Three Ways to Improve Instructional Scaffolding for Self-Study in Digital Learning Environments Insights from Two Exploratory Studies

Kathrin Schelling[1], Stefanie Go[2]

OWL University of Applied Sciences and Arts, Germany[1,2]

Abstract

This paper presents three ways in which teachers can support self-study in higher education by adding instructional scaffolding to the digital learning environments they use for their courses. These suggestions are based on two qualitative studies from the HAnS project, which aims to create an AI-enhanced assistance system meant to support self-study at German universities. The first of these studies, a series of interviews with students from different academic fields, was conducted in the summer semester of 2022 to gain insight into future HAnS users' needs and wants. The second, consisting of two group discussions, was conducted two years later, in the summer semester of 2024. Through a side-by-side analysis of these exploratory studies, we identified three scenarios that students in both samples described as negative: too many logins, invisible self-study progress, and lack of autonomy regarding exercises. We outline these scenarios, briefly discuss their implications for self-study in higher education, and offer ideas on how to use instructional scaffolding to prevent them, not just regarding the further development of HAnS, but also in other digital learning environments, such as courses in learning management systems (LMS).

Keywords: *instructional scaffolding, self-study in higher education, learning management system (LMS), digital learning environment, self-regulated learning*

1. Introduction: Instructional Scaffolding in Digital Learning Environments

Self-study is an integral part of higher education. From preparatory reading to end-of-semester revision right before the exams, there are many learning processes that students need to plan and carry out by themselves. But this does not necessarily mean that no teachers are involved in these processes. By strategically preparing digital learning environments such as the commonly used learning management systems (LMS), they can add instructional scaffolding to self-study. "Borrowed from the field of construction, where a scaffold is a temporary structure erected to help with the building or modification of another structure, the use of scaffolding as a metaphor within the domain of learning refers to the temporary support provided for the completion of a task that learners otherwise might not be able to complete" [1] (pp. 271–272). In digital learning environments, this instructional support can take two very different shapes as both the learning materials—the content of a platform—and the functions of the system can be leveraged to help students when their teachers are not around to do so.

This paper presents three ways in which self-study processes in higher education can be improved by adding specific forms of instructional scaffolding to digital learning environments. To begin, we provide a brief overview of the HAnS project and the research questions that led us to conduct the two exploratory studies upon which we draw for this paper. Against this backdrop, we then present three self-study scenarios that were identified by comparing students' descriptions of positive and negative experiences in digital learning environments with their wants and needs regarding self-regulated learning. We briefly evaluate how each of these scenarios might impact students' self-study success and offer suggestions on what kind of instructional scaffolding could be added to improve the situation. While the HAnS platform is AI-enhanced and meant for self-study processes that involve audiovisual media (e.g., lecture recordings, podcasts), the scenarios discussed here focus on neither of these factors. Instead, we decided to share three insights that can be applied to a wide variety of platforms. Therefore, some of the proposed changes concern the content provided by the teachers,

while others focus on the way the digital learning environment is organized to help students navigate tasks and learning materials.

2. The Hans Project: A Brief Overview

The HAnS project (2021–2025) brings together nine German universities and three associated research institutions to create an intelligent assistance system for higher education (HAnS, short for "Hochschul-Assistenz-System") that aims to support students as they work with audiovisual teaching and learning materials such as lecture recordings or podcasts [2]. HAnS uses Natural Language Processing [3] to automatically transcribe and index all recordings uploaded to the platform. This allows students to read along as they watch and listen, or to forgo the audiovisual media entirely and just read, if they prefer—and it lays the groundwork for three more AI-based functions that use these transcripts.

Inspired by the concept of the intelligent tutoring system (ITS) [4], a tool for digital learning that leverages AI to provide individual feedback and exercises tailored to each user's knowledge and goals, HAnS is meant to help students personalize their self-study processes and navigate their learning materials more easily. The first of its three AI-based ITS functions is therefore an intelligent search that lets users skip right to those sequences within a recording (and the corresponding slides, if available) where the search term is used. The second ITS function is an exercise mode that uses the transcripts to generate multiple-choice questions on the topic of each recording. Students can use these AI-generated quizzes to revise and to turn working on audiovisual media, usually a passive task, into a more activating process that improves understanding and retention [5]. The third AI-powered ITS function of HAnS has changed over time. Originally, a recommender system was planned through which students would have been able to find additional learning materials that match search parameters such as topic, language, or subject. Against the backdrop of the AI Act and its high-risk category for AI in education, into which the recommender system might have fallen [6], it was replaced with a chatbot based on a Large Language Model [3].

