Petko Maznev[1], Cathleen M. Stützer[2] & Stephanie Gaaw[3] (Dresden)

AI in higher education: Booster or stumbling block for developing digital competence?

Abstract

Since the Artificial intelligence (AI) revolution catalyzed by ChatGPT, the discourse of students' digital competence has become prevalent in German higher education institutions (HEIs). While educators recognize the potential for using AI in higher education, concerns persist about students needing more necessary skills. This paper presents findings from a comprehensive lecturer survey that provides insights into educators' perspectives on the opportunities and challenges associated with AI integration in HEIs. Furthermore, it addresses the conditions required for successful AI implementation in German HEIs to promote, rather than hinder, students' digital competence and future skills.

Keywords

digital competence, future skills, digital literacy, Artificial Intelligence, requirement analysis

1 Corresponding author; TU Dresden; petko.maznev@tu-dresden.de; ORCiD 0009-0005-8762-2922
2 TU Dresden; cathleen.stuetzer@tu-dresden.de; ORCiD 0000-0003-4431-5752
3 TU Dresden; stephanie.gaaw@tu-dresden.de

https://doi.org/10.21240/zfhe/19-01/06

KI in der Hochschulbildung: Booster oder Stolperstein für die Entwicklung digitaler Kompetenz?

Zusammenfassung

Seit der durch ChatGPT katalysierten künstlichen Intelligenz (KI)-Revolution ist der Diskurs über die digitale Kompetenz der Studierenden an deutschen Hochschulen hochaktuell. Während Lehrende das Potenzial für den Einsatz von KI in der Hochschulbildung erkennen, bestehen nach wie vor Bedenken, dass Studierende weitere Fähigkeiten für die Nutzung von KI benötigen. Dieser Beitrag präsentiert Ergebnisse einer umfangreichen Lehrendenbefragung, die Einblicke in die Perspektiven der Lehrenden auf die Chancen und Herausforderungen des Einsatzes von KI an Hochschulen bieten. Darüber hinaus werden mit Blick auf das Ziel, die Entwicklung digitaler Kompetenz und sogenannter „future skills“ von Studierenden zu fördern statt zu behindern, die Voraussetzungen für eine erfolgreiche Implementierung von KI im deutschen Hochschulkontext thematisiert.

Schlüsselwörter

digitale Kompetenz, Future Skills, Digital Literacy, Künstliche Intelligenz, Bedarfsanalyse

1 Introduction

Since the Corona outbreak as a global pandemic led higher education institutions (HEIs) to teach remotely and develop new digital practices due to the challenges of shut-down campuses and lack of face-to-face interaction as part of on-site teaching (Carmean et al., 2023), the issue of digital competencies has increasingly been at the center of educational policy debates. Although it was initially unclear whether, after the pandemic, HEIs would continue their digital transformation and further develop digital education strategies or instead return to old-fashioned ways of teaching (ibid.), with the recent Chat-GPT-induced artificial intelligence (AI) revolution, there is now a renewed need for HEIs to catch up with emerging technologies and their potential use in teaching and learning (Pelletier et al., 2022). Therefore, questions about what skills are needed to use AI in teaching and learning and how technologies such as intelligent chatbots contribute to students' digital literacy or a decline in digital and other skills are becoming increasingly important topics in the higher education discourse. For example, current discussions suggest that AI would pose challenges for educators and HEIs, such as issues associated with the potential use of AI to cheat or students losing essential skills due to delegating their work to AI (Pelletier et al., 2023). In addition, further questions arise to what extent lecturers must be prepared for the AI transition in teaching and learning at HEIs.

Getting insights into students' and lecturers' attitudes and opinions on the use of AI in HEIs is essential for understanding under which circumstances AI can be beneficial or hindering the further development of digital competence. Within different applied research projects funded by the Federal Ministry of Education and Research, the key role of lecturers and students as key stakeholders in HEIs was taken into account by conducting several studies on the use of AI and the lecturers' and students' perspectives on it.

