Reconceptualizing Online Assessment as Learning Support in Higher Education:
A Multi-Method Approach Toward Effective Implementation

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Abstract

Assessment plays a central role in learning processes. However, current practice in higher education is inadequate when it comes to implementing learning-oriented assessment that focuses on active engagement and effective feedback. The use of artificial intelligence and online assessment does not only create new tools and opportunities, but also a momentum for rethinking and redesigning assessment practices in higher education. The research of this doctoral thesis aims to leverage these disruptions to derive guidelines for the implementation and execution of sustainable learning-oriented online assessment. Through a multi-method approach, including a systematic review, two quantitative studies (a survey study and a quasi-experiment) and one qualitative study, it encompasses the current trends in research as well as university teachers and students' practical views on the design, development and realization of online assessment in higher education. The systematic review focusing on empirical research on online assessment in higher education (1) builds the theoretical groundwork for this thesis. It classifies current practical implementations and introduces objectives and success factors of online assessment. The results highlight the broad range of design possibilities as well as the effects of formative assessment on different learning outcomes. To develop a comprehensive understanding of online assessment and the impact of AI, it is necessary to investigate students' perceptions and evaluations of these tools. Therefore, this thesis includes an international survey study on students (2), analyzing different application scenarios of different AI-based tools to achieve a nuanced view on how students intend to use GenAI in higher education assessment and in how far individual AI competence can influence the evaluation of these tools. Furthermore, the design possibilities of assessment identified in Paper 1 pose the question how students accept and benefit from them. Therefore, a quasi-experimental study was conducted to investigate students' evaluation of and learning from self-, peer and teacher assessment (3). The paper identifies the potential of peer assessment and emphasizes the call for a broader online assessment design and implementation. It also highlights the impact that individual feedback literacy can have on the improvement based on feedback. A qualitative interview study (4)

includes the perspective of teachers reflecting their expectations and identified challenges of online assessment in higher education. The results further point towards the transformative effect that online assessment can have on their current practices while highlighting existing challenges. Ultimately, overall implications based on all four studies are drawn for research, as well as multiple stakeholders in practice. In addition, perspectives for future research are outlined, and clear questions raised that need to be addressed to guarantee the effective implementation of online assessment.

Zusammenfassung

Prüfungen spielen eine zentrale Rolle im Lernprozess. Die derzeitige Praxis im Hochschulbereich ist jedoch unzureichend, wenn es um die Umsetzung von lernorientiertem Assessment geht, das sich auf aktives Engagement und effektives Feedback konzentriert. Der Einsatz von künstlicher Intelligenz und Online-Assessment schafft nicht nur neue Werkzeuge und Möglichkeiten, sondern auch einen Impuls, die Bewertungspraktiken im Hochschulbereich zu überdenken und neu zu gestalten. Die Forschung dieser Dissertation zielt darauf ab, diese Umbrüche zu nutzen, um Leitlinien für die Umsetzung und Durchführung eines nachhaltigen lernorientierten Online-Assessments abzuleiten. Durch einen multimethodischen Ansatz, der eine systematic review, zwei quantitative Studien (eine Umfrage und ein Quasi-Experiment) sowie eine qualitative Studie umfasst, werden die aktuellen Trends in der Forschung sowie die praktischen Ansichten von Hochschullehrenden und Studierenden zur Konzeption, Entwicklung und Umsetzung von Online-Assessment im Hochschulbereich erfasst. Eine systematic review mit Fokus auf empirischer Forschung zu Online- Prüfungen in der Hochschulbildung (1) bildet die theoretische Grundlage für diese Arbeit. In diesem Kapitel werden aktuelle praktische Umsetzungen klassifiziert und Ziele und Erfolgsfaktoren für Online-Assessments vorgestellt. Die Ergebnisse verdeutlichen die vielfältigen Gestaltungsmöglichkeiten sowie die potenziellen Auswirkungen der formativen Prüfung auf verschiedene Aspekte des Lernerfolgs. Die durch KI verursachten Disruptionen bzgl. Prüfungen erfordern es, die Wahrnehmung dieser Tools durch die Studierenden sowie ihr Verständnis für deren Anwendungen zu untersuchen. Daher umfasst diese Arbeit

eine internationale Umfrage unter Studierenden (2), in der verschiedene Anwendungsszenarien von KI analysiert werden, um ein differenziertes Bild davon zu erhalten, wie GenAI in Assessments im Hochschulbereich eingesetzt wird und inwieweit individuelle KI-Kompetenz die Bewertung von diesen Tools durch Studierende beeinflussen kann. Des Weiteren wirft die in Paper 1 identifizierte Gestaltungsvielfalt von Online-Assessments die Frage auf, wie Studierende diese bewerten und davon profitieren können. Daher wurde eine quasi-experimentelle Studie durchgeführt, um das Lernen aus der Selbst-, Peer- und Lehrendenbewertung sowie die Einschätzung der Modi durch Studierende zu untersuchen (3). Der Beitrag identifiziert das Potenzial des Peer-Assessments und betont die Notwendigkeit einer breiteren Gestaltung von Online-Prüfung. Darüber hinaus wird der Einfluss hervorgehoben, den die individuelle Feedback-Kompetenz auf die Verbesserung auf Grundlage von Feedback haben kann. Eine qualitative Interviewstudie (4) umfasst die Perspektive von Lehrkräften, die ihre Erwartungen und die von ihnen identifizierten Herausforderungen des Online-Assessments im Hochschulbereich widerspiegeln. Die Ergebnisse weisen auf die transformative Wirkung hin, die Online-Assessments auf die derzeitigen Praktiken haben kann, und heben gleichzeitig bestehende Herausforderungen hervor. Zuletzt werden auf der Grundlage aller vier Studien allgemeine Schlussfolgerungen für die Forschung sowie für verschiedene Interessengruppen in der Praxis gezogen. Darüber hinaus werden Perspektiven für die zukünftige Forschung aufgezeigt und klare Fragen aufgeworfen, welche in Zukunft beantwortet werden sollten, um eine effektive Umsetzung von Online-Assessments zu garantieren.

For my parents
Susanne Hering & Bernhard Heil

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List of Abbreviations

AaL	Assessment as Learning
AfL	Assessment for Learning
AI	Artificial Intelligence
AoL	Assessment of Learning
GenAI	Generative Artifical Intelligence
HE	Higher Education
HEI	Higher Education Institution
LA	Learning Analytics
MOOCs	Massive Open Online Courses
OA	Online Assessment

1 Introduction

1.1 The role of online assessment in higher education

Concerns about online assessment (OA) and Artificial Intelligence (AI) in education are increasingly becoming central topics of public discourse. Especially the switch to emergency remote teaching and the widespread accessibility of generative AI (GenAI) led to great attention both in popular media as well as the research community on the topic of digital change in higher education (Casillas Alvarado et al., 2024; Scholkmann et al., 2024). Higher education (HE) is important as mass education functions as a basis for national citizenship, sustaining professionalism, rationalization of society and conceptualizes economic positions (Schofer et al., 2021). However, higher education internationally is accompanied by challenges, as Halabieh et al. (2022) identified in their systematic review. Among others, they point out inequitable accesses, geographical and financial, a weak utilization of technology for pedagogical improvements, outmoded teaching methods and content, as well as a lack of training in career-relevant skills. Online learning can play a central role in addressing key concerns relating to technology, teaching methods, and career-relevant skills, by facilitating a shift from using assessment to evaluate learning outcomes to using assessment to support learning (Yang & Xin, 2022). In higher education, assessment is crucial for students' perception of their learning, and many learning processes are connected to assessment (Gibbs & Simpson, 2005).

Assessment in higher education can have multiple functions, including selection and recruitment, prognosis of future achievements, as well as a didactical purpose (Tsarouha, 2019). Therefore, assessment should be viewed as an integral part of the learning process, rather than as an obstacle to be overcome on the way to achieving a more distant goal (Gibbs, 2006). Additionally, a systematic review by Butler-Henderson and Crawford (2020) highlighted the need for authentic assessment in higher education due to its influence on students' demand, success, and wellbeing. Simultaneously, the main concerns of the public discourse center around the question of quality loss and a lack of validity of university examinations, if students were to be assessed online. In this discussion, it is important to take a step back and consider whether assessment in higher education has thus far been

designed and implemented in the way that findings of pedagogical research would recommend. Dating back now thirty years, Boud already pointed out that assessment is probably the area of learning and teaching that employs most ignorant practice, even though it is so influential in students' learning (Boud, 1995). However, discussions in research still reflect that higher education assessment research seldom relies on findings from theoretical and empirical research surrounding assessment (Nieminen et al., 2023). In the same vein, research on assessment does not seem to influence practice as the decisions are up to practitioners (Buckley, 2024). Accordingly, the effectiveness of an overreliance on summative assessment has been under discussion for many years (Knight, 2002), and approaches have been brought forward in addressing this through formative online assessment (Spector et al., 2016). However, we still see a strong focus on high-stakes examination as summative assessment in practice, which is poorly justified pedagogically and might become a problem, if it is used at the expense of more supporting forms of assessment (French et al., 2024). High-stakes testing can furthermore lead to a narrower curriculum and a lack of teaching and assessing 21st-century skills such as critical thinking or problem solving (Berliner, 2011).

Historically, assessment has always adapted to the circumstances in higher education, such as mass enrollments, curricula adaptations, or technological advancements (Brown, 2022). In Europe, the introduction of the Bologna reform aimed at shifting from final examinations to study-accompanying and competence-oriented assessment, and a stronger focus was put on the didactical role of assessment (Gallner, 2022). In higher education practice, however, the significant role of summative assessment did not go away, and the introduction of innovative assessment practices was slow due to the needed administrative effort, the subordinate importance of teaching in an academic career, and a lack of interest in pedagogical innovation (Wannemacher, 2009). Simultaneously, resistance to change in higher education assessment seems to be especially prevalent, manifesting on an epistemic, questioning the reasoning for change, pragmatic, concerning time and workload, and procedural levels, focusing on adhering to administrative procedures (Deneen & Boud, 2014). Especially, external factors of assessment hinder new practitioners in revitalizing assessment strategies (Norton et al., 2013). Assessment seems to be built upon tradition and the role that technology can take, and a design

of assessment to prepare learners for a digital world seems to be overlooked (Bearman et al., 2020). Evidently, adaptations in assessment do not occur by themselves but are reliant on stakeholders in higher education. A central factor in exploring innovative and supportive assessment strategies is trust in the responsible behavior of all stakeholders, such as administration, teachers, and students (Carless, 2009).

When discussing assessment processes, feedback is a central aspect to be simultaneously considered. Feedback design needs to be understood as an interaction of practices, context, and individuals (Henderson et al., 2019). The focus needs not only to be on the content of the feedback, but also the processes and strategies employed to provide it (Haughney et al., 2020). The issue pertains to the challenges and opportunities introduced through the online medium, but also whether using this momentum to question current practices. In practice, there is a disconnect between the desires and efforts to assess learning and the simultaneous demands for accountability and rigorous assessment criteria. In addition, there are differences in processes between bottom-up and top-down processes, depending on how the processes are set in motion, as well as slow change among teachers (Black, 2015). This leads to new challenges, especially as teachers need knowledge and skills, social & psychological factors to implement effective formative assessment (Schildkamp et al., 2020). Research highlights in this context that pedagogical knowledge is even more important than technological when it comes to implementing digital assessment (Viberg et al., 2024).

The COVID-19 pandemic accelerated the introduction of digital technology in higher education, but the fast disruption left the question of how to implement pedagogically valid solutions that are here to stay (García-Morales et al., 2021). The change was fast, and many institutions and teachers had to improvise with the tools at hand to perform online assessment (Montenegro-Rueda et al., 2021). Therefore, the adaptation during emergency remote teaching is not to be considered a sustainable approach for changing assessment in higher education, as "[...]pragmatic responses to an abrupt pivot are unlikely to provide a solid plan on which to build back better" (Bartolic et al., 2022, p. 530). Additionally, the dominant approach was often applying existing practices to the online format without adapting the pedagogy behind it (Slade et al., 2022). Next to the introduction of online assessment in

emergency remote teaching, new possibilities and challenges emerge through the implementation of AI and GenAI systems in the higher education sector. While on the one hand, GenAI bears a lot of potential in supporting students learning in assessment (Lim et al., 2023), it remains a challenge to make universities data-based institutions, that do not only collect data about learning processes but actually use them in order to enhance learning and teaching (Komljenovic et al., 2025). For AI to fulfill its potential in assessment, redesigning assessment and supporting the literacy and professional development of learners and teachers are crucial (Xia et al., 2024; Zhao et al., 2024). In the same vein, effective implementation of analytics requires a shift of the institutions' assessment understanding from assessment of learning to assessment for learning and an effective integration of all stakeholders into the discourse (Macfadyen et al., 2014). The implementation of analytics still falls short in practice, as there is a lack of wide-spread implementation in higher education (Viberg et al., 2018), an absence of strategy connected to pedagogical research, lack of use to support learners in developing self-regulated learning skills, and when they are implemented, mostly in small scale approaches (Tsai et al., 2020). Large-scale implementation of learning analytics would require identifying a purpose, key stakeholders, desired behavior change, developing an engagement strategy, analyzing internal capacity, and establishing monitoring and learning frameworks (Tsai et al., 2018). Considering the fear of academic misconduct, research calls for designing innovative assessment modes that cannot be solved by GenAI (Cotton et al., 2024). New questions regarding fair assessments are raised, considering how online tests and standards are fair if the changing circumstances are not considered, and how assessments can be adapted accordingly (Gamage et al., 2022). Concerns emerge regarding misconduct and simultaneously using tools that aim to prevent it, which compromise ethical and privacy standards. Important questions and discussions were raised and started with these concerns, especially considering the different socio-economic status of students and the implications the fast introduction had on students. It is even more important now, when implementing long-term solutions, to put the ethical concerns first and build them into the solutions rather than using them as an afterthought (Heil & Ifenthaler, 2024).

The challenge remains in considering how online assessment can be designed long-term, acknowledging both the concerns and the excitement. What

benefits it might bring, and which challenges are the important ones to be addressed. It is crucial not to forget that these processes are about learning. Technology and assessment need to be used in a way to support learners in their practices and not replace the assessor with a form of machine (Brown, 2022). Therefore, the main goal of this thesis is to investigate online assessment from a theoretical and empirical viewpoint, including stakeholders' wishes, concerns, and actual learning processes. Furthermore, the current literature proposes implications for many design options of assessment through the new technological possibilities. Therefore, different research questions are raised.