The project's framework is inspired by design-based research (DBR), an exploratory approach that has become especially popular in the educational sciences as a way to incrementally improve teaching and learning conditions [7]. The aim of a typical DBR project is to develop an intervention that addresses a specific problem in a particular teaching and/or learning scenario. In order to adapt this intervention to its intended area of application and the actors involved, it is repeatedly tested—as part of a prototyping stage—and adapted over the course of several design cycles [8]. The HAnS project uses both quantitative and qualitative methods to provide recommendations for the iterative (re)design of the prototype that are based on empirical evidence. Potential users' experiences and opinions are of particular interest to this research, as they can contribute to the creation of an assistance system that offers teachers and students in higher education the support they want and need.

3. Exploring Students' Scaffolding Needs in Digital Learning Environments

Put simply, self-regulated learning in higher education requires students to use their individual mental abilities to solve specific academic tasks. They need to work with the skills they already have because there is no teacher present to help them in case they cannot plan, conduct, and evaluate the learning process on their own [9]. This, in turn, means that students need to come up with and implement three different types of strategies: cognitive strategies to solve the task, metacognitive strategies to ensure an efficient and successful learning process, and strategies for managing the resources—both internal and external—that are available to them [10]. Keeping track of all this takes time and practice. Consequently, learners who are not (yet) proficient in the use of these strategies are constantly at risk of falling behind in their self-study. Some may simply not want to make the effort necessary to complete their coursework while left to their own devices, while others might be motivated but unaware of the tools they could use to overcome obstacles.

To complicate matters further, students' efficient use of digital learning environments for self-study purposes also depends on their ability to use information and communication technologies. This so-called "ICT literacy," which not only includes students' actual skills but also their feelings of self-efficacy and self-confidence when handling ICT [11], is known to vary greatly within the student population. For example, students from academic fields related to IT and technology in general tend to

have greater confidence in their digital media skills than students from the humanities [12]—unsurprisingly, as students who frequently use a wide variety of ICT as part of their studies have more opportunities to develop these skills than students who only need a small selection of digital tools in their chosen fields.

For a digital learning environment such as HAnS, this makes instructional scaffolding even more important as students with very different skill sets need to be able to use the system with ease. In order to generate evidence-based ideas for the incremental improvement of the HAnS scaffolding, we therefore posed the following three research questions:

RQ1: What do students from different academic fields need for successful self-study in digital learning environments?

RQ2: Are there scenarios for self-study in digital learning environments that students across different academic fields describe as problematic?

RQ3: How can instructional scaffolding be used to change these situations for the better?

To provide answers for both the HAnS developers and the teachers in higher education who would like to integrate the system into their courses, we conducted two exploratory studies. The following sections provide a brief overview of their methodologies and samples.

3.1 Interviews with Students

The first study, a series of interviews with students from different academic fields, was conducted in the summer of 2022 to gain insight into future HAnS users' needs and wants. At this point, the first iteration of the HAnS prototype was still being developed and could not be used to study actual users' reactions. Within the project's DBR-inspired framework, which combines iterative research and design cycles with a rather strict timetable, this presented a problem. When the project was initiated, there was only a small number of AI-enhanced learning platforms for higher education that had already been piloted and evaluated. Therefore, the time allotted for the first research cycle could not be used to work with the prototype nor to draw on existing studies to gain insight into how HAnS might be improved in the next design cycle.

For this reason, our first interviews were conducted using the problem-oriented method proposed by Witzel [13], which allowed us to work with a scenario instead of an actual prototype. At the beginning of each interview, the AI-based functions of HAnS—as initially planned, including the recommender system—were described to the participants. To ensure that all students were presented with the same description, this introduction was written down beforehand and read out by the researcher conducting the interview. Then, using a script to guide the conversation, the students were asked to share their views regarding the opportunities and risks of HAnS and to imagine how they themselves would use the platform for self-study.