Our recent studies indicate that both students' and lecturers' views on the use of AI are – among other things – strongly influenced by considerations of how AI can be used to support students' learning processes, and particularly the development of digital skills, as well as by concerns about students' ability to use AI correctly.

Hence, in this paper, we want to present insights into these new questions gained from our surveys. The presented results are preliminary and focused on our most recent lecturers' survey. Answering the following research question is central:

What do HEIs and lecturers need to consider when using AI in higher education to ensure that AI enhances rather than inhibits the development of digital competencies?

2 Background

Digital competence is considered to be one of the most important future skills. In 2006, the European Commission (EC) defined it as one of the eight competencies for ensuring lifelong learning, personal development, sustainable and healthy living, active citizenry, and social inclusion. Based on the scientific literature, the concept of digital competence cannot be considered a standalone but rather a multifaceted one that intersects with various other competencies (Vuorikari et al., 2022).

In 2011, Ala-Mutka noted that digital competence intersects with literacy (digital, information, and media) (2011, pp. 29–30). Other authors further elaborate that it overlaps with social, personal, and learning competencies (Vuorikari et al., 2022, p. 6). In addition, the ability to think critically and flexibly about a subject and data and creatively about problem solutions plays a significant role in facilitating digital competence (Hartmann & Hundertpfund, 2015; Sala et al., 2020). Digital competence can also be differentiated into various skills promoting specific kinds of thinking, which can be included in its broader definition. For example, in the Swedish curricula, programming in terms of computational thinking is strongly related to digital competence (cp. Heintz et al., 2015). Furthermore, participants in the digital world it is required to know how to articulate their information needs, locate, evaluate, synthesize, and communicate information, which in literature is referred to as skills of online inquiry (Kiili et al., 2021) and is considered to be a part of a new literacy debate (Kiili et al., 2021; Leu et al., 2015).

Understanding what digital competence means evolves with the development of new technologies (Retelj, 2022). According to EC, the first adopted official definition implies that digital competence refers to the confident and critical use of Information Society Technology (IST) in the context of work, leisure, and communication (cp. European Cimmission, 2006, pp. 15–16). In its later iteration, the definition was expanded to include new aspects of the current reality. It adds a responsibility aspect to the use of digital technologies. It considers different facets of digital competence, such as information and data literacy, media literacy, digital content creation (inc. programming), safety, communication, intellectual property-related questions, problem-solving, and critical thinking (European Commission, 2018, p. 9).

To further develop the definition of digital competence from the EC, Vuorikari et al. (2022) identify five key areas of digital competence such as information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving, and ascribe 21 specific competencies relating to these five key areas (cp. Vuorikari et al., 2022). However, how does digital competence evolve in the context of emerging technologies such as generative AI in HEIs?

In recent years, the terms digital competence and digital literacy have been widely used in relation to the enabling of expression, communication, and access to knowledge in a variety of fields, such as literacy in the digital space, computational literacy, literacy in the scientific field or data literacy (Long & Magerko, 2020).

Given these considerations for possible further definitions, such as AI literacy, it remains to be seen whether digital literacy is also a prerequisite for understanding AI, as individuals need to understand how to use digital tools to make sense of AI.

3 Methodology

The objective of the presented survey is to explore the benefits and challenges of the use of AI as well as the requirements for successful AI implementation in HEIs. The data analysis focuses on answering what we need to consider when using AI in HEIs to ensure that AI helps rather than hinders digital competence development.

For this purpose, a comprehensive lecturer survey was conducted at TU Dresden. The aim was to identify potential developments on the didactical, technological, and organizational levels.

Within the recent societal and scientific research discourse, the use of generative AI models in combination with chatbots, such as ChatGPT, stands out. Our survey focused on this particular use of AI so a broader public can comprehend it. Furthermore, generative AI is a key component of the AI-based mentoring tool developed in our project – "tech4compKI".

3.1 Research Question

Our research seeks to explore and answer the following research question (RQ): What do HEIs and lecturers need to consider when using AI in higher education to ensure that AI enhances rather than inhibits the development of digital competencies?

