer programs. This can be highly automated without the individual support of an instructor.
2. Developing students' competencies is an individual process under the guidance of an instructor. This process can't be automated by using digital means.

## 7. Summary and Conclusion

The authors see fundamental changes in the way how students will learn in the future as required learning outcomes and available methodologies are changing completely. Digitalization will force a change in the mindset of lecturers and learners for education to remain effective. Competencies in working life that have been essential in the past will be obsolete. Many tasks will be performed much better and cheaper by AI in the future. Other competencies that correspond to the nature of human beings will become increasingly important. Consequently, successful education will need to undergo fundamental changes. Education of human nature will be much more important than it was in the past. Integration of human interaction and AI computer programs into courses will be a key development for future learning programs to increase the efficiency and effectiveness of teaching and learning.

## References

- Ahmadaliev, D., Metwally, A., Yousef, A. M. F., & Shuxratov, D. (2022). The Effects of Educational Robotics on STEM Students' Engagement and Reflective Thinking, 1–7.
- Asimov, I. (1957). Profession. *Astounding Science Fiction*, 59(3), 8–55.
- Barbosa, C. E., de Lima, Y. O., Costa, L. F. C., dos Santos, H. S., Lyra, A., Argôlo, M., da Silva, J. A., & de Souza, J. M. (2022). Future of work in 2050: Thinking beyond the COVID-19 pandemic. *European Journal of Futures Research*, 10(1), 1–19.
- Berger, T., & Frey, B. (2015). Bridging the skills gap. In T. Dolphin (Ed.), *Technology, globalisation and the future of work in Europe: Essays on employment in a digitised economy* (pp. 75–79). Institute for Public Policy Research.
- Boden, M. A. (1998). Creativity and artificial intelligence [Artificial Intelligence 40 years later]. *Artificial Intelligence*, 103(1), 347–356.
- Claxton, M. (2023). *PAINFUL TRUTH: AIs and the age of digital lying*. Retrieved January 22, 2023, from <https://www.langleyadvancetimes.com/columns/painful-truth-aisand-the-age-of-digital-lying/>
- Dondi, M., Klier, J., Panier, F., & Schubert, J. (2021). Defining the skills citizens will need in the future world of work. *McKinsey*. Available at: *defining-the-skills-citizens-will-need-in-the-future-world-of-work.pdf* (*mckinsey.com*) (Accessed: 30 June 2021).
- Mazzone, M., & Elgammal, A. (2019). Art, creativity, and the potential of artificial intelligence. *Arts*, 8(1), 26.
- OpenAI. (2023). *ChatGPT*. Retrieved January 17, 2023, from <https://chat.openai.com/chat>.
- Shneiderman, B. (2020). Human-centered artificial intelligence: Three fresh ideas. *AIS Transactions on Human-Computer Interaction*, 12(3), 109–124.
- Ugras, M. (2018). The Effects of STEM Activities on STEM Attitudes, Scientific Creativity and Motivation Beliefs of the Students and Their Views on STEM Education. *International Online Journal of Educational Sciences*, 10, 165–182.