The sample consisted of N=10 students enrolled in bachelor's and master's programs at German universities. They were selected using the Purposeful Sampling method [14], which means that we, as researchers, deliberately chose participants who we considered likely to contribute insight into how HAnS would need to be set up to support self-regulated learning in higher education. This is why the students who participated in this study represented a total of twelve different academic fields, taking into consideration both majors and minors to diversify the sample. By including a variety of academic disciplines such as design, cognitive studies, biology, and literature, we aimed to gather information on a wide variety of tasks that students in higher education need to solve as part of self-study within their respective fields.

3.2 Participatory Group Discussions

The second exploratory study with students was conducted two years later, during the summer semester of 2024, and consisted of two group discussions. This study was based on the concept of participatory research [15], which aims to include (potential) stakeholders—in our case, students in higher education—not only as a means of collecting data, but as partners who may not be scientists

themselves but whose perspectives and experiences can add a new dimension to how data is evaluated and which conclusions are drawn from it [16]. Instead of just having students from different academic fields discuss their ideas for the further development of HAnS, we therefore expressly addressed them as stakeholders in the design process. They were asked to evaluate four hypotheses [17] that had been derived from a comparison between the different research groups' findings [2] and recommend a course of action for the next design cycle.

First, each group of students was briefly introduced to the HAnS project and the AI-based functions of the current prototype, which now included the LLM-based chatbot instead of the recommender system. Then, they were provided with the login details for a special HAnS user account that was created exclusively for demonstration purposes. Where standard accounts allow students to access the learning materials from classes in which they are currently enrolled, this trial account contains a sample of videos that have been published as Open Educational Resources with a Creative Commons license that allows the HAnS researchers to use them in studies. The students had twenty minutes to freely explore HAnS before they were asked to discuss the design hypotheses and write a "do and don't" list for the next iteration of the system.

The sample consisted of N=7 students enrolled in German universities. As in the preceding interview study, the participants were selected via Purposeful Sampling [14] to include a variety of academic fields. To further diversify the sample, we included students from bachelor's and master's programs as well as one postgraduate student who had completed their master's degree a few weeks before the study and had just begun self-organized preparation for their dissertation project. Two of the students who volunteered for this study had already participated in the 2022 interviews. They were selected again because they had since completed their bachelor's degrees and started master's programs, providing them with new experiences regarding the tasks they were expected to complete as part of self-study. To ensure that possible comparisons between the first idea and the current prototype of HAnS would not make up a large part of the discussion, however, these two participants were assigned different groups.

4. Scaffolding Self-Study in Digital Learning Environments: Insights from The Hans Project

To compare students' ideas for an ideal digital learning environment and identify the topics that were prevalent in both 2022 and 2024, we conducted a side-by-side analysis of the two exploratory studies. For this, we treated the transcribed and anonymized interviews and discussions as a single body of text that was analyzed using the method of qualitative content analysis as described by Mayring [18]. We chose this method because it allows small research teams such as ours to analyze large bodies of text both systematically and quickly while maintaining an interpretative approach that remains sensitive to not explicitly expressed "latent" meanings within the text [19]. In a first step, we created what Mayring calls "inductive categories" [18], clusters into which we sorted the paragraphs that focus on similar topics. For this comparative analysis, the most important inductive category was "*students' needs and wishes for self-organized learning*"—both fulfilled and frustrated—which we separated from "*positive experiences with digital learning environments*" and "*negative experiences with digital learning environments*". This allowed us to correlate individual students' experiences regarding specific digital applications with the needs and wishes for self-study that were described across the different interviews and group discussions. The resulting clusters were then used to create scenarios for self-study in higher education that correlate with challenges that, in turn, could be solved via instructional scaffolding.

In the following sections, we present three findings from this side-by-side analysis that point to students' needs not being met by the way their teachers are currently using digital learning environments. We first outline students' needs and experiences as they were described in the material[1] before discussing possible implications for students' self-regulated learning processes. At the end of each section, we propose three ideas on how teachers might improve instructional scaffolding for self-study using strategies that could be applied not only to HAnS but to any given LMS.