We approach the analysis from a lecturer's perspective. To contribute to the RQ, we focused on the following subquestions:

- RQ1. According to the key stakeholder group, what are the benefits and challenges of using AI in German higher education?
- RQ2. What are the general requirements from the lecturers' perspective for a sustainable implementation of AI in German higher education?

3.2 Data Collection

Data were collected by using an online survey methodology. The survey explores perceptions and attitudes, focusing on lecturers related to study and teaching. Previous studies have shown that lecturers were identified as the most important stakeholders in the learning process. We want to highlight the lecturer's attitudes and (virtual) behavior as key performance indicators for the successful implementation of AI in HEIs. We integrated an adapted semi-standardized questionnaire into an annual university lecturer survey conducted at TU Dresden to access the data. Out of 5.456 addressed employees at the university, 667 individuals responded to the complete lecturer survey. The response rate was approximately 12.2 %. Out of 667 responders, a total of 664 indicated their involvement in teaching and were presented with the adapted questionnaire section designed to measure the attitude and perception regarding the potential use of AI in teaching and learning. We base our further analysis on their data.

The questionnaire used for data collection was initially introduced and tested in the field in 2021 (Stützer, 2022) to measure AI acceptance. An adapted version for this lecturer survey consisted of eleven questions, seven standardized and four open-ended. We used a question inventory with Likert scales to measure multiple aspects for some standardized questions.

3.3 Data Analysis

Quantitative and qualitative data analysis was conducted to answer our research questions. Closed and open-ended questions about the attitude and perception, the usage and use scenarios of AI, e. g., in the form of chatbots, in studies and teaching were analyzed. These questions are presented in Chapter 4. For categorizing open-ended questions, a text-driven quantitative content analysis was used (Krippendorf, 2019; Züll, 2016). As previous research points out, it is an established type of analysis to use if existing research is limited (Vears & Gillam, 2022). In our method, we utilized an inductive process that involved iterative coding. By inductive process, we

refer to the development of labels used to categorize the data during the coding process, which is determined based on the actual content of the dataset (Krippendorf, 2019). After the initial coding process, we categorized the results.

4. Results

4.1 General insights

This section presents some of the most notable and insightful results from our descriptive analysis of the implemented items. Asked about how lecturers perceive AI, a large majority (41 %) of the lecturers (n=664) see the use of chatbots in university teaching (rather) as an opportunity. In comparison, 15 % of the respondents see AI in university teaching (rather) as a risk. At the same time, around 44 % of the lecturers claim that they cannot yet judge this. However, if asked about their usage of AI, only about 18 % of the teachers had already used chatbots in their courses at the time of the survey. The findings indicate that the integration of AI in German universities and practical contexts within higher education has remained relatively the same, defying initial expectations due to the ChatGPT bubble burst.

Of those lecturers who have already used AI, e. g., in the form of chatbots, in their teaching sessions, the vast majority (86 %) state that they will continue to use them. However, of the respondents who have not yet used a chatbot in teaching, around 57 % of the teachers already state that they can imagine doing so in the future. Around 43 % of the lecturers surveyed currently rule out the use of AI in university teaching. Reasons for this cannot be derived from the present survey.

4.1.1 Perceived benefits/potential use cases for AI in HEIs

In addition, we formulated items presenting potential uses of AI for students, and we asked the lecturers to assess them. Teachers who already use chatbots in their courses (n=90) see potential in the fact that chatbots (1) can help students to acquire digital skills (55.6 %), (2) can make it easier to find information, teaching materials, etc.

(52.2 %), (3) can help students to achieve their individual learning goals more quickly (47.8 %), and (4) can effectively support students in preparing for exams (44.4 %). The lecturers were also asked about what opportunities arise for them as lecturers when using AI, e. g., chatbots, among other things, (1) simplifying the provision of self-study materials (e. g., texts, scripts, links) (33.3 %), (2) making it easier to prepare and do teaching (33.3 %), (3) responding to individual questions about the learning material (30.0 %), and (4) reducing the time and effort required for mentoring or support (23.3 %).