1.2 Research questions of this thesis

Based upon the research on assessment and specifically online assessment, as well as the identified gaps in practical implementation, the goal of this thesis is to investigate the steps of the implementation process and identify the central aspects to be considered, the ultimate goal being answering the question: "How can assessment practices that support learning in the context of higher education be implemented through means of online assessment?" As this is quite a broad question, multiple aspects must be covered to ensure a comprehensive overview of central agents and their dispositions in higher education. The following sub-research questions can be seen as guiding a process of implementing online assessment in an ideal scenario, and how it can be used to support learning. These approaches are loosely built upon the ADDIE instructional design model (Molenda, 2003). To cover the different aspects of this process, multiple different methodological approaches were taken. First, a systematic review on the topic of online assessment in higher education was conducted to create an overview of the state of research (Paper 1). Additionally, a quantitative survey study was performed with participants from three countries (Germany, Italy, and Australia) to analyze students' competence in using AI tools for learning and assessment (Delcker et al., 2024), as well as their evaluation of these tools (Paper 2). A quasi-experimental study was carried out to investigate the effect that different human-led modes of assessment can have on students. Furthermore, the effect of individuals' feedback literacy on the uptake of feedback (Carless, 2022; Tepgec et al., 2024) was investigated (Paper 3). Lastly, to also integrate the teachers' perspective, as they are central in implementing the higher

education assessment (St-Onge et al., 2022), a qualitative study was conducted, investigating the greater purpose that teachers identified regarding higher education and their expectations of online assessment (Paper 4).

A graphical representation can be found in Figure 1 – 1 and an overview of the included papers in Table 1 – 1.

Figure 1 – 1 Graphical representation of the papers in this thesis
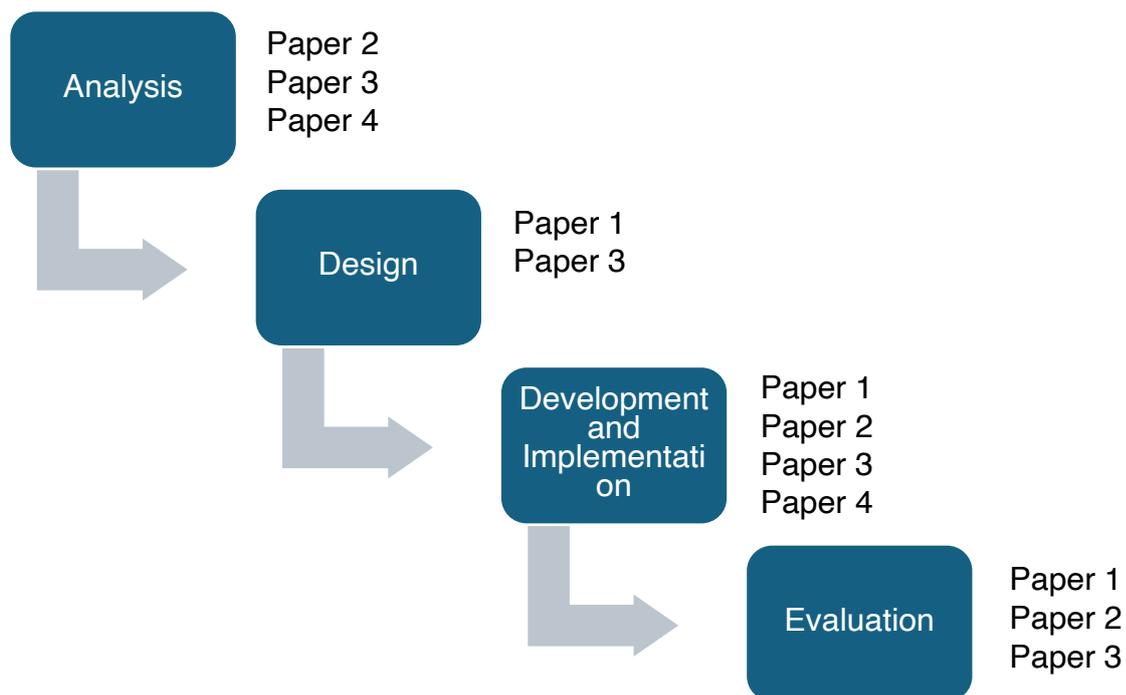
Analysis

RQ 1 a: *What expectations, challenges, and needs do teachers and students in higher education express regarding online assessment*

RQ 1 b: *Which perceptions do students have about aspects of online assessment?*

This question is addressed by Studies 2, 3, and 4. Studies 2 and 3 focus on students' disposition. The respective relevant research questions in the studies are for Paper 2: "Which usage benefits do students perceive for each AI-tool?", "Does the AI competence influence the evaluation of the tools?" and "Does students AI competence vary across disciplines?" Paper 3, on the other hand, answers to the question: "How do students evaluate different feedback modes in an online

assessment setting?" Paper 4 investigates teachers' expectations and wishes for online assessment in higher education. The specific research question is: "Which conventions do university teachers report concerning the common good of education, and which reasons for and against using online assessment can be derived based on different conventions? ". Based on the results from the studies addressing these questions, answers to the main research question will be developed.

Design

RQ 2: *How can online assessments be effectively designed to support student learning in higher education?*

Regarding assessment design, Studies 1 and 3 provide a strong basis. Study 1 raises central questions about how different assessment design aspects are realized in empirical research. The central research question in Paper 1 is: "Which modes (e.g., self-assessment, peer-assessment, teacher-assessment, automated-assessment) are used in online and blended learning, and for each assessment mode, what formats (formative or summative), and types (e.g., quiz, essay), and feedback are implemented in higher education?" Based on this derived classification, the design is tested in a quasi-experiment in Study 3. The central research question for the design is "What impact do different modes of feedback have on students' improvement in online assessment, and what is the role of feedback literacy?" Therefore, different modes of online assessment are evaluated.

Development and Implementation

RQ 3: *How can online assessment be developed and implemented in higher education to support learning?*

As a successful implementation includes all stakeholders as well as a sound theoretical basis, the results from all four studies can be fruitfully combined to create implementation guidelines. The concrete research questions are from Study 1: "What are the success factors for accepting and using online assessments in higher education?" and from Study 4: "What expectations do university teachers have of the HEI and themselves to provide for fruitful implementation of online assessment?"

Furthermore, the individual disposition of students regarding AI and different assessment modes, as highlighted in Studies 2 and 3, points out implicit implementation aspects to be considered.

Evaluation

RQ 4: *How do aspects of online assessment in higher education influence students learning processes?*

Various aspects of online assessment that can influence the learning process are examined in Studies 1, 2, and 3. Initial aspects can be derived here, which should be further developed in future research. Paper 1 asks: "What are the objectives of online assessments in higher education?" and highlights the implementation of design features in order to influence students' learning. Paper 2 focuses on AI competence and encompasses the research question "Does the AI competence influence the evaluation of the tools?". Paper 3 focuses on assessment modes through the research question "What impact does the perception of the assessment mode have on students' improvement?" as well as the question of "What is the role of feedback literacy?"

Table 1 – 1 Overview of the papers in this thesis

	Paper 1	Paper 2	Paper 3	Paper 4
Title	Online assessment in higher education: A systematic review	Students' perceived impact of GenAI tools on learning and assessment in higher education: The role of individual AI competence.	Effects of teacher, peer and self-feedback on student improvement in online assessment: The role of individuals' presumptions and feedback literacy	Expectations, challenges and opportunities of online assessment in higher education according to university teachers
Citation	Heil, J., & Ifenthaler, D. (2023). Online assessment in higher education: A systematic review. *Online Learning*, *27*(1), 187-218. https://doi.org/ 10.24059/olj.v27i1.3 398	Heil, J., Ifenthaler, D., Cooper, M., Mascia, M. L., Conti, R., & Penna, M. P. (2025). Students' perceived impact of GenAI tools on learning and assessment in higher education: The role of individual AI competence. *Smart Learning Environments, 12*(1), 37. https://doi.org/10.11 86/s40561-025-00395-0	Heil, J., & Ifenthaler, D. (2025). Effects of teacher, peer and self-feedback on student improvement in online assessment: the role of individuals' presumptions and feedback literacy. *Assessment & Evaluation in Higher Education.* https://doi.org/10.10 80 /02602938.2025.25 30452	Heil, J. & Ifenthaler, D. (under review). University teachers' expectations for successful implementation of online assessment in higher education: A convention-based analysis. *Journal of Applied Research in Higher Education*
Research method	Systematic review ($N = 114$)	Survey study ($N = 223$)	Quasi-experiment ($N = 62$)	Qualitative interview study ($N = 33$)
Focus	Conceptual analysis of state-of-the-art research in online assessment	Students' individual AI competence and evaluation of GenAI tools for assessment	Students' perception of assessment modes and improvement as well as their individual feedback literacy	Teachers' wishes from online assessment in the context of their goal of higher education
Target group	Research	Students	Students	Teachers

1.3 Structure of this thesis

This thesis is structured into seven chapters. The first chapter establishes the relevance of the topic. The second chapter is concerned with the questions raised in the first chapter and positions this thesis in the context of established pedagogical findings and the current state of the literature. The focus lies in the design and development of assessments in higher education, exploring their application possibilities, and specifically how online assessments and AI can support learning. The subsequent four chapters encompass the four research studies. Chapter three reflects on the findings of a systematic review on online assessment in higher education to set a basis of understanding of how research is designing and implementing online assessment, as well as the identified benefits and challenges. Chapter four reflects on the student perspective and their intended use of different GenAI tools in assessment, as well as their perception of the influence on their learning processes. Chapter five moves on to different modes of feedback in online assessment as well as students' acceptance of these, and the effect of individual feedback literacy. Chapter six adds a new perspective by including a qualitative interview study with teachers at universities and their individual expectations of online assessment. After the presented four studies in their respective chapters, the findings are summarized and synthesized, as well as future research perspectives pointed out in Chapter seven.

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2 Conceptual foundation

This thesis is based on current research in the field of online learning, as well as sound pedagogical and psychological research. Therefore, first, a comprehensive understanding of assessment in higher education is developed, with a focus on learning-oriented assessment approaches. Following this, the role of online assessment is approached, and the potential of online assessment and artificial intelligence in higher education assessment is evaluated. It is crucial to engage in a critical discussion about the implications of online assessment, therefore, the challenges of online assessment in higher education are furthermore discussed.

2.1 Assessment in higher education

In practice, assessment serves a dual purpose: certification of competences on one side and ongoing learning support on the other (Boud, 2000; Winstone & Boud, 2022). In higher education this holds especially true, as it is a crucial phase for students seeking employment, while also equipping learners with the potential skill set for lifelong learning outside of the formal educational setting (Boud & Falchikov, 2006). Employability as a factor bridges the gap from HE to workplace learning, emphasizing for domain-specific knowledge as well as overarching competences such as social and metacognitive skills. Students rate employability skills as equally important as gaining knowledge for solely academic success (Cachia et al., 2018). Therefore, this double duty should not be understood as two separable goals that must be weighed against each other. Current assessment research, however, rarely engages with educational theory, even though assessment itself is a central component in pedagogical research (Nieminen et al., 2023). Therefore, it is essential to provide a short overview of the theories and research that shaped the current understanding of assessment in practice.

The discourse surrounding the term assessment encompasses a broad range of alternatives, including evaluation, examination, and testing. Assessment as a term refers to the collection of information from a learner in order to draw conclusions about their learning (Baker et al., 2016). Pellegrino et al. (2001) proposed that assessment as a process can be visualized in an assessment triangle consisting of the elements cognition, observation, and interpretation, which need to be

successfully aligned. According to the authors, assessment can only ever be an estimate. Cognition refers to how students develop a skill or competence in a specific area, which must be specified before designing the assessment. Observation refers to the tasks in assessment that will lead for the learner to provide evidence of their developed knowledge or competence. The interpretation is then applied to the observation, examining how it constitutes evidence about the assessed construct. This model was further adapted into an iterative square loop model as it can also measure a construct that is not cognitive and includes multiple steps of analysis (Shavelson et al., 2003). Assessment is therefore not only understood as a process of grading but bears greater potential beyond this purpose (Boud & Falchikov, 2007).

Several approaches in instructional design research shaped the general understanding of how to design the artifacts for assessment. Dating back to 1956, the development of Bloom's Taxonomy for learning outcomes is central in defining assessment criteria by focusing on different dimensions of cognitive processes, which are expected to be hierarchical (Krathwohl, 2002). This was followed by Gangés' domains of learning outcomes that require different training and assessment methods, such as verbal information, intellectual skills, psychomotor skills, attitudes, and cognitive strategies (Curry et al., 2021; Reiser, 2001). The 1970s witnessed a shift in focus toward criterion-referenced measurement, a concept that emphasizes measuring competencies in relation to defined criteria within a domain of tasks, rather than comparing learners (Glaser, 1990; Hambleton, 1993; Reiser, 2001). In addition to defining how to assess learning outcomes effectively, central theories in the learning sciences have developed active learning, considering students' preconceptions, metacognition, and learning development as central factors when creating assessments (Bransford et al., 2000). The focus on development is embedded in pedagogical theory such as the zone of proximal development by Vygotskij et al. (1978), which calls for dynamic assessment by supporting learners after their identified development potential through assessment, as well as his understanding that learning is socially and culturally dependent. Following this, based upon a social constructivist view, assessment has to be designed in understanding that students construct knowledge within a social context, and students need to take an active role in assessing their learning (Shepard, 2000). Ultimately, building up on this, the concept of constructive alignment was introduced (Biggs, 1996), which is

understood as a combination of constructivism and instructional design, by understanding that learners are central in creating in meaning and including the central assumption of instructional design that the objects of a course and the assessment should be aligned. According to constructive alignment, teachers should define the outcome that is intended to be achieved by the learner and then align the teaching activities as well as assessment tasks towards these goals (Biggs et al., 2022).

2.2 Learning-oriented assessment

Building upon this research, Carless (2007) introduced the concept of learning-oriented assessment, in which learning and not measurement is a central figure in assessment (Boud et al., 2018). Learning-oriented assessment should be implemented by augmenting the summative assessment and developed based upon an alignment of learning, teaching, and assessment (Davidson & Coombe, 2022). Three principles can be derived from this orientation:

1. Assessment should be designed to support active learning

2. Students should be involved and engage with the assessment and its criteria

3. Students should receive feedback as learning support (Carless, 2007).

Following, a model for learning-oriented assessment was developed, focusing on three key factors: learning-oriented assessment tasks, developing evaluative expertise in learners, and student engagement with feedback, all integrated as elements of a process (Carless, 2015).