Insight #1: Students want to log in as few times as possible.

[1] Since the interviews and group discussions were originally conducted in German, all the quotes included here are translations created by the authors of this paper.

One of the most often discussed topic in both studies was students' dissatisfaction with the number of digital tools their universities provide for self-study purposes. In five of the ten interviews and both group discussions, students pointed out that they have to log in several times to access the different learning materials and applications they need to complete their coursework. "So if we now add HAnS, and about 20 percent of the lectures you're hearing are uploaded there, and the rest of them somewhere else, that just won't be practical" (interview 2). In both studies, a further fragmentation of the digital learning environment was anticipated and framed as a negative outcome by several participants. The students described this *status quo* as an issue caused by their teachers'—and/or entire faculties'—default use of different LMS: some use moodle, others ILIAS, and some universities collect lecture recordings in yet another digital repository.

Services outside the LMS, such as the universities' library catalogues, further complicate the matter, as they each require another sign-in. This also affects self-study processes that begin in the LMS and then require students to access more and more external services. "[T]he current situation is that if I want to search for literature," one student (discussion 2,2)[2] explains, "is that I have to close it [the LMS], open a new tab, log in to the VPN if necessary, then open the respective databases. And *then* I can search there." Another student (interview 10) humorously pointed out that every new application comes with a user profile, leading students to create "the hundred thousandth password, maybe we can find a solution to do something about that (laughs). Please register. Oh no, not again!"

Why this might negatively impact self-study can be explained with the Technology Acceptance Model (TAM) as proposed by Davis [20], which considers *perceived ease-of-use* to be proportional to *perceived effort*. The more intuitive the use of an application is, the more user-friendly it appears—and the more likely people are to actually use this technology. Conversely, this also means that a fragmented process with many different logins, as described by the students in our exploratory studies, can greatly reduce *perceived ease-of-use* while increasing *perceived effort*. Considering that students in higher education appear to prefer familiar applications such as Google or Wikipedia to more research-intensive options like academic journals [21], it therefore seems highly unlikely that they would be willing to spend time and (perceived) effort on getting to know a large network of digital tools. Instead, they might either use a select few applications—most likely preferring those that are familiar and/or do not require a login—or none at all. And "[d]espite the perceived benefits of e-learning [...], the efficiency of such tools will not be fully utilized if the students fail to use the system" [22] (p.165) and, consequently, the instructional scaffolding their teachers have prepared to support them in their self-study processes.

<u>Three ways to improve scaffolding by maximizing perceived ease-of-use:</u>

1. Try to use as few different digital learning environments per course as possible.
2. Ensure that all third-party applications used for a course can be reached through links embedded in the LMS.
3. Reduce the number of logins students have to perform by providing audiovisual media and the materials necessary to work on the corresponding exercises (e.g., worksheets, textbook excerpts) via the same LMS.

Insight #2: Students want to see that they are making progress.

Another negative scenario for self-study that we identified in our exploratory studies concerns students' overview of their own learning progress, which can be hard to gauge, especially for those who are not (yet) sufficiently familiar with metacognitive strategies [9] for realistic self-evaluation. This topic can be found in four interviews and both group discussions, but it is discussed in two very different ways. On the one hand, students would like the digital learning environment to provide the tools and instructional scaffolding they need to gain an overview of how much of the course content they already know. "I would find it really practical if there were exercises that showed me [...] where I need to catch up," one student (interview 7) explained. Several others, not only in the discussions but also in the earlier interviews, suggested that this could be achieved by presenting quiz scores in a way

[2] The group discussions' ciphers represent the session number (first digit) and the order in which the students entered the conversation (second digit). The student marked 2,2 therefore participated in the second session and was the second person to speak up.

that shows “in percent: I already have this much knowledge” (discussion 1,4), thereby making students’ progress quantifiable.