4.1.2 Perceived challenges and risks for the use of AI in HEIs

Lecturers who already use chatbots in their courses (n=90) were asked to assess items corresponding to the challenges and risks of AI for students and lecturers. They consider (1) spreading misinformation to students (78.9 %) the most significant risk. In addition, they also mentioned that (2) interpersonal contacts in teaching will suffer as a result of the use of AI (28.9 %), and (3) support and mentoring students will become more impersonal with the use of AI (36.7 %). For themselves as teachers, they perceive the most significant challenges to be (1) the use of AI may lead to more plagiarism attempts (66.7 %), (2) the arising of uncertainties in being able to control the use of AI in university teaching (53.3 %), and (3) the developing and evaluating exams under the possible use of AI (46.7 %). Asked to assess AI's ethical and legal aspects, only about a quarter of lecturers (about 23.3 %) say that students are treated fairly and equally when interacting with AI (e. g., avoiding algorithmic bias, gender neutrality, etc.). About 14 % of respondents say they have no concerns about compliance with data ethics and legal standards when using AI.

4.2 Benefits and challenges for the development of digital competence

Implementing AI in HEIs can benefit students by bolstering the acquisition of general competencies, mainly digital competence. Nevertheless, students can face challenges in using AI, and if these challenges are not addressed, they can hinder the development of those competencies.

Our text-based quantitative content analysis found that around 92 % of the 144 open answers mentioned the **benefits** of implementing an AI-based mentoring tool directly corresponding to the acquisition of broader competencies. Around 42 % of the mentions are directly related to digital competence. An overwhelming number of these mentions relate to lecturers seeing potential benefits for students (digital) competence development.

For example, one of the major potential benefits of AI in higher education for students lies in (1) supporting and fostering students' writing skills and competence. Specifically, 17.4 % of the given mentions indicate the possibility that an AI could help students summarize information, translate texts, or write and revise texts efficiently. (2) Due to the capabilities of generative AI, students have easy and quick access to factual, conceptual, and procedural knowledge (16.7 %), which could help students learn more efficiently and promote the competency of learning to learn. Lecturers see another essential benefit of AI in (3) encouraging and supporting students' self-regulated learning (11.1 %) in delivering learning material to students, generating trial questions for exams, and acting as a personal tutor.

Furthermore, one of the first crucial digital competence-related benefits students can have from the implementation of AI in HEIs is the general development of AI literacy. According to the material, lecturers are optimistic that such a tool would foster better use of AI and promote general digital competence. Specifically, such a tool would support students in understanding and meaningfully using AI technologies and reflecting on their results. Another potential benefit for the development of digital competence is seen in core student competence, such as the skill to search for relevant (scientific) information on a specific topic, especially the acquisition of

online research skills and effective research (e.g., literature searches, literature reviews) supported by AI.

Another way in which generative AI could enhance students' competencies relates to their general thinking skills. In terms of assessing and using generated information, lecturers indicate that exposing students to AI would promote and support the development of critical and analytical thinking, help students generate ideas, and, therefore, assist students in solving problems creatively.

When asked about **potential risks and challenges** for students using AI in HEIs, 74 lecturers mentioned 99 different aspects. The statements mostly pertained to risks associated with the student's current competencies and those that could be lost.

For example, one-third of the responses (33.3 %) indicated that lecturers saw a risk in students using AI unreflectively and without critical questioning, leading to a high level of misinformation or misinterpretation. Additionally, 23.2 % of the responses stated that students lose or fail to develop general (digital) competencies (independent thinking/working, independent research, scientific thinking/writing/working, creative thinking & problem-solving) and expertise through the use of or dependence on AI.

In addition, a notable number of responses identified risks not directly related to student competencies. These included a possible increase in plagiarism and attempted cheating, a reduction in social interactions, a negative impact of AI on motivational aspects of student learning, and potential privacy and equity issues.