2.2.1 Active engagement in assessment

The active engagement of learners is central to learning-oriented assessment and has been highlighted in research (Carless, 2015). Considering the current research on assessment, there are a multitude of terms that are discussed and evaluated, including assessment-as, -for, and -of learning, formative and summative assessment. The goal of this paragraph is to provide a short overview of these constructs and how they can support active learning, beginning with formative and summative assessment.

Generally, the main differentiation lies in the timing of the collection of data on the learning process. While formative assessment is used during and throughout a learning process to support further learning by identifying achieved goals and gaps in learning, summative is used at the end of a unit, to assess the outcome of a learning process (Dolin et al., 2018) and is commonly used for high-stakes, cumulative purposes (Shute & Becker, 2010). Formative assessment emerged as a method based on theoretical works such as cognitive acceleration and Perrenoud's concept of regulation, supporting cognitive growth in learners and fostering interactive regulation (Black & Wiliam, 2009). Furthermore, it ties in with the understanding of Vygotsky's calls for dynamic assessment. The use of formative assessment in university teaching shows a positive effect on learner attainment with testing as a basis for feedback, as well as peer feedback bearing promising potential (Morris et al., 2021). Furthermore, repeated testing is also understood to support learning retention based on the testing effect, aiding in bridging the forgetting curve and reconnecting knowledge (Roediger & Butler, 2011; Rowland, 2014). However, this separation is not all-compassing as the central idea of formative assessment can also be used at the end of a unit, informing further learning and summative assessment can be employed formatively to evaluate further topics to be covered in upcoming learning units (Dixson & Worrell, 2016). Summative assessment can also provide information used for the development of formative and the support of self-assessment (Biggs, 1998).

In addition to this distinction, research also uses other terms that focus more on the purpose of the assessment rather than the timing: assessment as, for, and of learning. All three terms are used inconsistently in current assessment research, the separation is still under debate, and practice reflects furthermore a lack of clarity (Schellekens et al., 2021). Broadly speaking, assessment *of* learning (AoL) is central in confirming what students learnt and how it aligns most with pre-defined criteria, it is often used interchangeably with summative assessment (Shute & Becker, 2010). Assessment *for* learning (AfL) calls for using assessment to identify gaps in the current learning and the subsequent adaptation of the learning process based on the results (Wiliam, 2011). AfL is shown to support students' intrinsic motivation (Pat-El et al., 2024). It is often implemented as formative assessment, and the terms are used interchangeably. In 2003, Earl introduced assessment as learning (AaL) as a

subset of assessment for learning (Earl, 2012). Assessment *as* learning focuses on the activity of the learner and refers to assessment being a central activity that fosters learning. Students learn from engaging with the materials and take on active and reflective roles supporting their development of metacognition and self-regulated learning (Yan & Boud, 2021). Students' participation in AaL activities positively impacts learning outcomes, especially cognitive abilities (Liu et al., 2024). Both AaL and AfL combine the focus on enhancing students' learning, one with a focus on a more intrinsic learning through the assessment and the other on using the assessment outcome in the learning process. The different purposes should be coherently linked to realize their full potential (Schellekens et al., 2021). As emphasized in the design of AaL and AfL, assessment can be used as a central pillar in the student learning process. This is not exclusive to formative, but also applicable to summative assessment.

2.2.2 Feedback

Next to student engagement, feedback is central in learning-oriented assessment; therefore, it is important to look at what feedback entails and how it ties into assessment. Feedback, especially formative, is understood as information and support that students receive in order to adapt their behavior to improve their learning (Shute, 2008). According to Hattie & Timperley (2007), effective feedback must answer three questions:

1. Where am I going?
2. How am I going?
3. Where to next?

In recent research, we see a shift from understanding feedback as a transmission of information to feedback as part of a learning process (Winstone et al., 2022). Dialogue should be at the center of feedback, which often falls short in higher education and leads to a general dissatisfaction among teachers and students (Nicol, 2014). Accordingly, the teachers' role in feedback is not to be understood as a sole provision of information but as providing students an environment to develop their ability to assess themselves and take action (Carless, 2022). Therefore, it is important to consider the ability of learners to use the feedback they receive to adapt their learning. Sutton (2012) introduced the concept of feedback literacy as a form of

academic literacy in order to effectively take up feedback. Winstone & Carless (2019) define it as the understandings, capacities and dispositions needed to make effective use of feedback information. Multiple different frameworks were proposed in order to identify the concepts building up feedback literacy of students. Carless & Boud (2018) define appreciating feedback, making judgements, managing affect and taking actions as central to feedback literacy. Molloy et al. (2020) identified in a focus group study that feedback literate students should accept, process, as act upon feedback. Dawson et al. (2024) developed a feedback literacy scale focusing on behavioral terms to measure individuals' literacy based on the two concepts. It consists of the five sub-components:

1. seek feedback,
2. make sense of the information,
3. use the feedback,
4. being able to provide feedback to others and
5. manage one's affect towards it.

Nieminen & Carless (2023) call for a nuanced discussion of the concept, which can be considered as either inherent to the individual or as a socially constructed phenomenon. As feedback is always an interplay between teachers and learners, teachers' feedback literacy is also central in enhancing feedback scenarios (Carless & Winstone, 2023). Carless & Boud (2018) identified practices of active engagement, such as engaging with exemplars or peer assessment, as supporting the feedback literacy of students.

2.3 Self-and peer assessment

Accordingly, it is evident that in order to engage learners in their assessment as well as supporting their development of feedback literacy, alternative modes of assessment can play a central role (Carless & Boud, 2018). Especially formative assessment is shown to support the learners' evaluative judgement by employing peer- and self-assessment aligned with supporting students' self-regulated learning (Panadero, Broadbent, et al., 2019). These modes of assessment move away from a teacher-centered focus and position the student as not only the assessed, but also the assessor. While in peer assessment, students rate other equal-level students work (Topping, 2009), they evaluate their own work in self-assessment (Boud, 2013;

Falchikov & Boud, 1989). Self-assessment can be defined as students collecting information about their progress in a descriptive and evaluative act and is shown to have the potential to be used in practice to enhance students' learning (Boud, 2013; Brown & Harris, 2013). While self-assessment is not be considered a very accurate form of measurement, its potential rather lies in improving learning outcomes and self-regulation, especially if the involvement is on a profound level (Brown & Harris, 2013). Accordingly, a meta-analysis by Panadero et al. (2017) identified that self-assessment can have a positive effect on students' self-regulated learning and support self-efficacy. A recent meta-review concerning self-assessment by Nieminen & Boud (2025) identified four central discussions in research on self-assessment, psychological, educational, performance and societal. The performance approach highlights the impact that self-assessment can have on learners' external assessment results, while the educational approach emphasizes the subjective agency that learners can exert in their learning processes. Quite similarly, research proposes the concept of evaluative judgement to position the discourse rather in a pedagogical and not a measurement-context. Evaluative judgement refers to the ability to make judgements about the quality of work (Tai et al., 2018) and can be supported by enabling learners to self-assess and therefore foster their critical thinking and evaluation abilities (Gladovic et al., 2024; Tai et al., 2018). Furthermore, Panadero, Lipnevich, et al. (2019) call for a transmission from self-assessment to self-feedback by enabling students to not only assess their work but also provide themselves with steps to further support their learning.

In a systematic review on designing peer assessment, Fleckney et al. (2025) highlight the potential of peer assessment, especially in formative settings, to enhance feedback literacy. They point out multiple factors, among others, supporting students by clear criteria, explaining the benefits, flexibility and supporting the teachers through culture and policy change as clear aspects to enhance learning environment A meta-analysis by Double et al. (2020) identified the robust effect that peer-assessment can have on academic performance and the potential it has as formative practice. While discussing self and peer assessment separately, these can also be fruitfully combined in learning practices (Cheong et al., 2023; Fleckney et al., 2025).

2.4 Online assessment

Having covered the foundational aspects of assessment, this thesis will focus on its central topic: online assessment and specifically, its application, design and reception in higher education. It is therefore important to examine this specific application, the impact it has on higher education practices, the challenges it poses and consider the need for changes in higher education assessment. The ways in which this can be achieved in detail through AI, analytics and alternative methods will be explained in more detail.

Online assessment in the context of this thesis is understood as conducting assessment through means of online technologies and entails a broad range of possibilities in implementation. Online assessment can help to rethink assessment practices that are centered around the teacher and summative-focused, and support learning-oriented assessment. Its introduction into higher education can be seen as an incentive to redesign and an opportunity to reflect on pre-existing assumptions and assessment design (Amrane-Cooper et al., 2024). Introducing digital tools into assessment can serve different purposes. For example, it can improve the assessment practice, support students in developing digital literacies and skills to complement digital technology work in the future (Bearman, Nieminen, et al., 2023).

A learning of the implementation in practice is that online assessment needs to be connected to educational goals and should not be implemented on top of pre-existing assumptions about technology. Rather than being implemented based on preconceived ideas about technology, they should be aligned with educational goals and reflected upon (Allan, 2020). This is because transferring traditional assessment on a new medium could perpetuate pre-existing problems or keep and enhance the best of tried and tested approaches (Conrad & Openo, 2018). The past introduction of technology has shown promising approaches as it led to a new range of classroom practices and supported out-of the box thinking, including flipped classroom approaches, Massive Open Online Courses (MOOCs), and adaptive learning (Jones et al., 2016) and in early research on this topic, projects, portfolios, weekly assignments as well as self- and peer-assessments were identified as high potential task types of taking assessments online (Gaytan & McEwen, 2007). Generally, due to asynchronous learning environments, shifts of assessment to a more formative, structured and active format were expected (Vonderwell et al., 2007). In evidence of

this, Gikandi et al. (2011) identified in their systematic review the potential impact of online formative assessment on supporting learning in higher education by allowing students to self-assess. However, more than that, through online tools, formative assessment with immediate feedback on the one hand, as well as competence-oriented assessment focusing on activities within the online environment, is possible (Guerrero-Roldán & Noguera, 2018). Additionally, aspects such as adaptation, personalization and intelligent tutoring can be implemented through online assessment (Webb & Ifenthaler, 2018). These approaches of online assessment can support developments towards an effective implementation of AaL by supporting learners in active engagement with their learning (Yang & Xin, 2022). Furthermore, authentic assessment can be employed through online assessment, fostering 21st century skills such as problem-solving, critical thinking and collaboration through flexibility and accessibility. Example methods include e-portfolios, online written assignments, podcasts or projects (Vlachopoulos & Makri, 2024). While large-scale multiple-choice tests online have the potential to assess large groups, provide real-time feedback and relieve teachers with regard to correction-workload, online assessment can also realize its full potential by allowing for authentic context assessment, group or peer learning and cognitive engagement (Boitshwarelo et al., 2017). Considering not only the effect of assessment on learning but also the administration of technology-based assessment, Chen et al. (2023) highlighted measurement accuracy, clarity, engagement, interaction, and in some instances even economic aspects as benefits in their systematic review.

Furthermore, the introduced alternative modes of assessment can be enhanced by being applied online. Peer assessment can be supported specifically by online systems through transforming classrooms, scalability, efficiency, and helping to enable learners to move away from studying for the test (Babik et al., 2024), as well as the possibility of anonymity (Seifert & Feliks, 2019). In the online setting, it is especially important to highlight the social context and support social interactions in order for peer assessment to achieve its potential (Kulkarni et al., 2016). Allowing students to self-assess online can be beneficial for their learning success (Ćukušić et al., 2014). Not only the medium of conducting the assessment online, but also the generated data can support learning significantly, which offers new possibilities that have not been possible in paper-pencil assessments. Building on this, the

implementation of Artificial Intelligence into higher education and assessment specifically creates new opportunities.

2.5 AI in higher education assessment

In a systematic review, Zawacki-Richter et al. (2019) identified central components of AI in education as: 1. profiling and prediction, 2. assessment and evaluation, 3. adaptive systems and personalization and 4. intelligent tutoring systems. When considering the area of assessment and evaluation, they identified four subcategories. 1. automated grading, 2. automated feedback, 3. evaluation of student understanding, engagement and academic integrity and 4. evaluation of teaching (Zawacki-Richter et al., 2019). Cavalcanti et al. (2021) conducted a systematic review on AI-based automated feedback and identified that most of the studies reported automatic feedback increasing student performance and that there is no evidence that manual feedback would be more efficient. They identified the main method for automated assessment as a comparison between answers and the expected solution. Chiu et al. (2023) identified in their systematic review predicting student performance as well as automated assessment as the central application scenario of AI in HE. However, apart from these more basic applications, over the years, generative Artificial Intelligence (GenAI) has gained significant attention in assessment research. GenAI can be defined as AI that generates seemingly new content in a natural language or as images or audio (Feuerriegel et al., 2024). A recent scoping review by Xia et al. (2024) identified the application scenarios of GenAI in assessment as providing immediate and perceived unbiased feedback, which might however, include other forms of biases, more diverse and innovative assessment, as well as aiding students in self-assessment. AI-tools in supporting self-assessment and personalization, if developed in a way of scaffolding, can support the developments of students in their zone of proximal development by providing real-time feedback and personalizing assessment (Cai et al., 2025). A systematic review by Lee and Moore (2024) focusing on GenAI automated feedback highlighted the reduction of teacher workload and the creation of supportive, stress-free learning environments. Zhao et al. (2024) also point out the potential for creating personalized assessments as well as grading students' work, this can include the process of automated essay grading (Ifenthaler, 2022), which rather focuses on long-

form assessment and not short answers. Generally, these models tend to grade specifically more style-related features of essays and less the content (Ramesh & Sanampudi, 2022). Therefore, these models are not applicable as a replacement for human grading of essays but rather as a support for self-assessment and providing support in developing writing skills. As aforementioned, AI can also complement peer feedback by rather concentrating on descriptive feedback, albeit possibly being of lower quality than peer feedback (Banihashem et al., 2024). Most importantly, automated assessment and feedback are not to be understood as replacing teachers in assessment.