On the other hand, the students in our exploratory studies also discussed the possibility of visualizing self-study progress by having the learning environment itself track their activities, e.g., by documenting how much of a lecture recording they have already watched. This way, they argued, it would be easier to keep track of their own learning processes. In this context, one group stressed the importance of a learning platform’s content being kept up to date as the courses progress. They pointed out that, in their opinion, students should be able to log in to an LMS at any point during the semester and see “okay [...] so this is what has been uploaded yet, and I have to catch up on this and that” since this real-time overview of the available learning materials “would be quite helpful, especially when one is juggling several courses at the same time” (discussion 1,3) and might fall behind in one or more of them as new learnings materials keep piling up.

The ability to self-evaluate plays a crucial role in successful self-study—after all, students cannot and will not close knowledge gaps if they don’t see the need to do so in the first place [23]. In order to help them develop the skills they need to self-assess, instructional scaffolding in digital learning environments could therefore include learning materials that guide self-study novices through the process of identifying and/or applying criteria with which they can evaluate their own progress [24]. Yet, it should be noted that using this type of instructional scaffolding requires both skill and effort. Students who are only beginning to develop their self-assessment skills might find this process overly demanding, as might those who are more skilled but currently stressed, tired, or simply distracted by trying to simultaneously keep track of their progress in several courses. If these students experience “cognitive overload,” they may end up skipping self-assessment entirely. To avoid this, some automatically triggered feedback mechanisms and/or low-effort evaluation activities could be added to a digital learning environment, since “learning situations with an extremely high [cognitive] load will benefit from practice conditions that reduce the load to more manageable levels” [25] (p. 1).

Three ways to improve scaffolding by helping students assess individual progress:

1. Create a detailed plan for the semester that includes all course sessions, their respective topics, and the syllabus for mandatory reading. Make this plan a printable and/or clickable to-do list and encourage students to keep track of their progress.
2. Provide non-mandatory exercises (including solutions) that students can use to self-evaluate.
3. Find out if your LMS supports plugins—such as “Level Up XP” for moodle—that allow you to implement progress bars that visualize students’ coursework success.

Insight #3: Students want to have (some) control over when and how they practice.

The third and last result from our studies that we want to discuss here concerns students’ need for autonomy in self-study, especially regarding exercises. This topic was touched upon in most of our interviews and both group discussions. Almost every student at some point explained an idea for the HAnS platform and then immediately framed it as a function that might not be useful in every situation or for every user and should therefore be an opt-in solution. “I could imagine that it [a progress bar] could help me when I’m preparing an experiment or something,” one student (discussion 1,2) reasoned. “[M]aybe it could be something that you can simply switch on and off. So if [...] you don't need it, you can turn it off again.” Another student (discussion 1,1) had a similar approach to the AI-generated quizzes on the HAnS platform: “The idea of automatically being asked questions doesn’t sound good to me,” they explained. “What I would like instead is to click a button to generate questions. If I don’t click it, I don’t get any questions.”

With regard to the design of digital learning environments, this means a delicate scaffolding balance: students might need their teachers’ support to overcome obstacles in self-study, but they also need to be able to make their own decisions. If they feel that they can only have one at the cost of the other, they might even refuse instructional scaffolding they recognize as potentially helpful in favor of autonomy. Such deliberations were expressed as follows by a student in one of our very first interviews: “Personally, I don’t like being treated like I’m in school. It rather annoys me, so if someone were to tell me what to do [with HAnS], I don’t even know if I would end up using the system like that, although it would certainly have advantages to do so” (interview 3).

To prevent students from feeling restricted and therefore opting out of using a digital learning environment that could offer much-needed support, instructional scaffolding, especially for exercises,

might have to allow for more participation [26]. This could mean involving students in the creation of the actual scaffolding by asking them directly what kind of support they would like to work with. It could also mean creating several scaffolding options for the same exercise and letting the students decide whether they would like to follow beginner-friendly instructions or challenge themselves a little more. At the same time, however, it could be helpful to combine more participation concerning students' choice of learning activities with less scheduling flexibility. After all, both a fixed schedule for learning activities [27] and externally imposed deadlines [28] can improve performance in e-learning. To leverage this effect for self-study, teachers could provide a course schedule with a few deadlines that help students stay focused on their self-study while still allowing them to set their own pace and choose learning activities within a scaffolding framework that gently nudges them along.