However, it should be noted that lecturers see risks and challenges for students when using AI, primarily regarding their competency development. Few cases indicate that this might be compromised to the point where students are no longer employable.

4.3 General requirements for a sustainable implementation of AI

Lecturers were asked to openly state the prerequisites necessary to sustainably implement AI (e. g., in the form of a chatbot) in HEI. More than a third of the responses (n=235) provide insights into the requirements for the implementation at an organizational level. These include an appropriate legal framework, establishing standards and best practices in dealing with AI, and the necessity of adapting the study and examination regulations, including forms, as essential requirements. Additionally, it becomes clear that financial, human, and time resources are particularly needed to increase the willingness to use AI in the teaching-learning context.

Approximately one-third of the mentions relate to technological requirements for a sustainable implementation of AI. The main topics addressed were the comprehensiveness and transparency of AI, data security and data protection, ethical aspects in connection with its use, and fundamental technical infrastructure.

Additionally, 31 % of the responses address the individual needs associated with successful AI implementation in HEIs. The vast majority of these (about 85 %) focus on the need to acquire and advance new digital competencies. Furthermore, prerequisites such as fundamental acceptance and openness to new technologies, as well as personal efforts and benefits, are discussed. Lecturers also emphasize the demand for further training (about 37 %) on how to use AI, its potential, and possible application areas or teaching use cases. Moreover, about one in five lecturers indicate that they expect a certain level of expertise and experience in dealing with AI before being willing to incorporate it into the teaching-learning context. In this regard, some lecturers specify that this includes, among other things, a basic understanding of the technology and the ability to use AI responsibly. While they relate the latter primarily to students' experiences and competencies, they also relate the former to themselves.

5 Recommendations for fostering students' digital competence

By elaborating on the results presented in this paper, we aimed to answer the research questions formulated at the beginning. A final summary of the key findings for each of these questions will be used to answer the overarching research question:

What do HEIs and lecturers need to consider when using AI in higher education to ensure that AI enhances rather than inhibits the development of digital competencies?

As evident from the discussion above on the perspective of lecturers regarding the potential benefits of using AI in HEIs, they primarily see this in the fact that students can learn more or less new facets or variations of existing competencies. Among other things, the necessity of skills in (efficient) information research, increasingly creative and critical thinking, and the discovery of new solutions were emphasized. Furthermore, it is interesting to note that lecturers, alongside the dangers of potential unreflective use of AI by students, also identify the possible loss of competencies as one of the main risks regarding the use of AI in HEIs.

While lecturers' responses regarding the possible opportunities and challenges associated with using AI revealed a strongly competence-oriented perspective, when asked about the necessary prerequisites for a successful implementation of AI in German HEIs, there was a predominant focus on organizational and technological conditions. The results show, among other things, that lecturers, at the current stage, still see a strong responsibility on the part of universities to establish the basic conditions for the successful use of AI in teaching. On an individual level, however, educators also indicated that they recognize the need for self-improvement in necessary professionalization through appropriate further training in AI technologies and the utilization of training opportunities.

In light of these central findings, the following general principles for the meaningful use of AI to improve students' digital competencies can be derived:

1. For the successful implementation of AI in **HEI**s, there is a fundamental need for broader acceptance and willingness to incorporate and use new technologies in the teaching-learning context. Besides considerations regarding the legal framework, such as adjustments in study and examination regulations and the establishment of standards, it is evident that financial, human, and time resources are particularly required to support an "intelligent" transformation of university infrastructures. A similar point was presented by recent studies (Aler Tubella et al., 2024).
2. Considering the lecturers' expressed needs for further education offers and their concern about students' unreflected use of AI in higher education, **universities** must address how to introduce educators to concepts for pedagogically meaningful integration of AI in teaching and learning. Suitable further education programs need to be provided both for lecturers who lack any technical understanding of the use of AI and those who have already experimented with it but need more clarification about its didactical framework. For inexperienced lecturers, this could mean an overview of available tools and an introduction to their technical functionalities. For somewhat experienced educators, the development of formats for exchange, sharing of best practices, and guidelines for possible didactical use cases should be considered. This recommendation adds more depth to points made by recent studies (cp. Okulich-Kazarin et al., 2024; Pelletier et al., 2023, p. 44).
3. These measures also enable **lecturers**, based on their expertise, to contribute to developing new didactical concepts, including targeted offerings for developing students' digital competencies through AI. Furthermore, this could involve promoting specific competencies relevant to dealing with AI (AI literacy; see Chiu, 2024; Song, 2024). The latter is particularly significant considering lecturers' indications that students might require an entirely new level of critical reflection abilities, research skills, and ways of thinking. When viewed more broadly, given the continuous emergence of new technologies, students also need a certain level of general adaptability (learning to learn). For example, dealing with