2.6 Assessment analytics

An important application regarding online assessment to highlight is assessment analytics (Sahin & Ifenthaler, 2024), the connection between learning analytics and assessment. Learning analytics can be defined as the use of dynamic information about learners and their environments, assessing, eliciting, and analyzing them, in order to model, predict, and optimize learning processes, learning environments, and educational decision making (Ifenthaler, 2015). The central goal is gaining insights into unseen relationships through data mining or visualization (Ifenthaler & Drachsler, 2020), therefore it is vital that Learning Analytics should not be used just for the sake of an outcome but rather developed based on learning and teaching practices (Gašević et al., 2015). A meta-analysis by Zheng et al. (2024) identified that learning analytics have the potential to positively influence learning achievements but should be deliberately designed and connected to the respective learning design. Clow (2012) developed a learning-analytics cycle, according to which it is central to 'close the loop', in using the data that is generated by learners to inform metrics, analytics and visualizations. In this cycle, assessment can take on a specific role. In a traditional learning setting with summative assessment, the loop is not complete, as there is no feedback to the learner. However, data as an intermediate variable, as for example, through formative assessment, can provide valuable insights and inform interventions (Clow, 2012). The term assessment analytics was first coined by Ellis (2013), who called for its use, as previous research had not considered assessment data for learning analytics. The case for assessment analytics mostly focuses on using assessment data to support analytics. However,

when considering assessment, learning analytics can have the double potential of assessment of and for learning, by assessing indicators of learning as well as informing future assessment strategies and therefore enhancing the learning process (Archer & Prinsloo, 2020). Gašević et al. (2022) call for a stronger link between assessment and analytics and see future potential in analytics *for* assessment, analytics *of* assessment, and validity measurement in assessment. On the one side, the data-based analysis of learning allows for improved assessment of learning (Macfadyen, 2022), but as assessment is central in learning, the data that is elicited through assessment, can also be important for learning analytics by informing interventions, adaptive feedback or help students in self-assessment (Ifenthaler, Heil, et al., 2023).

Caspari-Sadeghi (2023) identified four main functions of LA in assessment:

1. monitoring,
2. automated feedback,
3. prediction, prevention and intervention
4. new forms of assessment.

Clear application scenarios can be created for each function. In this case, the accessibility of data presentation is central to include all learners (Gardner et al., 2021). Furthermore, computerized classification testing, including dashboards, can support automated feedback (Ifenthaler & Sahin, 2023). Assessment analytics can further support students' learning processes in personalizing learning environments, identify patterns and inform interventions (Sahin & Ifenthaler, 2024). Different kinds of assessment data can be used to inform about learners' progress (Ifenthaler, Schumacher, et al., 2023), including Pass or Fail information, the number of achieved points, or the number of attempts (Nouira et al., 2019). GenAI can also play a central role regarding LA, however, currently it is mostly implemented for automating discourse coding, scoring, or classification tasks and in practice, it is not frequently used for dashboard generation or automated feedback (Misiejuk et al., 2025). New forms of assessment might include methods such as stealth assessment, measuring learning continuously in the background while students engage, e.g. with games (Rahimi & Shute, 2024). Tying into this is the concept of serious game analytics, in which data such as time needed, number of mistakes and corrections, amounts of access, content accesses and types of contents accessed can be analyzed and used

for learning analytics and assessment (Loh et al., 2015). Furthermore, analytics can support self- and peer assessment. Considering self-assessment, learning analytics systems can provide the objectives, rubrics, and standards as well as supporting them with automated feedback and prompting learners in taking personalized assessments (Schumacher, 2023). Additionally, peer assessment is supported in practice by analytics and AI (Misiejuk & Wasson, 2023). This can be achieved, for example, through:

1. guidelines and assistance to student-assessors during for better feedback,
2. improving the accuracy of the assigned grades,
3. developing feedback on review strategies that enable peer assessors to better review
4. spot-checking mechanism to assist instructors in overseeing the process (Darvishi et al., 2022)

In the context of employing AI in higher education assessment, it is not only crucial that learners are literate concerning feedback but also competent when dealing with AI, as it is seen to be a significant contributor in the interaction with AI-tools in their learning processes (Chiu, 2024; Delcker et al., 2024). AI-competence encompasses multiple sub-categories, including theoretical knowledge, legal framework, implications, attitudes, learning with AI and ongoing professionalization (Delcker et al., 2025). While this research has traditionally taken place in a more computer science-led field, it has gained significant attention in educational research in recent years (Sperling et al., 2024). Considering AI, training and support regarding GenAI for students and teachers, as well as guidelines by institutions and piloting new assessments to support students' needs are crucial (Zhao et al., 2024). Therefore, it is important to consider not only how online assessments can be designed, but also how they can be implemented in higher education.

2.7 Ethical challenges

When discussing the potential of online assessment, it is central to also consider potential drawbacks and necessary barriers. Ethical consideration in online assessment, especially with consideration of AI-based systems and analytics, should not be an afterthought, but an integral part of the development and implementation strategy (Heil & Ifenthaler, 2024).

In research, the most addressed concerns when it comes to implementing analytics are transparency, privacy, and informed consent (Pargman & McGrath, 2021). A review by Tzimas & Demetriadis (2021) identified a lack of empirical evidence-based guidelines on learning analytics ethics, therefore, they developed a checklist including privacy, autonomy, non-probabilitic algorithms, duty to act, openness and transparency, resolve the data ownership, and all stakeholders (PANDORA).

Major challenges that were identified by Ferguson (2019) include a duty to act, supporting the idea that HE has the duty to provide learners with the possibility to enhance their learning, informed consent, safeguarding, equality and justice, and privacy and integrity of self.

Two main discourses, that arise through the implementation of GenAI lie in imperative change (inevitable change to which all need to respond) and altering authority (spreading responsibility from teachers to machines and institutions) (Bearman, Ryan, et al., 2023). An important consideration when students use large language models is that it can lead to so-called 'sealed knowledge'. This does not encourage complex engagement with materials but rather provides single answers that are accepted as facts, in contrast to engaging with multiple sources (Lindemann, 2024). Other ethical challenges that emerge through the usage of AI in education are considering the equality of all learners, as well as the potential biases of AI systems when used for grading (Amrane-Cooper et al., 2024). Furthermore, it is important to keep in mind that the costs of premium GenAI-tools can create an unfair advantage between students based on their financial situation (Foung et al., 2024).

2.7.1 Misconduct

Concerns about possible misconduct in online assessment have been a constant companion of research. The empirical results of cheating occurring more online and offline are mixed (Holden et al., 2021), a recent systematic review, however, highlighted an increase in self-reported cheating in summative examinations during the COVID-19 pandemic, mostly by searching the web during the exam (Newton & Essex, 2024). This, however, was focused on emergency remote teaching and summative examinations, and it is pertinent to consider that the

discussion of academic misconduct often relies on summative, knowledge-based assessment methods that would be considered Assessment *of* Learning.

Beyond cheating on exams, GenAI, as mentioned, has created a new challenge for online assessment by the ability to create large bodies of text (Zhao et al., 2024). The main concern lies in the academic integrity of students' work, which could be created by GenAI and passed off as their own (Xia et al., 2024). Luo (2024) additionally raises the question how, in times of GenAI, the concept of originality can even be approached and understood, considering the omnipresence of GenAI. Addressing these concerns, Chiu (2024) expanded the role of GenAI in assessment by including the changes brought to assessment through GenAI. Summative exams might no longer be sufficient to satisfy their needs and prepare them for the future, as they are not the most effective way to assess, especially if GenAI could do it for students. Therefore, in-class activities should be adapted by including formative assessment and furthermore, more single artefacts created by students should be used for assessment and regarding originality, students should be required to use different sorts of evidence, develop new materials and engage in peer feedback.

2.7.2 Privacy concerns

Considering analytics, students report being quite conservative considering the amount of data they would be willing to share (Ifenthaler & Schumacher, 2016). Furthermore, the concerns of misconduct also raise an additional ethical concern. When addressing misconduct, especially during large-scale assessments, many universities decide to use proctoring as exam supervision. This creates new ethical challenges, as it puts students' privacy at risks, contributing to a fear of surveillance, mining of massed personal data and AI-based decision making (Coghlan et al., 2021). Simultaneously, more data does not automatically mean better data. Institutions need to prepare for analytics and need to define who has access, which data is even relevant and should be stored and consider aspects of how long and where to store the data (Ifenthaler & Tracey, 2016).

Summary

Research clearly highlights the potential of online assessment in higher education, while also pointing out aspects to be considered in effective

implementation. Foremost, online assessment can be used to support adaptive and personalized learning, alternative learning-oriented assessment modes, flexibility and formative assessment. However, online assessment cannot fulfil the anticipated potential if it is just used as a technological tool to transfer pre-defined assumptions about assessment of learning onto a new platform. To elicit this change, all stakeholders must be included and ethical as well as privacy-related concerns must be taken seriously. Furthermore, the momentum disruption of online assessment could be used as a time to step back and reconsider how assessment is used in higher education right now and how alternatives to high-stakes summative assessments can be implemented.

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3 Online assessment in higher education: a systematic review

3.1 Introduction

Tracing the history of educational assessment practice is challenging as several diverse concepts refer to the idea of assessment. Our recent search in scientific databases identified an increase in research publications focusing on assessment from the 1950s to the 2020s by over 380%. Despite an intense debate over the past seven decades, the distinction between formative and summative assessment has not resulted in a precise definition and the distinction between the two remains blurry (Newton, 2007). The nature of formative and summative assessment and the difficulties of characterizing their differences and interrelationships have been discussed extensively in the literature (Black & Wiliam, 2009). Further, other terms have been introduced such as learning-oriented assessment emphasizing the development of learning elements of assessment (Carless, 2007), sustainable assessment, proposing the support of student learning beyond the formal learning setting (Boud, 2000), or stealth assessment denoting assessments that take place in the background without the user noticing it (Shute et al., 2016). More recently, the use of online assessments has been increasing rapidly, as they offer the promise of cheaper ways of delivering and marking assessments as well as access to vast amounts of assessment data from which a wide range of judgments might be made about students, teachers, schools and education systems (Webb & Ifenthaler, 2018). However, the various opportunities of online-enabled assessment also resulted in conceptual inconsistencies concerning the formats, modes, and types of online assessment.

In this article, online assessment is defined as a systematic method of gathering information or artifacts about a learner and learning processes to draw inferences about the person's dispositions using information and communication technology (Baker et al., 2016). We argue that the future of assessment faces major challenges including, perhaps most importantly, the extent to which assessments, when realized in online environments, can serve simultaneously the needs of learners and those of teachers as well as the educational organization. Gikandi et al. (2011) emphasized the opportunities of online assessments for enabling meaningful feedback and providing interactive support for learners. Further empirical research

concerning online assessment highlights possible influences on the engagement of learners and learning outcomes (Nguyen et al., 2017). With the increased usage of online learning environments, such as MOOCs (Bonk et al., 2015), and the stronger presence of distance education programs (Moore & Kearsley, 2011), empirical studies have focused on different implementations of online assessments: for instance, online formative assessments (Baleni, 2015), digital game-based assessments (Kim & Ifenthaler, 2019), or online peer- and self-assessments (Admiraal et al., 2014). Attention has also been paid to best practice examples of embedding assessments in online learning environments (Martin et al., 2019). Further, developments in data analytics increased the awareness of Machine Learning and related algorithms for (semi-)automated assessment approaches (Lee et al., 2021), or analytics-enhanced online assessment (Ifenthaler et al., 2018; Gašević et al., 2022). A promising line of research emphasizes the opportunities of learning analytics and online assessments for providing (near) real-time informative feedback to learners and teachers (Gašević et al., 2022; Ifenthaler & Greiff, 2021; Martin & Whitmer, 2016; Tempelaar et al., 2018).

Given the controversial findings and discussions on online assessment, especially the conceptual inconsistencies of online assessments, the purpose of this systematic literature review is to identify and synthesize original research studies focusing on online assessments in higher education. The systematic review follows the PRISMA guideline for reporting systematic reviews (Page et al., 2021). We provide a functional platform for the scientific community to better understand differences in the design of online assessments, highlight the affordances for technological implementation of online assessments, and identify new research areas focusing on online assessments. Implications for pedagogical practice emphasize the requirement of a design framework for online assessments in higher education.

Online assessment in higher education

Black (1998) defines three main distinctions of assessment: (a) formative assessment to aid learning; (b) summative assessment for review, transfer, and certification; (c) summative assessment for accountability to the public. Pellegrino et al. (2001) extend this definition with three main purposes of assessment: (a) assessment to assist learning (formative assessment), (b) assessment of individual

student achievement (summative assessment), and (c) assessment to evaluate programs (evaluative assessment). To facilitate learning through assessment, Carless (2007) emphasizes that assessment tasks should be learning tasks, that are related to the defined learning outcomes and distributed across the learning and course period.

3.1.1 Online assessment

Online assessment describes the assessment of students learning with methods including information and communication technologies (Conrad & Openo, 2018). This does not restrict online assessment to fully online courses and can also be implemented in a blended learning format (Gikandi et al., 2011). Online assessments may take on different pedagogical functions as part of online learning environments (Webb & Ifenthaler, 2018), for example, scaffolding students to complete a task and measuring how much support they need (Ahmed & Pollitt, 2010), or providing students with semantic rich and personalized feedback, as well as adaptive prompts for reflection (Ifenthaler, 2012; Schumacher & Ifenthaler, 2021). Other examples of online assessments include a pedagogical agent acting like a virtual coach tutoring learners and providing feedback when needed (Johnson & Lester, 2016) as well as an analysis of a learner's decisions during a digital game or simulation (Bellotti et al., 2013). Other online assessments use multimedia-constructed response items for authentic learning experiences (Lenhard et al., 2007) or provide students with an emotionally engaging virtual world experience that unobtrusively documents the progression of a person's leadership and ethical development over time (Turkay & Tirthali, 2010). Thus, online assessments offer a broad range of pedagogical functions including a medium for communication, a learning assistant, a judge, a test administrator, a performance prompt, a practice arena, or a performance workspace (Webb et al., 2013). Online assessment can be performed formatively throughout the learning progress or in a summative way at the end of a learning segment (Gikandi et al., 2011).

3.1.2 Types, modes, and formats of online assessments

In the course of drawing inferences about students' learning process, online assessment can include different *types of assessments*, ranging from single- and

multiple-choice quizzes, written exams or essays, and oral presentations to authentic assessments including project-based cases, games and simulations, or e-Portfolios (Conrad & Openo, 2018). (Audience Response Systems are not included in our definition of online assessment.)

The assessment process can be performed by different individuals or groups, i.e., different *modes of assessment*. Peers have the potential to take on the role of the assessor and provide each other with feedback (Admiraal et al., 2014). Learners might also self-assess by evaluating their learning process and outcome themselves or by reflecting on their learning (Conrad & Openo, 2018). Furthermore, the possibilities in online assessment also allow for automated assessment providing automated feedback (Gamage et al., 2019).

In this systematic review, an *online assessment format* can either be formative or summative. An *online assessment mode* may be self-assessment, peer-assessment, teacher-assessment, or automated-assessment (system-based). An *assessment type* refers to the implemented task of the assessment. This might include for example quizzes, essays, e-Portfolios, project-based tasks, or others.