Three ideas to improve scaffolding by adding structure without impacting students' autonomy:

1. Make time at the beginning of the semester to discuss self-study habits with your students to find out which kind of exercises they prefer and avoid.
2. Create an exercise pool that allows students to freely mix and match learning activities with different levels of difficulty.
3. Set regular self-study deadlines over the course of the semester. For each, students must hand in a certain number of exercises from the pool.

5. Conclusion

The ideas for instructional scaffolding in digital learning environments that we present in this article are like the two qualitative studies on which they are based: exploratory in nature. Within the DBR-inspired framework of the HAnS project, a succession of studies with small samples has proved advantageous due to the high pace of the interlocking cycles of research and development. To fill gaps and complement the larger studies conducted by other teams within the consortium by contributing empirical data on emergent topics, we used methods that allowed us to provide insight into potential users' needs and experiences—preliminary as the results might be—as needed to drive an agile, iterative process.

There are, however, two limitations to this setup that might bias the self-study scenarios we created using these results. Firstly, the number of students involved in our studies is not large enough to confidently generalize our findings. Despite our efforts to create a diverse sample, the interviews and discussions we conducted only provide insight into a small selection of academic fields. Secondly, all of the students who participated in our studies were enrolled in *German* universities, so we cannot rule out the possibility that the scaffolding scenarios we address in this article have their roots in local phenomena. For these reasons, this article should not be seen as an exhaustive report on students' wants and needs regarding instructional scaffolding in digital learning environments but rather as a starting point for further studies, both quantitative and qualitative. Our aim was to provide ideas on how to improve instructional scaffolding for self-study in digital learning environments. This is why we turned students' opinions and suggestions into design ideas that can be applied to any given LMS—and thus field-tested, evaluated, and incrementally refined by researchers and teachers in higher education alike.

6. REFERENCES

[1] van de Pol, J., Volman, M., & Beishuizen, J. (2020). Scaffolding in Teacher–Student Interaction: A Decade of Research. *Educational Psychology Review, 22*, 271–296.

[2] Schmohl, T., Schelling, K., Go, S., Freier, C., Hunger, M., Hoffmann, F., Helten, A.-K., & Richter, F. (2023). Combining NLP, speech recognition, and indexing: an AI-based learning assistant for higher education. In Pixel (ed.), *Conference proceedings. 13th international conference "The future of education".* 29–30 June 2023, *Bologna*.

[3] Ranzenberger, T., Freier, C., Reinold, L., Riedhammer, K., Schneider, F., Simic, C., Simon, C., Freisinger, S., Georges, M., & Bocklet, T. (2024). A Multidisciplinary Approach to AI-based self-motivated Learning and Teaching with Large Language Models. In S. Schulz & N. Kiesler (eds.), *DELFI 2024. Lecture Notes in Informatics (LNI)* (pp. 133–140). Gesellschaft für Informatik.

[4] Nwana, H. S. (1990). Intelligent tutoring systems: an overview. *Artificial Intelligence Review, 4*.