text-generating AI might require learning the ability to formulate precise instructions, whereas newer AI technologies could demand entirely different competencies.

4. As indicated in Point 1, **universities** will need to be significantly more agile in terms of curriculum development in order to meet the ongoing technological dynamics and, hence, teach new competencies. This is a prerequisite for educators to develop new teaching offerings, methods, and examination formats. This point reflects and expands on earlier findings and more recent studies (Stützer, 2022; Aler Tubella et al., 2024; Song, 2024).
5. Considering the findings that students may need to be responsible and critically reflective users of AI, **lecturers** must develop appropriate use cases for integrating AI into the student learning process (see also Park et al., 2023). Tailored exercises where students specifically learn to evaluate AI-generated content are necessary to promote increased critical engagement by students with the output of AI. Simultaneously, **lecturers** and **students** need to foster a fundamental competence in evaluation regarding the differentiation between human and AI outputs.
6. Finally, to prevent the feared loss of competencies among students, **universities** in general and **lecturers** in particular should thoroughly reflect on when the use of AI in HEIs is meaningful or should be allowed. To achieve this, corresponding regulations (e. g., prohibiting the use of AI in introductory courses) and standards from universities (see also Okulich-Kazarin et al., 2024) are required. On the other hand, lecturers must consider the didactical implications at the level of their teaching offers.

By taking such actions, an increasing professionalization of lecturers' use of AI in higher education can be achieved. The sustainable implementation of AI in higher education, as shown above, mainly depends on the agility of the socio-technical infrastructures of the universities to ultimately use the opportunities offered by the technological capabilities of AI and to provide students with a future-oriented education. Since our results and recommendations are solely based on a lecturer's survey, we are currently also analyzing the data from our student survey. Furthermore,

we assume and have already shown that the implications of this paper will be confirmed by further studies and, therefore, apply to the higher education context.

6 References

Ala-Mutka, K. (2011). *Mapping Digital Competence: Towards a Conceptual Understanding.* https://doi.org/10.13140/RG.2.2.18046.00322

Aler Tubella, A., Mora-Cantallops, M., & Nieves, J. C. (2024). How to teach responsible AI in Higher Education: challenges and opportunities. *Ethics and Information Technology, 26*(1). https://doi.org/10.1007/s10676-023-09733-7

Carmean, C., Kil, D., & Baer, L. (2023). *Why Data Matters for Student Success in a Post-Pandemic World*. https://er.educause.edu/articles/2021/8/why-data-matters-for-student-success-in-a-post-pandemic-world

Chiu, T. K. (2024). Future research recommendations for transforming higher education with generative AI. *Computers and Education: Artificial Intelligence, 6*, 100197. https://doi.org/10.1016/j.caeai.2023.100197

European Commission (2006). *Recommendation of the European Parliament and of the Council of 18 December 2006 on key competencies for lifelong learning*.

European Commission (2018). *Council Recommendation of 22 May 2018 on key competences for lifelong learning*.

Hartmann, W., & Hundertpfund, A. (2015). *Digitale Kompetenz: Was die Schule dazu beitragen kann* (1. Auflage). hep der Bildungsverlag.