3.1.3 Previous systematic reviews

The above-noted increase in assessment-related publications also set forth several systematic reviews concerning the field of assessment. The work by Dochy et al. (1999) emphasized the relationship between learning and assessment. The review included $N = 63$ studies suggesting that different assessment forms, such as self-, peer, and co-assessment support learners in becoming more responsible and reflective. With the advent of online technologies, assessment-related research included new approaches, especially online assessments. Gikandi et al. (2011) provided the first comprehensive overview of online formative assessment. The findings of the $N = 18$ key studies suggested that effective online formative assessment can foster formative feedback and enhanced learner engagement. Furthermore, the field has undergone many developments in the last few years. In a more recent publication, Wei et al. (2021) reviewed $N = 65$ studies that focused on MOOCs and the different assessment types related to learning outcomes. Montenegro-Rueda et al. (2021) focused on the implementation of assessment with consideration of the impact of the COVID-19 pandemic on higher education.

Therefore, this review of $N = 13$ articles did not provide a comprehensive overview of how online assessment is developed and used, irrespective of the necessity due to the worldwide exceptional situation. The rationale behind this review was to provide an updated, broad overview of variations of online assessment in higher education and to analyze how they are designed and implemented as well as their potential in supporting learning and teaching in emergency situations.

3.1.4 Purpose of the study and research questions

Given the renewed awareness of online assessments (Gašević et al., 2022), the purpose of this systematic literature review is to identify and synthesize original research studies focusing on online assessments. Three main research questions guide the systematic review process: (1) Which modes (e.g., self-assessment, peer-assessment, teacher-assessment, automated-assessment) are used in online and blended learning and for each assessment mode, what formats (formative or summative), and types (e.g., quiz, essay) and feedback are implemented in higher education? (2) What are the objectives of online assessments in higher education? (3) What are the success factors for accepting and using online assessments in higher education?

3.2 Method

This systematic review followed the PRISMA guideline for reporting systematic reviews (Page et al., 2021).

3.2.1 Data sources and search strategies

The research process is outlined in Figure 3 – 1 and involves a systematic search of international research databases including ScienceDirect, Web of Science, ACM Digital Library, DBLP, Google Scholar, ERIC, etc. Additionally, relevant journals in the field of Learning Sciences and Educational Technology were used in the research process and are listed in the next section. The search includes articles published since January 2010 (marking the increased availability of empirical findings focusing on online environments such as MOOCs) until June 2022 to ensure that there were enough publications to capture different research trends. Keywords for the literature search in titles, abstracts, keywords, and full texts include combinations of

"assessment," "online," "higher education," "learning outcomes," "MOOCs," plus additional keywords based on a first scan of results.

3.2.2 Identification and screening process

Initial screening of articles followed specific inclusion criteria: The study (1) presents empirical findings, (2) examines online assessments, (3) is in the field of higher education, (4) is published between 2010 and 2022, (5) is written in English, (6) is published in a peer-reviewed scientific journal, and (7) has an abstract available. The methodology strictly followed the use of a pre-defined research protocol and included a rigorous validation process involving human raters. The research protocol included a detailed description of the identification, screening, and inclusion criteria (see Figure 3 – 1 for a description of main criteria). For example, the screening process followed exclusion criteria such as the language of the article not being English, the articles not including empirical findings, or the research was not focused on higher education. The key insights from these publications were synthesized into the final findings reflecting the state of research on online assessments for supporting learning and teaching in higher education as well as highlighting implications for pedagogical practice.

Figure 3 – 1 Diagram of the systematic literature review process.
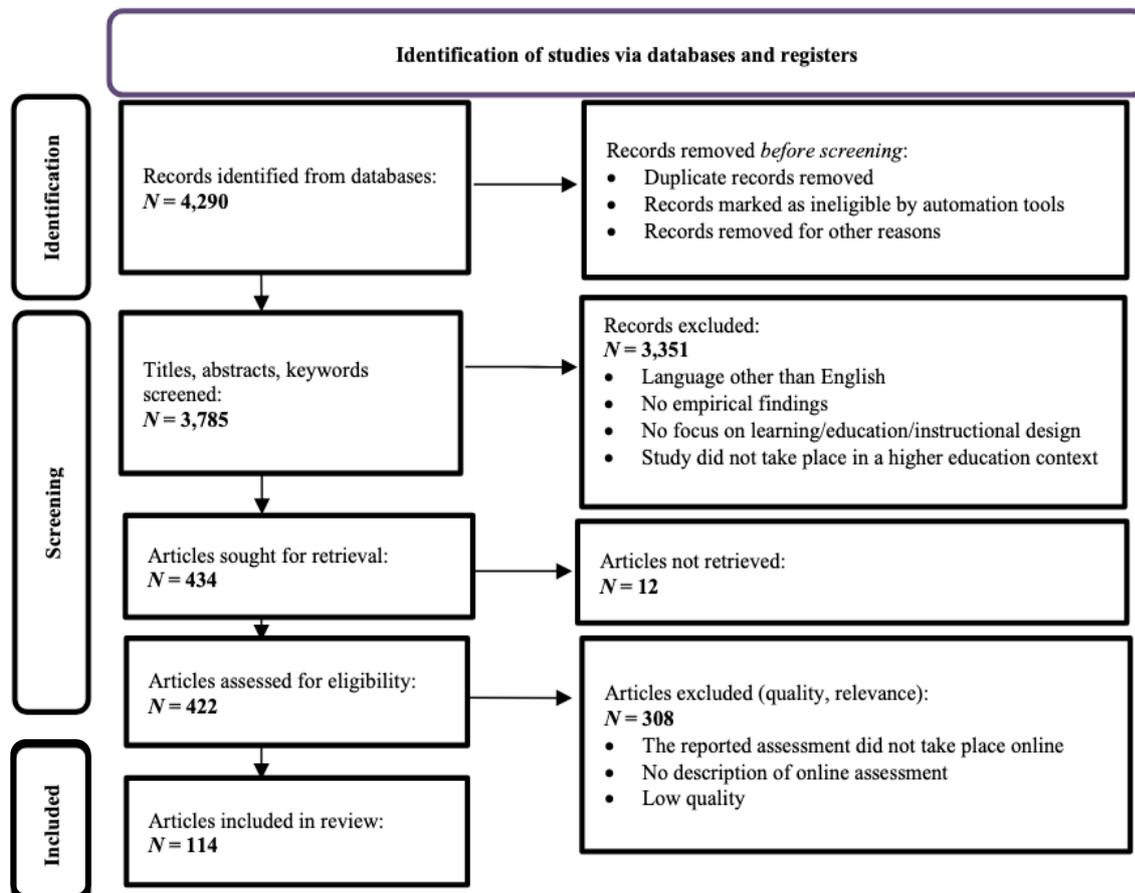
The predefined identification and screening process included five major steps as follows: Identification of international databases: GoogleScholar, ACM Digital Library, Web of Science, Science Direct, ERIC, and DBLP.

Specific search in relevant peer-reviewed scientific journals, according to the top 20 journals on educational technology in Google Scholar to cover the most impactful contributions in the field. These are: *Australasian Journal of Educational Technology*, *British Journal of Educational Technology*, *Computer Assisted Language Learning*, *Computers & Education*, *Education & Information Technologies*, *Educational Technology Research & Development*, *IEEE Transactions on Learning Technologies*, *Interactive Learning Environments*, *International Journal of Artificial Intelligence in Education, International Journal of Educational Technology in Higher Education*, *International Journal of Emerging Technologies in Learning*, *International Journal of Instruction*, *Journal of Computer Assisted Learning*, *Journal of Educational*

Computing Research, *Journal of Educational Technology & Society, Language Learning & Technology*, *TechTrends*, *The International Review of Research in Open and Distributed Learning*, *The Internet & Higher Education*.

The search was conducted using the terms: "assessment," "online," "higher education," "learning outcomes," and "MOOCs." Based on this search, $N = 4{,}290$ publications were found. After the removal of duplicates, the sample included $N = 3{,}785$ publications. A title search removing publications with irrelevant topics leads to $N = 1{,}401$ and an in-depth abstract search to a final $N = 434$ publications. After a full-text search, $N = 114$ publications were identified and included in this systematic review.

3.2.3 Data coding

The selected publications were open-coded. The coded items included as descriptive information the authors and the year of publication. Concerning the reported assessment, formats, modes, types, and feedback were coded. Relating to the context of the assessment of the course, its type (blended vs. online) as well as the domain, country, and educational level were classified. Additionally, the objective of the study was analyzed and summarized.

3.2.4 Data analysis

The data analysis was conducted in the form of qualitative content analysis. Based on the coded data, central concepts were identified, summarized, and synthesized in an inductive format. The data was then analyzed quantitatively as well as qualitatively.

3.3 Results

3.3.1 Summary of publications

Out of the 114 publications (see Table 8 – 1 in Appendix), the majority came from the United States ($N = 30$; 26%) as well as from Australia ($N = 18$; 16%), the United Kingdom ($N = 13$; 11%), Spain ($N = 10$; 9%) and Germany ($N = 6$; 5%). Out of these studies, 42% ($N = 48$ researched online assessments in blended learning scenarios, while 33% ($N = 38$) investigated assessments in fully online courses. Five studies (4%) included blended and online scenarios, and 23 (20%) studies did not

state the learning and assessment scenario. Eight publications investigated assessments that took part in Computer Science, Education Science, or Teacher education, as well as in Mathematics, seven in Business Education, five in English Second Language Learning, four in Psychology, and three in both Pharmacy and Statistics & Biology. Ten studies investigated multiple domains.

Most studies included participants from undergraduate courses ($N = 65$; 57%), ten from graduate, and one from postgraduate. A further 18 studies included participants from multiple educational levels, twelve studies researched MOOCs, in which the educational level of participants was not assessed and eight did not clearly state. Most publications included in the final sample were published in the year 2018 ($N = 23$); 13 were published in 2021 and in 2020, 12 in 2019, 11 in 2016, 10 in 2017 as well as in 2014, 6 in 2015, 2013, and 2012, 2 in 2022 and 1 in 2011 as well as in 2010.

3.3.2 Types of online assessment in higher education (RQ1)

Assessment types are diverse and include a broad range of possible implementations. Additionally, many publications included multiple types. Some main categories of types could nonetheless be identified. $N = 42$ (37%) publications reported some type of quiz, $N = 18$ (16%) essays or other writing tasks, $N = 15$ (13%) ePortfolios, and equally $N = 15$ (13%) publications included in their work other tasks such as programming, calculations, translation etc. $N = 12$ (10%) cases described a type of project-based learning and $N = 11$ (9%) short- or open answer questions. $N = 4$ reported students working on a Wiki, $N = 2$ learner-generated questions and $N = 2$ journaling. $N = 13$ (11%) did not clearly state the actual type of assessment.

Modes of online assessment in higher education (RQ1) The modes of online assessment were identified as peer-assessment, automated-assessment, teacher-assessment, and self-assessment. Concerning assessment formats, the publications included $N = 49$ (43%) studies that described solely formative assessment, $N = 34$ (30%) studies that examined formative as well as summative assessment, $N = 26$ (23%) only summative, and $N = 4$ did not clearly state the format of assessment. One publication focused on pre-class assessment.

Figure 3 – 2 provides an overview of the included assessment modes by year of publication.

Figure 3 – 2 Summary of publications identifying the focus of assessment modes
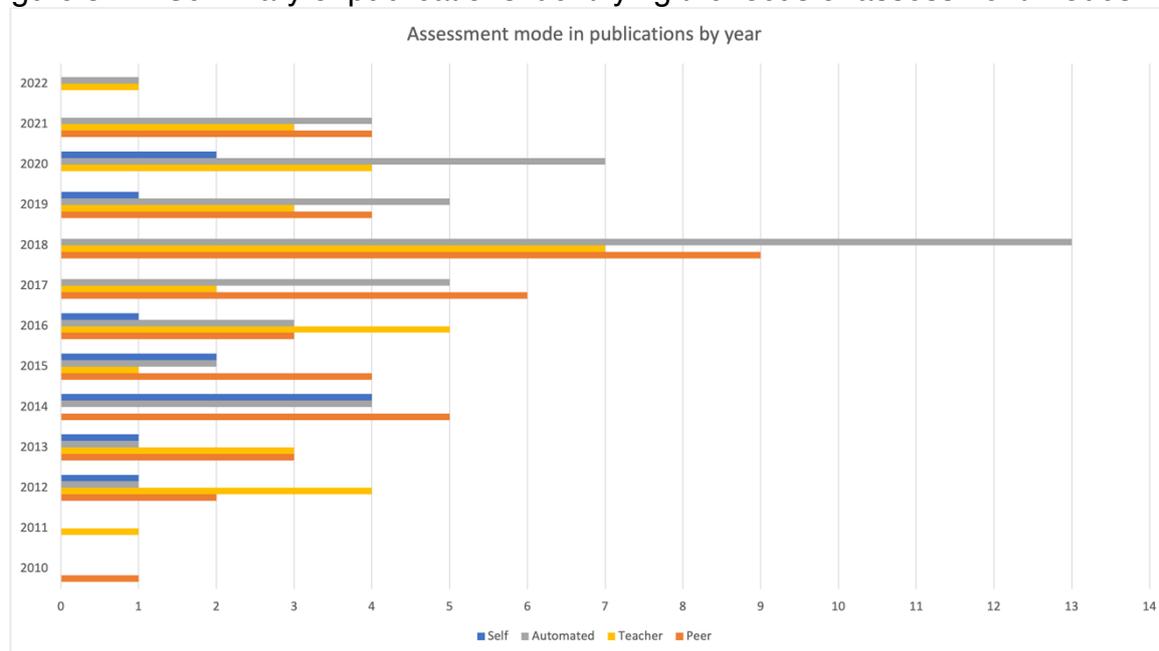
Assessment mode: Peer assessment

Out of the 114 publications, $N = 41$ (36%) included some mode of peer assessment.