[5] Chi, M., & Wylie, R. (2014). The ICAP Framework: Linking Cognitive Engagement to Active Learning Outcomes. *Educational Psychologist, 49*(4).
[6] Novelli, C., Casolari, F., Rotolo, A., Taddeo, M., & Floridi, L. (2024). Taking AI risks seriously: a new assessment model for the AI Act. *AI & Society*, *39*, 2493–2497.
[7] Tinoca, L., Piedade, J., Santos, S., Pedro, A. & Gomes, S. (2022). Design-Based Research in the Educational Field: A Systematic Literature Review. *Education Sciences, 12*, 410.
[8] Bakker, A., & van Eerde, D. (2015). An introduction to design-based research with an example from statistics education. In A. Bikner-Ahsbahs, C. Knipping & N. Presmeg (eds.), *Approaches to qualitative research in mathematics education. Advances in Mathematics Education* (pp. 429–466). Springer.
[9] Kopp, B., & Mandl, H. (2011). Selbstgesteuertes Lernen. In S. Rahm & C. Nerowski (eds.), *Enzyklopädie Erziehungswissenschaft Online. Fachgebiet: Schulpädagogik, Unterricht: Geschichte, theoretische Grundlagen, empirische Befunde, Diskursfelder*. Juventa.
[10] Pintrich, P., Smith, D., Duncan, T., & Mckeachie, W. (1991). *A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ).* National Center for Research to Improve Postsecondary Teaching and Learning, Ann Arbor.
[11] Senkbeil, M. (2022). ICT-related variables as predictors of ICT literacy beyond intelligence and prior achievement. *Education and Information Technologies, 27*, 3595–3622.
[12] Bedenlier, S., Händel, M., Kammerl, R., Gläser-Zikuda, Kopp, B., & Ziegler, A. (2021). Akademische Mediennutzung Studierender im Corona-Semester 2020. Digitalisierungsschub oder weiter wie bisher? *MedienPädagogik, 40 (CoViD-19)*, 229–252.
[13] Witzel, A. (1985). Das problemzentrierte Interview. In G. Jüttemann (ed.), *Qualitative Forschung in der Psychologie: Grundfragen, Verfahrensweisen, Anwendungsfelder* (S. 227–255). Beltz.
[14] Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health, 42*(5), 533–544.
[15] Vaughn, L. M., & Jacquez, F. (2020). Participatory Research Methods – Choice Points in the Research Process. *Journal of Participatory Research Methods, 1*(1).
[16] Bergold, J., & Thomas, S. (2020). Partizipative Forschung. In G. Mey & K. Mruck (eds.), *Handbuch Qualitative Forschung in der Psychologie* (pp. 113–133). Springer.
[17] Schelling, K., & Go, S. (2025). Vom Lernmanagementsystem zum Personal Learning Environment. Fünf forschungsbasierte Handlungsimpulse für mehr Gestaltungsfreiraum im Selbststudium. *DiNa Didaktik-Nachrichten*.
[18] Mayring, P. (2022). *Qualitative Inhaltsanalyse. Grundlagen und Techniken* (13th, revised edition). Beltz.
[19] Mayring, P. & Fenzl, T. (2019). Qualitative Inhaltsanalyse. In N. Baur & J. Blasius (eds.), *Handbuch Methoden der empirischen Sozialforschung* (pp. 633–648). Springer VS.
[20] Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly, 13*, 319–340.
[21] Besa, K.-S., & Biehl, A. (2023). Veränderungen von Mediennutzung und Medieninteresse bei Lehramtsstudierenden während der Corona-Pandemie. In R. Porsch & C. Reintjes (eds.), *Digitale Bildung im Lehramtsstudium während der Corona-Pandemie: Befunde, Erfahrungen, Perspektiven* (pp. 21–38). Waxmann.
[22] Tarhini, A., Masa'deh, R., Al-Busaidi, K. A., Mohammed, A. B., & Maqableh, M. (2017). Factors influencing students' adoption of e-learning: A structural equation modeling approach. *Journal of International Education in Business, 10*(2), 164–182.
[23] Cassidy, S. (2011). Self-regulated learning in higher education: identifying key component processes. *Studies in Higher Education, 36*(8), 989–1000.
[24] Boud, D. (ed.) (1995). *Enhancing Learning through Self Assessment.* Routledge Falmer.
[25] Paas, F., Renkl, A., & Sweller, J. (2004). Cognitive Load Theory: Instructional Implications of the Interaction between Information Structures and Cognitive Architecture. *Instructional Science, 32*, 1–8.
[26] Mayrberger, K. (2019). *Partizipative Mediendidaktik: Gestaltung der (Hochschul-)Bildung unter den Bedingungen der Digitalisierung.* Beltz Juventa.
[27] Ihantola, P., Fronza, I., Mikkonen, T., Noponen, M., & Hellas, A. (2020). Deadlines and MOOCs: How Do Students Behave in MOOCs with and without Deadlines. *Proceedings oft he 2020 IEEE Frontiers in Education Conference (FIE)*, 1–9.

[28] Ariely, D., & Wertenbroch, K. (2002). Procrastination, deadlines, and performance: Self-control by pre commitment. *Psychological Science, 13*(3), 219–224.