Heintz, F., Mannila, L., Nygårds, K., Parnes, P., & Regnell, B. (2015). Computing at School in Sweden – Experiences from Introducing Computer Science within Existing Subjects. In A. Brodnik & J. Vahrenhold (Eds.), *Lecture Notes in Computer Science. Informatics in Schools. Curricula, Competences, and Competitions* (Vol. 9378, pp. 118–130). Springer. https://doi.org/10.1007/978-3-319-25396-1_11

Kiili, C., Forzani, E., Brante, E. W., Räikkönen, E., & Marttunen, M. (2021). Sourcing on the internet: Examining the relations among different phases of online inquiry. *Computers and Education Open*, *2*, 100037. https://doi.org/10.1016/j.caeo.2021.100037

Krippendorff, K. (2019). *Content analysis: An introduction to its methodology* (4th ed.). SAGE.

Leu, D. J., Forzani, E., Rhoads, C., Maykel, C., Kennedy, C., & Timbrell, N. (2015). The New Literacies of Online Research and Comprehension: Rethinking the Reading Achievement Gap. *Reading Research Quarterly*, *50*(1), 37–59. https://doi.org/10.1002/rrq.85

Long, D., & Magerko, B. (2020). What is AI Literacy? Competencies and Design Considerations. In R. Bernhaupt (Ed.), *Proceedings of the CHI '20 Conference on Human Factors in Computing Systems* (pp. 1–16). Association for Computing Machinery. https://doi.org/10.1145/3313831.3376727

Okulich-Kazarin, V., Artyukhov, A., Skowron, Ł., Artyukhova, N., Dluhopol-skyi, O., & Cwynar, W. (2024). Sustainability of Higher Education: Study of Student Opinions about the Possibility of Replacing Teachers with AI Technologies. *Sustainability, 16*(1), 55. https://doi.org/10.3390/su16010055

Park, J., Teo, T. W., Teo, A., Chang, J., Huang, J. S., & Koo, S. (2023). Integrating artificial intelligence into science lessons: teachers' experiences and views. *International Journal of STEM Education, 10*(1). https://doi.org/10.1186/s40594-023-00454-3

Pelletier, K., McCormack, M. H., Reeves, J., Robert, J., & Arbino, N. (2022). *2022 EDUCAUSE Horizon Report: Teaching and Learning Edition*. EDUCAUSE.

Pelletier, K., Robert, J., Muscanell, N., McCormack, M. H., Reeves, J., Arbino, N., & Grajek, S. (2023). *2023 EDUCAUSE Horizon Report: Teaching and Learning Edition*. EDUCAUSE.

Retelj, A. (2022). Entwicklung der digitalen Kompetenz von angehenden DAF-Lehrkräften an der Universität Ljubljana. *Folia Linguistica Et Litteraria*, *XIII*(41), 139–161. https://doi.org/10.31902/fll.41.2022.7

Sala, A., Punie, Y., Garkov, V., & Cabrera, M. (2020). *Lifecomp: The European Framework for Personal, Social and Learning to Learn Key Competence*. European Union.

Song, N. (2024). Higher education crisis: Academic misconduct with generative AI. *Journal of Contingencies and Crisis Management, 32*(1), Article e12532. https://doi.org/10.1111/1468-5973.12532

Stützer, C. M. (2022). *Künstliche Intelligenz in der Hochschullehre: Empirische Untersuchungen zur KI-Akzeptanz von Studierenden an (sächsischen) Hochschulen*. TU Dresden. https://doi.org/10.25368/2022.12

Vears, D. F., & Gillam, L. (2022). Inductive content analysis: A guide for beginning qualitative researchers. *Focus on Health Professional Education: A Multi-Professional Journal*, *23*(1), 111–127. https://doi.org/10.11157/fohpe.v23i1.544

Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *Digcomp 2.2, The Digital Competence framework for citizens: With new examples of knowledge, skills and attitudes* (EUR JRC128415). Luxembourg. Europäische Kommission.

Züll, C. (2016). *Offene Fragen.* https://doi.org/10.15465/gesis-sg_en_002