    Implementation type: Peer assessment was frequently realized using essays (Admiraal et al., 2015; Chew et al., 2016; Formanek et al., 2017; Huisman et al., 2018; ; Meek et al., 2017; Sullivan & Watson, 2015; Zong et al., 2021). But also other writing types were reported, such as creative writing (Ashton & Davies, 2015), scientific writing (Herzog & Katzlinger, 2017; Mao & Peck, 2013), creating entries in a shared wiki (Hickey & Rehak, 2013; Sampaio-Maia et al., 2014), translation tasks (Ortega-Arranz et al., 2019), or letter-writing (Liu et al., 2018). Peer assessment also included types such as e-Portfolios (Chew et al., 2016; Vaughan, 2014; Xiao & Hao, 2018), or e-Journals (Zhan, 2021). In addition, peer assessment was implemented in the context of project-based learning. For example, in tasks of creating plans, such as business plans (Sekendiz, 2018) or teaching plans (L. Li et al., 2010; Li & Gao, 2016). Others focused on educational projects (Wadmany & Melamed, 2018), research projects (Liu & Lee, 2013; Wu et al., 2014), art (Tucker et al., 2014), or design projects (McCarthy, 2017). Peer assessment was also implemented as team projects (Tucker, 2014), or on shorter project tasks in linguistics (Rogerson-Revell,

2015). Other types of assignments that were assessed through peers included mathematical calculations (Kristanto, 2018), or statistical exercises (ArchMiller et al., 2017). Further, oral assignments in language learning (Chen et al., 2021), diagram exercises (Pinargote-Ortega et al., 2021), discussion entries (Wang, 2019), and question generation (Yeh & Lai, 2012) were implemented assessment types.

Assessment format: In *N* = 15 (13%) articles, peer assessment was implemented in the format of formative assessment (Chen et al., 2021; Elizondo-Garcia et al., 2019; Filius et al., 2018; Filius et al., 2019; Hickey & Rehak, 2013; Kristanto, 2018; Mao & Peck, 2013; McCarthy, 2017; Ogange et al., 2018; Rogerson-Revell, 2015; Sekendiz, 2018; Tucker et al., 2014; Vaughan, 2014; Xiao & Hao, 2018; Zong et al., 2021). In 14 cases, peer assessment was implemented for solely summative assessment format (ArchMiller et al., 2017; Ashton & Davies, 2015; Formanek et al., 2017; *L.* Li et al., 2010; Luaces et al., 2017; Pinargote-Ortega et al., 2021; Sampaio-Maia et al., 2014; Sullivan & Watson, 2015; Tenório et al., 2016, Tucker, 2014; Wadmany & Melamed, 2018; Wang, 2019; Wu et al., 2014; Zhan, 2021). A combination of formative as well as summative assessment formats was reported in 12 learning scenarios (Admiraal et al., 2015; Chew et al., 2016, Herzog & Katzlinger, 2017; Huisman et al., 2018, Li & Gao, 2016; Liu & Lee, 2013; Liu et al., 2018; McCracken et al., 2012; Meek et al., 2017; Nguyen et al., 2017; Ortega-Arranz et al., 2019; Yeh & Lai, 2012).

Feedback: In most cases, peer feedback was provided in a written format and if graded, included reasoning for a given grade. Grades and feedback were frequently based on some form of a pre-defined grid, such as a rubric, for students to align with when creating their feedback and giving grades to their fellow students (Admiraal et al., 2015; ArchMiller et al., 2017; Ashton & Davies, 2015; Chen et al., 2021; Chew et al., 2016; Elizondo-Garcia et al., 2019; Formanek et al., 2017; Herzog & Katzlinger, 2017; Huisman et al., 2018; Liu & Lee, 2013; Li & Gao, 2016; Liu et al., 2018; Luaces et al., 2017; Mao & Peck, 2013; McCarthy, 2017; Meek et al., 2017; Pinargote-Ortega et al., 2021; Tenório et al., 2016; Tucker et al., 2014; Tucker, 2014; Wadmany & Melamed, 2018; Wu et al., 2014; Xiao & Hao, 2018; Zhan, 2021; Zong et al., 2021). Other cases, in which written feedback was given without a rubric, included reviews (Sampaio-Maia et al., 2014), feedback in a narrative form (Sullivan

& Watson, 2015), constructive criticism (Kristanto, 2018; Rogerson-Revell, 2015, Sekendiz, 2018; Wang, 2019), or comments on the work of other students (Ogange et al., 2018; Yeh & Lai, 2012). Other modalities of peer feedback were examined in studies, such as dialogue peer feedback, including the responses of the assessed students on the feedback (Filius et al., 2018; Hickey & Rehak, 2013), providing peer feedback in an audio format (Herzog & Katzlinger, 2017) or with a gamified approach (Ortega-Arranz et al., 2019)

Assessment mode: Automated assessment

Some variation of automated assessment mode was included in $N = 46$ (40%) studies.

Implementation type: Automated assessment was mostly used on quizzes. Quizzes included all sorts of tasks that did not require students to write longer answer, such as multiple-choice questions, single-choice questions, blank-filling or crossword-type tests (Admiraal et al., 2015; Azevedo et al., 2022; Babo et al., 2020; Bacca-Acosta & Avila-Garzon, 2021; Bekmanova et al., 2021; Carpenter et al., 2017; Chaudy & Connolly, 2018; Davis et al., 2020; Dermo & Boyne, 2014; Förster et al., 2018; Gamage et al., 2019; : Guerrero-Roldán & Noguera, 2018; Hughes et al., 2020; Huisman et al., 2018; Kühbeck et al., 2019; López-Tocón, 2021; Mao & Peck, 2013; Meek et al., 2017; Mora et al., 2012; Ortega-Arranz et al., 2019; Reilly et al., 2016; Ross et al., 2018; Sancho-Vinuesa et al., 2018; Schaffer et al., 2017; Shaw et al., 2019; Stratling, 2017: Taghizadeh et al., 2014; Tempelaar, 2020; Thille et al., 2014; Wilkinson et al., 2020). Automated assessment, including Natural Language Processing, was also used on short-answer questions (Carnegie, 2015; Chen et al., 2018; Ellis & Barber, 2016), or tasks including longer texts (Reilly et al., 2016; Santamaría Lancho et al., 2018; Xian, 2020). Other implementation types included mathematical exercises (Acosta-Gonzaga & Walet, 2018; Yang et al., 2016), programming tasks (Polito & Temperini, 2021; Thille et al., 2014), or interactive activities (MacKenzie, 2019; Turner & Briggs, 2018). Additional automated assessments included the assessment of language proficiency (Fratter & Marigo, 2018).

Assessment format: Automated assessment was mostly used for formative assessment and rarely for summative. In 23 cases, an automated assessment was

used in the context of solely formative assessment (Acosta-Gonzaga & Walet, 2018; Bacca-Acosta & Avila-Garzon, 2021; Bekmanova et al., 2021; Carpenter et al., 2017; Chen et al., 2021; Förster et al., 2018; Gámiz Sánchez et al., 2014; Hughes et al., 2020; Kühbeck et al., 2019; López-Tocón, 2021; MacKenzie, 2019; Meek et al., 2017; Ogange et al., 2018; Polito & Temperini, 2021; Reilly et al., 2016; Sancho-Vinuesa et al., 2018; Santamaría Lancho et al., 2018; Scalise et al., 2018; Schaffer et al., 2017; Stratling, 2017; Tempelaar, 2020; Wilkinson et al., 2020; Xian, 2020). A total of 15 cases included formative as well as summative assessments (Admiraal et al., 2015; Azevedo et al., 2022; Babo et al., 2020; Carnegie, 2015; Davis et al., 2020; Dermo & Boyne, 2014; Gamage et al., 2019; Guerrero-Roldán & Noguera, 2018; Huisman et al., 2018; Mora et al., 2012; Nguyen et al., 2017; Ortega-Arranz et al., 2019, Wells et al., 2021; Yang et al., 2016, Turner & Briggs, 2018) and only six cases used automated assessment exclusively as summative assessment (Chaudy & Connolly, 2018; Ellis & Barber, 2016; Ross et al., 2018; Shaw et al., 2019; Taghizadeh et al., 2014; Mao & Peck, 2013). In one case it was used pre-class (Fratter & Marigo, 2018).

Feedback: Feedback provided through automated assessment mostly included some form of corrective feedback (Bacca-Acosta & Avila-Garzon, 2021; Carpenter et al., 2017; Chen et al., 2018; Förster et al., 2018; Gámiz Sánchez et al., 2014; López-Tocón, 2021; MacKenzie, 2019; Meek et al., 2017 , Ross et al., 2018; Sancho-Vinuesa et al., 2018; Stratling, 2017; Wilkinson et al., 2020; Davis et al., 2020). Other types of automated feedback included guidance in case of wrong answers towards the correct solution (Acosta-Gonzaga & Walet, 2018; Carnegie, 2015; Guerrero-Roldán & Noguera, 2018), explanation for common mistakes (Gamage et al., 2019), retrieval cues (Shaw et al., 2019) or explanations & worked solution (Scalise et al., 2018). More elaborated, personalized feedback included tailored feedback on personal proficiencies (Ellis & Barber, 2016; Hughes et al., 2020; Stratling, 2017; Taghizadeh et al., 2014; Thille et al., 2014), and recommendations on topics to further study (Yang et al., 2016). Feedback was also provided to students as automatic comments on writing (Xian, 2020), or a report on the students' performance (Schaffer et al., 2017). The potential of automated feedback was also used to develop visual representation of the retrieved data, such as histogram about students' proficiencies (Fratter & Marigo, 2018), or graphical

representations of accuracy of answers (Santamaría Lancho et al., 2018). One approach included feedback in alignment with the learning behavior (Tempelaar, 2020). In other cases, feedback was given by means of gamification, such as badges and rewards (Ortega-Arranz et al., 2019; Polito & Temperini, 2021).

Assessment mode: Teacher assessment

Assessment of students through a teacher was identified in $N = 34$ (30%) studies. Teacher assessment mode in this context includes tutors, graduate assistants, a teaching team, or the instructors of the classes.

Implementation type: The assessment by teachers was incorporated in a variety of cases. For instance, teacher assessment was frequently used on e-Portfolios (Birks et al., 2016; Farrelly & Kaplin, 2019; Jarrott & Gambrel, 2011; McNeill et al., 2012; Nicholson, 2018; Wang & Wang, 2012; Xiao & Hao, 2018), and in other cases on essay tasks (Law, 2019; Milne et al., 2020; Reilly et al., 2016; Sarcona et al., 2020; Turner & Briggs, 2018; Luaces et al., 2017; Chew et al., 2016), as well as on other forms of writing exercises, such as scientific writing ; Mao & Peck, 2013), wiki entries (Hickey & Rehak, 2013), or writing exercises in language learning (Xian, 2020). Teacher assessment was also used for statistical programming tasks (ArchMiller et al., 2017) as well as in modeling exercises (Garcia-Peñalvo et al., 2021). Concerning more practical tasks, teacher assessment was also used for cases of skill demonstration in medicine (Hay et al., 2013). Shorter forms of assessments, such as quizzes (Guerrero-Roldán & Noguera, 2018; McNeill et al., 2012), or interactive activities (Gonzalez-Gomez et al., 2020; Turner & Briggs, 2018) were also assessed by teachers. Other implementation forms included exam questions in an essay format (Turner & Briggs, 2018; Senel & Senel, 2021), conceptual questions (Scalise et al., 2018), question generation by students (Yeh & Lai, 2012), and e-tivities including audio und written tasks (Rogerson-Revell, 2015).

Assessment format: Teacher assessment was used in seven cases in context of only summative assessment (ArchMiller et al., 2017; Birks et al., 2016; Chew et al., 2016; Luaces et al., 2017; Schultz et al., 2022; Tawafak et al., 2019; West & Turner, 2016), however, 16 times in a formative assessment format (Gonzalez-Gomez et al., 2020; Jarrott & Gambrel, 2011; Kim et al., 2021; Law, 2019; Mao & Peck, 2013; Milne et al., 2020; Nicholson, 2018; Ogange et al., 2018; Reilly et

al., 2016; Rogerson-Revell, 2015; Sarcona et al., 2020; Scalise et al., 2018; Senel & Senel, 2021; Wang & Wang, 2012; Xian, 2020; Xiao & Hao, 2018). Additionally, ten cases included formative as well as summative assessments (Farrelly & Kaplin, 2019; Garcia-Peñalvo et al., 2021; Guerrero-Roldán & Noguera, 2018; Hay et al., 62013; Herzog & Katzlinger, 2018; Hickey & Rehak, 2013; McCracken et al., 2012; McNeill et al., 2012; Turner & Briggs, 2018; Yeh & Lai, 2012).

Feedback: Teacher assessment included corrective feedback (Yeh & Lai, 2012), classifying submissions as suitable or not suitable (Gonzalez-Gomez et al., 2020), or scores on draft (Mao & Peck, 2013). More elaborated feedback by teachers included feedback guiding students towards correct answers (Guerrero-Roldán & Noguera, 2018), or suggestions for the learning process (Garcia-Pealñvo et al., 2021). Similar to peer assessment, teacher feedback was frequently provided based on a rubric (ArchMiller et al., 2017; Chew et al., 2016; Herzog & Katzlinger, 2017; Law, 2019; Luaces et al., 2017; Milne et al., 2020; Senel & Senel, 2021; West & Turner, 2016; Xiao & Hao, 2018). Other forms of written feedback included written reviews (Jarrott & Gambrel, 2011; Rogerson-Revell, 2015), comments on portfolios (Nicholson, 2018; Wang & Wang, 2012; Farrelly & Kaplin, 2019), or comments on writing (Xian, 2020). Sometimes other modalities of teacher feedback were investigated, such as the form of discussion (Hickey & Rehak, 2013), in a video format (Hay et al., 2013, West & Turner, 2016), or audio format (Sarcona et al., 2020).

Assessment mode: Self-assessment

Some mode of self-assessment was reported in $N = 12$ (11%) studies. In these cases, a self-assessment mode is defined as assessing the proficiency of oneself not including automated assessment components.

Implementation type: Self-assessment was often implemented in the form of electronic portfolios (Amhag, 2020; Faulkner et al., 2013; Hains-Wesson et al., 2014; Hwang et al., 2015; Mason & Williams, 2016; Vaughan, 2014), on essays (Admiraal et al., 2015), or wiki entries (Vaughan, 2014). Self-assessment was also implemented in projects, such as technical and design group projects (Tucker, 2014) or research projects (Wu et al., 2014). In one case, students were asked to assess their own level of self-control (Bohndick et al., 2020).

Assessment format: Two cases used self-assessment for summative assessment (Tucker, 2014; Wu et al., 2014), five for formative assessment (Amhag, 2020; Bohndick et al., 2020; Hwang et al., 2015; Mason & Williams, 2016; Vaughan, 2014), and three for formative as well as summative assessment (Faulkner et al., 2013; McCracken et al., 2012; Admiraal et al., 2015).

Feedback: Self-assessment was used as a form of reflection (Amhag, 2020; Faulkner et al., 2013; Hains-Wesson et al., 2014; Hwang et al., 2015), or measuring the own performance by comparing it to a rubric or guideline (Admiraal et al., 2015; Mao & Peck, 2013; Tucker, 2014; Vaughan, 2014; Wu et al., 2014).

Summary of results for RQ1

Concerning research question one, the results of this systematic review indicate that studies focused on online assessment in higher education used the modes self-assessment, peer assessment, automated assessment, as well as teacher assessment. Peer assessment was used on the assessment types of writing tasks, e-Portfolios, or projects and was frequently used in formative as well as in summative assessment, often in combination. Automated assessment on the other hand was used on quizzes, short text answers, or standardized exercises, such as programming tasks. It was used frequently in formative assessment form only and seldomly in summative assessment. Teacher assessment was used on a broad variety of types such as e-Portfolios, essays, or project-based tasks. Teachers assessed mostly in a formative format or formative and summative in combination. Self-assessment was realized through e-Portfolios, essays, wikis, or projects and mostly in a formative format as a reflection of the current learning process. Overall, the formative format was used more often than summative and automated the most used mode, followed by peer and teacher assessment and ultimately self-assessment.

3.3.3 Objectives of online assessment in higher education (RQ2)

The purposes of the publications in this systematic review can be divided into two categories: (1) the objective of the presented form of online assessment and (2) factors influencing the effectiveness of the online assessment. First, regarding the objective of the presented form of online assessment, multiple studies of this review

looked at the effect of feedback on latent factors of the learning process of students such as motivation, self-regulation, engagement, reflection, and others. Accordingly, the key publications investigated how aspects of formative feedback might influence the motivation of students. Approaches included effects of repeated questions on motivation (Stratling, 2017), adaptive quizzes improving motivation and engagement (Ross et al., 2018), positive or negative feedback on self-assessment influencing the motivation of students (Bohndick et al., 2020), the influence of formative peer essay grading on motivation (Formanek et al., 2017), and formative teacher assessments in a science context influencing the motivation of students (Gonzalez-Gomez et al., 2020). Other studies focused on the self-regulation of students. Methods for increasing self-regulation by assessing students formatively included question generating and giving students responsibility for their assessment (Caspari-Sadeghi et al., 2021), possible interaction of students with formative questions (Chen et al., 2018), as well as the influence of journaling, self-assessment, and peer-sharing on cognition regulation strategies of students (Hwang et al., 2015). Other key publications focused on the increase of students' engagement through formative assessment, including online assessment through formative quizzes (Holmes, 2018; Hughes et al., 2020), formative portfolio assessment (Nicholson, 2018), or peer assessment (Chen et al., 2021; Sullivan & Watson, 2015; Vaughan, 2014). Another group of studies focused on increasing engagement and satisfaction based on different forms of formative assessment (Nguyen et al., 2017) and influencing students' engagement through gamified formative assessment (Polito & Temperini, 2021; Tenório et al., 2016). Studies that included assessment through ePortfolios frequently focused on the positive impact that formative assessment could have on the ability of students to reflect their own learning process (Amhag, 2020; Hains-Wesson et al., 2014; Jarrott & Gambrel, 2011; Mason & Williams, 2016; McWhorter et al., 2013) or giving students the possibility to reflect themselves meeting possible professional requirements (Faulkner et al., 2013). Other factors which have been influenced by the usage of formative assessment, were the sense of community (Kim et al., 2021), collaborative learning (Sampaio-Maia et al., 2014), an attitudinal change (Watson et al., 2017), reading comprehension (Yeh & Lai, 2012), critical thinking (Zhan, 2021), and usage of educational technology (Acosta-Gonzaga & Walet, 2018).

Second, a great share of the key publications in this systematic review described the goal of the presented online assessment as to increase learning success using variations of formative assessment. Formative quizzes were used to improve the final learning outcome of students and the achievement of their learning goals (Carnegie, 2015; Carpenter et al., 2017; Kühbeck et al., 2019; Gámiz Sánchez et al., 2014; Wilkinson et al., 2020) as well as supporting their learning process (Tempelaar, 2020). Formative feedback was also shown to improve accuracy in second-language writing (Xian, 2020). Additionally, not only formative but also summative assessment lead to increase of academic performance (Tawafak et al., 2019). E-Portfolios were used to foster higher-order thinking skills (Wang & Wang, 2012), to increase the creative thinking ability (Xiao & Hao, 2018), or to generally increase the final learning outcome (Hickey & Rehak, 2013; Farrelly & Kaplin, 2019). In the context of providing formative feedback to improve the final learning outcome, peer feedback was often an essential part, such as formative peer feedback to improve on writing skills (Huisman et al., 2018; Mao & Peck, 2013), improve projects (Li & Gao, 2016; L. Li et al., 2010; Liu et al., 2018; Sekendiz, 2018), or to foster deep learning (Filius et al., 2018). Other publications focused on using online assessment to improve the educational process. One of the goals was to enable personalization and adaptivity of learning processes with means of online assessment, such as creating an adaptive learning path based on the results of formative assessment (Bekmanova et al., 2021; Hashim et al., 2020), or more personalized feedback (Thille et al., 2014). Another advantage that online assessment could bring to the learning scenarios is the possibility to assess larger groups of students at the same time through quizzes (Gleason, 2012; Mora et al., 2012), but also on longer answers through means of automated essay scoring (Reilly et al., 2016; Santamaría Lancho et al., 2018). Online assessment was also attributed as giving the opportunity to correctly place students in the foreign-language learning (Fratter & Marigo, 2018; Taghizadeh et al., 2014), assessing different levels of understanding (Küchemann et al., 2021) and peer feedback for enhancing assessment and feedback experience for international students (Chew et al., 2016). The transformation of face-to-face courses to online courses showed that online assessment created possibilities for peer assessment that went beyond paper-based peer methods (Wu et al., 2014). Last, in some cases, the objective of the assessments was to be used as part of an approach

to analyzing students learning behavior and providing them feedback on their learning process. Analyzing behavior together with grade outcome such as assessing the behavior of students (Wells et al., 2021), using assessment data for diagnosing learning problems (Yang et al., 2016) or providing assessment feedback in combination with learning analytics feedback (Tempelaar, 2020) were methods used for this process. Other approaches focused on connecting assessment with the sentiment of discussion (Tucker et al., 2014) or a gamified analytics approach (Chaudy & Connolly, 2018).

Summary of results for RQ2 Concerning research question two, the objectives of online assessment can be found in supporting learning as well as teaching processes in higher education. The impact of formative assessment was reported not only on the final learning outcome but also on factors influencing the learning process such as motivation, self-regulation, engagement, or reflection. Additionally, a goal of using online assessment can lie in enhancing the learning and assessment process such as assessing greater courses, providing learners more elaborate feedback, and creating adaptive learning paths.

3.3.3 Success factors of online assessment in higher education (RQ3)

Design principles for online assessment were extracted from the publications by examining the experienced acceptance of students and the reported success of online assessment scenarios. Authentic assessments, presenting students with tasks they would likely face in a real-world setting, were found to be central to successful online assessments (Dermo & Boyne, 2014; Martin et al., 2019; McCracken et al., 2012; Schultz et al., 2022). Additionally, online assessments are expected to be well-aligned with the course materials and competencies for the desired learning outcome as well as the prerequisites of the students (Guerrero-Roldán & Noguera, 2018; McCracken et al., 2012; McNeill et al., 2012). The online assessment criteria need to be made as transparent as possible (Martin et al., 2019; McCracken et al., 2012) and, from the teacher's side, availability and communication with the students were found to be essential success factors (Martin et al., 2019). Additional factors from the student's perspective were perceived ease of use and perceived usefulness of online assessments (Bacca-Acosta & Avila-Garzon, 2021).

Concerning peer assessment in particular, multiple factors are identified in their influence on the quality of peer assessment. Findings support a discussion-based assessment training, leading to more accurate peer feedback (Liu et al., 2018). Additionally, factors of the respective courses' instructional design are seemingly supporting the quality of peer feedback, as aligning the guidance of the students and tasks with the amount of students (Herzog & Katzlinger, 2017) and increasing the level of guidance through providing the students a rubric as the base of their assessment process (ArchMiller et al., 2017). Other key publications recommended to provide guidelines (Wadmany & Melamed, 2018) as well as explaining to students the rationale of the online peer assessment (Meek et al., 2017). Concerning the format of peer feedback, longer, rather than many, comments and comments aiding for revision were preferred by students (Zong et al., 2021). Approaches including natural-language processing proposed using sentiment analysis on feedback to detect inaccuracies in peer feedback between the given feedback and the given score have been highlighted (Pinargote-Ortega et al., 2021). Other findings advocate for using peer assessment mostly for formative and not summative assessment (Admiraal et al., 2015).

Concerning the design of formative online assessment through quizzes, the key publications suggest that quizzes should not only include true or false questions but a mixture of types (López-Tocón, 2021). Other studies found that quizzes are a well-suited form of online assessment for theoretical knowledge, but not necessarily for practical knowledge and should therefore be combined with other forms of online assessment, such as project-based learning or further homework tasks (Babo et al., 2020). While a higher correlation between final exam performance and the performance on formative quizzes with limited time and attempts was found (MacKenzie, 2019), unlimited attempts in general lead to a higher performance in the final exam (Davis et al., 2020).

Concerning summative online assessment, the key publications emphasize that end-of-module assessments in the form of essays, practical reports and/or applied assessments, were preferred by students over exams and led to higher completion rates (Turner & Briggs, 2018). Timely feedback (Martin et al., 2019; McCracken et al., 2012) was considered an essential success factor for online assessment. The key publications also considered the effects of the modality of peer

and teacher feedback, the support of video feedback, and the positive reception by students (West & Turner, 2016). Other studies found a preference by students for an audio format by peers (Filius et al., 2019) or a written format by teachers (Sarcona et al., 2020) In general, feedback in online assessment should be part of a broader approach and not only seen as part of one task (Milne et al., 2020).

Summary of results for RQ3 Concerning research question three, success factors for implementing online assessment include instructional support as well as transparent pre-defined grading criteria. Especially for peer assessment rubrics, guidelines and explaining the rationale to the learners are important for a successful implementation. Additionally, the overall design of the assessment should be chosen depending on the respective learning objective and potentially different modes, types, and formats combined.

3.4 Discussion

Online assessments enriched standard or paper-based assessment approaches, some of which hold much promise for supporting learning (Webb et al., 2013). A range of different online assessment scenarios have been the focus of educational research and development, however, often at small scale (Stödberg, 2012). Still, the complexity of designing and implementing online assessment and feedback systems has been discussed widely over the past few years (Sadler, 2010; Shute, 2008). Current research findings suggest that online assessment systems meet several specific requirements, such as (a) adaptability to different subject domains, (b) flexibility for experimental as well as learning and teaching settings, (c) management of huge amounts of data, (d) rapid analysis of complex and unstructured data, (e) immediate feedback for learners and educators, as well as (f) generation of automated reports of results for educational decision-making. This systematic review investigated the renewed awareness of online assessments (Gašević et al., 2022) by identifying and synthesizing original research studies focusing on online assessments in the context of higher education.

3.4.1 Summary of key findings

Modes and formats of online assessments. Regarding research question one (RQ1), the findings of this systematic review suggest that online assessment is

widely implemented, varying in the design and intended goals of the respective learning scenario. The four main modes of assessment were identified as peer-, teacher-, automated-, and self-assessment (e.g., Hickey & Rehak, 2013; Law, 2019; Luaces et al., 2017; Xian, 2020; Xiao & Hao, 2018). Frequently, various assessment modes are combined in assessment design, especially peer- and teacher-assessment as well as a combination of automated-, peer-, and teacher-assessment. While peer- and teacher-assessments are mostly provided on longer texts or project tasks, automated-assessments mostly take place on shorter assignments and self-assessments on reflection tasks. Concerning the assessment format, automated- as well as self-assessments were mostly implemented formatively and rarely in summative format (e.g., Acosta-Gonzaga & Walet, 2018; Bacca-Acosta & Avila-Garzon, 2021; Bekmanova et al., 2021; Förster et al., 2018; Gámiz Sánchez et al., 2014; Scalise et al., 2018; Schaffer et al., 2017). Peer- and teacher-assessments frequently were applied for both formative and summative formats. The scope of the feedback also differs depending on the assessment mode. While peer and teacher feedback included transparency measurements such as rubrics and provided numeric as well as more elaborated feedback, automated feedback was provided as correction, albeit the results from this review also suggest that there are also advances to provide more detailed feedback aiding students (e.g., Acosta-Gonzaga & Walet, 2018; Carnegie, 2015; Guerrero-Roldán & Noguera, 2018).

Objectives of online assessments. Regarding research question two (RQ2), the findings of this systematic review suggest that online assessment has promising potential in supporting and improving online learning processes (Amhag, 2020; Hains-Wesson et al., 2014; Jarrott & Gambrel, 2011; Mason & Williams, 2016; McWhorter et al., 2013;). Formative assessment has the potential to support the student's learning process by either influencing learning success factors or leading to an increase in the final learning outcome. Furthermore, online assessment can also be used as an analytical approach to provide more advanced feedback to students and teachers on learning processes. Additionally, to improve the learning environment through means of new opportunities created through technological enhancement such as personalization, adaptivity, or gamification (e.g. Tempelaar, 2020; Wells et al., 2021).

Success factors of online assessments. Regarding research question three (RQ3), the findings of this systematic review suggest that a successful implementation of online assessment is based on instructional support as well as clear-defined assessment criteria (Dermo & Boyne, 2014; Martin et al., 2019; McCracken et al., 2012; Schultz et al., 2022). The main factors examined by the key studies were the alignment of the assessment format, mode, and type with the targeted learning outcomes. Another takeaway from this systematic review is the benefits of implementing authentic tasks in online assessment (Conrad & Openo, 2018). On the side of teaching staff, transparency, communication, and timely as well as detailed feedback were found as main contributors to success. Similarly, when implementing peer-assessment, guidelines, such as rubrics, communication, as well as providing feedback useful for revision, are essential factors.

3.4.2 Implications for theory and practice

The findings of this systematic literature review pose implications for theory as well as practice. A major takeaway is the broad opportunities created through online assessments and their influence on learning processes as well as outcomes. Instructional practice in higher education might consider the potential of formative online assessment for supporting students' learning. Additionally, online assessment, in general, creates new possibilities such as elaborated productive feedback, assessment of greater groups, or adaptive learning. For designing online assessment certain success factors should be considered such as clear communication of pre-defined guidelines, support of the teachers and learners as well as timely feedback. Additionally, a combination of different modes, formats, and types could be chosen depending on the targeted learning objectives.

Concerning theory in this field, it appears to be important to further research the differentiation between automated- and self-assessment as well as determine a clear distinction between formative and continuous assessment. Clear definitions regarding assessment formats, modes, and types seem to be key to a substantial scientific discussion. In the future, research should focus on leveraging the objectives and potentials of online assessment for supporting learning as well as teaching in higher education. Furthermore, designing a coherent framework for the interaction and design of online assessment modes, formats, and types would be beneficial for

creating guidelines on the effective design, development, implementation, and evaluation of online assessments. Another factor will be how to further develop the online assessment techniques while addressing the identified challenges.

3.5 Limitations and future research

This systematic review is subject to limitations that provide implications for future research. First, even if keywords are applied, databases approached, and specific journals searched, some important research studies may still have been neglected in this systematic review. In addition, this systematic review only included articles published in the English language. Hence, important findings from articles published in other languages may have been overlooked. Second, the systematic review covers a limited time period. While writing this systematic review, further studies may have been published that could provide additional insights into the impact of online assessments on learning and teaching. Accordingly, a continuing meta-discussion of findings is required while the research area matures. Thus, additional research shall cover a wider time period to consider more publications focusing on online assessments with a specific emphasis on the historical development of online assessments.

Future research may address the multiple challenges identified in this systematic review when implementing online assessments. For example, the increased risk for academic misconduct (Tsai, 2016) and challenges due to higher initial investment (Azevedo et al., 2022). To enable equal opportunities, challenges include implementing an ICT infrastructure and reliable connectivity (James, 2016), equal internet access of the students (Hains-Wesson et al., 2014), and new study habits that students need to develop (Azevedo et al., 2022). Other challenges in creating fair online assessment include the heterogeneous educational background of learners (McCarthy, 2017) as well as multiple possible graduate destinations (Schultz et al., 2022). Additional concerns were raised on the fairness of peer-assessment, especially in group tasks (ArchMiller et al., 2017) as well as technological and logistical challenges in the widespread implementation of e-Portfolios in higher education (Birks et al., 2016).

Looking forward, online assessment harnesses formative and summative data from stakeholders and learning environments to facilitate learning processes in real-

time and help decision-makers to improve learning environments. Therefore, future research may focus on distinct features of online assessments, for instance providing semantic-rich feedback for written assignments in near real-time using natural-language processing (Bektik, 2019; Gottipati et al., 2018; Ifenthaler, 2023; Whitelock & Bektik, 2018), generating progress reports toward curricular required competences or learning outcomes including intra-individual and inter-individual comparisons (Ifenthaler at al., 2023; Lockyer et al., 2013), supporting peer-assessments focusing on specific learning outcomes or general study skills (e.g., learning strategies, time management) (Gašević et al., 2017; Gašević et al., 2019), or including pre- and reflective prompts highlighting persistence of strengths and weaknesses of specific learning events and assessment results (e.g., recurring errors, misconceptions, learning habits) (Schumacher & Ifenthaler, 2021).

3.6 Conclusion

Given the variety of online assessments documented in the 114 studies of this systematic review, the formative assessment format was used more often than the summative assessment. Implementations mainly used the automated-assessment mode, followed by peer- and teacher-assessment modes, while the self-assessment mode was used scarcely. Online assessments impact not only students' learning outcomes but also influence motivation, self-regulation, engagement, or reflection. The successful implementation of online assessments requires instructional support, transparent guidelines and regulations, as well as an alignment of possible assessment formats, modes, and types with expected learning outcomes.

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4 Students' perceived impact of GenAI tools on learning and assessment in higher education: The role of individual AI competence

4.1 Introduction

The advances in artificial intelligence are rapidly and continuously transforming various contexts of people's lives, the higher education sector is not immune to being affected by these advances and their related changes. In this specific education sector, AI has a lot of potential, such as, in analyzing vast datasets to improve student outcomes, in personalizing learning experiences, in rendering automate administrative tasks, and in providing adaptive learning (Bond et al., 2024). The confluence of these potentialities positions AI as a major emerging innovative factor in higher education, reshaping how current and future generations learn and teach in higher education institutions (HEIs). The rapid emergence of AI has resulted in research and practice in education being behind in unwrapping the full potential of AI compared to other disciplines, such as business or health (Luckin & Cukurova, 2019). From the incorporation of AI-powered adaptive learning environments by academic staff to the use of AI for the prediction and evaluation of student success by administrators and adaptive support whenever a student needs it, stakeholders across HEIs will inevitably encounter AI in different ways (Zawacki-Richter et al., 2019). However, most of these implementations are centered on using AI in instructors' assessments, although students can also employ AI-based tools to aid them. Accordingly, the presence of AI across the HEIs necessitates a dynamic interplay between different stakeholders and systems (Daugherty & Wilson, 2018; Ifenthaler & Schumacher, 2023). This engagement is crucial for fostering the development of AI competence – above all among students. AI competence is the ability to comprehend, utilize, and critically evaluate AI tools (Kim et al., 2021), it allows stakeholders to gain skills and knowledge about AI, interact efficiently with AI, and, also, make informed and productive decisions in implementing AI in their learning processes (Dai et al., 2023). Hence, AI competence in education is a set of skills that enable stakeholders to ethically and responsibly develop, apply, and evaluate AI for learning and teaching (Delcker et al., 2024).

In the scenario of AI application and utilization, since late 2022, witnessed a surge in accessible generative artificial intelligence (GenAI) tools, defined as deep

learning models trained on diverse datasets, such as large language models (LLMs), to process user prompts and create human-like outputs (Hsu & Ching, 2023). This emerging frontier launched a controversy surrounding the use of GenAI in schools and in universities, with some viewing it as a beneficial tool and others expressing concern about its potential impact on education (Mamo et al., 2024). Previous research showed a simultaneously enthusiastic, as well as concerned, opinion of students towards the usage of GenAI tools in HEIs, such as ChatGPT (Baig & Yadegaridehkordi, 2024; Chan & Hu, 2023; Chiu et al., 2023). A unified response among HEIs has been to adapt learning and assessment environments as well as introduce regulations to make AI use more appropriate in this new age of GenAI (Bhullar et al., 2024; Foung et al., 2024). The assistance of GenAI, however, extends beyond the automatic completion of tasks; AI in HEIs has the potential to both hinder and create educational opportunities (Lim et al., 2023), such as increasing support for learners in tasks as a form of guidance while potentially making it more difficult for teachers to differentiate student performance when AI-generated material is involved. Furthermore, a central point of discourse is the call to action in reacting to the application of specifically GenAI in the form of language production to hinder plagiarism (Lo, 2023).

However, many aspects remain to be investigated and discovered about how students use GenAI in learning and assessment processes and what their views are regarding these tools. Accordingly, this study explores the issues surrounding GenAI in HEIs from an international student perspective. Particularly, the research team utilized an online instrument to investigate students' AI competence and their perceptions of a range of GenAI tools in the context of learning and assessment within HEIs. This research may enable a critical evaluation of students' perceptions of GenAI tools and uncover possible benefits and application scenarios that may be employed in higher education learning and assessment.

4.2 Background

4.2.1 Artificial Intelligence competence in education contexts

With the rise of AI in the context of education, the research into AI competence in education is simultaneously increasing rapidly (Sperling et al., 2024). The existing literature on AI competence identifies different skills, which can be summarized in

distinctive competence dimensions. For instance, AI competence involves a basic understanding of the functionality of AI (Attwell et al., 2020), including identifying whether or not an application uses AI (Long & Magerko, 2020). Another dimension of AI competence is related to data security risks and data privacy assurance when collecting, analyzing, and managing data in education (Papamitsiou et al., 2021). This emphasizes identifying the potential and risks of AI in education, society, and the workplace (Attwell et al., 2020). AI competence is today fundamental, it allows students to not only gain skills and knowledge about AI but also to interact efficiently with AI and make informed and productive decisions in implementing AI in their learning process (Dai et al., 2023). Huang (2021) proposed a framework that places a weighting on specific AI-related concepts, such as machine learning, robotics, and programming, in combination with more general key competencies (e.g., self-learning and teamwork). In contrast, Kim et al. (2021) established their model on the foundations of AI knowledge, AI skills, and AI attitudes, highlighting the significance of critical reflection around the ethical implementation of AI. Sanusi et al. (2022) adopted a similar approach, integrating the ethics of AI as a competence dimension that bridges the other dimensions of their model, namely learning, teamwork, and knowledge competence. Based on a systematic literature review as well as expert interviews, Delcker et al. (2024) developed a framework of AI competence in the context of education, including the subcomponents of theoretical knowledge, legal framework and ethics, implications of AI, attitude towards AI, teaching and learning with AI and ongoing professionalization as the cornerstone of a competent approach to AI. This framework is modular and can be adapted according to the target group.

4.2.2 Generative artificial intelligence tools in education contexts

Since late 2022 there has been a rapid increase in the number and variety of available GenAI tools. GenAI is a term used to describe an advanced technology that integrates deep learning models, trained on extensive datasets gathered from various sources, which processes inputs (i.e., prompts) to generate output similar to human-generated content. In practice, this output frequently takes the form of text and images (Romero et al., 2024). Rudolph and colleagues (2023) posit the existence of three categories of AI tools: teacher-facing, system-facing, and student-facing. These systems mostly employ some sort of Natural Language Processing (NLP) or Natural

Language Production, which describes the ability of a system to process not only prepared and refined data but also language in the way a human user would naturally use it (Chowdhary, 2020). Examples of NLP-based AI tools commonly used in higher education include:

- Translation tools: Machine translation tools receive written text as input and provide translated text through neural methods in a selected language (Stahlberg, 2020; Polakova & Klimova, 2023).

- Paraphrasing tools: These systems, which often use similar techniques as neural machine translation, provide alternative formulations of written words or text segments (Rogerson & McCarthy, 2017).

- Summarizing tools: Automatic text summarization refers to eliciting the key relevant information of a piece of text and returning it as a compressed version (El-Kassas et al., 2021).

- Generative tools: Generative systems use methods that produce content on their own after being provided input in the form of prompts (Lim et al., 2023).

4.2.3 Learning, assessment and goal orientation in the HE system

Assessment is a factor that should act as a stimulus for student learning (Fischer et al., 2024). In this regard, the literature has often dwelt on the relationship between these two key processes in training and education; in fact, learning and assessment are linked and closely connected. it is from the relationship between these two processes that metacognitive awareness arises, enabling the learner to engage in critical and constructive thinking. Assessment, in particular, has or should have a fundamental role in helping institution to create effective learning systems, teachers to structure learning content in a functional way and in developing among students the ability to make evaluative judgements about their own learning, their own work and that of others. Assessment is understood as the systematic gathering of students' information to draw inferences about their learning process (Baker et al., 2016). It can be classified according to the mode, format, and type chosen in the assessment design (Heil & Ifenthaler, 2023). The mode can include teacher, automated, self, and peer assessment. The format may be diagnostic, formative or summative, and the type can be chosen from a broad range of tasks such as essays, quizzes, or project work. The design of assessment is important, as it profoundly influences the design of learning

processes (Martin et al., 2019) and fulfils an important role in our education systems as a means of differentiation and certification, but also as part of the learning process to support students (Black & Wiliam, 2018). especially formative assessment can support students by receiving continuous feedback, fostering engagement and address individual needs of learners (Gikandi et al., 2011). The connection among learning, assessment and goal orientation is very strong. For this reason, one cannot talk about learning and assessment without confronting what are the goals one intends to achieve and about the means one intends to employ and use to achieve the goals one intends to pursue. What is the goal, what means is most appropriate to achieve my goal optimally, how much time do I have and what resources can I use, what are my competences. These are all questions anyone with a goal asks or should ask. Various models and theories on goal achievement are proposed in the literature. The theory of achievement goal orientation differentiates between two overarching types: performance orientation and learning orientation. According to the theory, learners who pursue performance goals tend to be motivated by their evaluation and being judged competent, while pursuing learning goals might stem from the motivation to improve their abilities (Dweck & Leggett, 1988). The appropriate and motivating use of AI tools can be a contextual element in supporting student academic success, promoting students' retention and avoiding possible drop-out situations (Chiu et al., 2023). In the context of online learning, individual goal orientation significantly influences students' behavior (Adesope et al., 2015) as well as their preferences in learning analytics (Schumacher & Ifenthaler, 2018a). The distinction between performance and goal orientation is also linked to the broader picture we have of assessment and education and the distinction between seeing assessment as a way of certifying and classifying students or as a tool for encouraging reflection, providing feedback, and improving learning (Urdan & Kaplan, 2020). Guided by this thought and the public discourse surrounding the availability of AI for students in education, a new challenge emerges in investigating how GenAI tools can be used in different strategies of learners by either supporting them in fostering their learning in the process of assessment or allowing for them be judged competently by an assessor. The positive use of such tools can also be a useful element for the student's future, in fact, knowing about and knowing how to use AI and GenAI tools in the education context, can be useful for students' career

orientation and in the life-long learning process (Poquet & de Laat, 2021; Yupelmi et al., 2024)

4.2.4 GenAI: which relationship with learning, assessment and goal achievement in the HE context?

A specific use case of GenAI in education lies in different assessment scenarios, with the public discourse, as well as the research on this topic tending to focus on a potential disruptive potential of GenAI or a way to catalyze change (Jensen et al., 2024). Concerns include critical discussion about privacy and ethics as well as potential biases (Mao et al., 2024) but focus mostly on the integrity of assessment (Cotton et al., 2024). This is further reflected in the GenAI policies of universities, which predominantly focus on the originality of student work. (Luo, 2024). At the same time, the possibilities of GenAI in assessment go far beyond utilizing it for mere generation of content (Lim et al., 2023). Online assessment, especially supported by GenAI, may take on different pedagogical functions as part of online learning environments, for example, through scaffolding or adaptive learning (Webb & Ifenthaler, 2018).

Ansari et al. (2023) conducted a systematic scoping review with $N = 69$ studies of higher education literature regarding the use of GenAI in the form of ChatGPT and emphasized the importance of ensuring that teachers are designing assessment tasks that require critical thinking and human intelligence, as well as helping their students to develop AI literacy. A scoping review with $N = 32$ empirical studies by Xia et al. (2024) regarding the transformation of assessment through GenAI furthermore emphasizes the need for more AI-literacy as well as more diverse assessment methods and a re-thinking of assessment policies.

4.2.5 Research gap and study objectives

Research considering the transformation that GenAI can have on HE assessment encompasses the integrity of assessment (Cotton et al., 2024), while simultaneously opening up potential for additional assessment possibilities such as authentic assessment, adaptivity or automated feedback (Mao et al., 2024). Additionally, there is a clear call for more AI competence for all stakeholders (Xia et al., 2024; Ansari et al., 2023). The need to develop GenAI tools that are both user-friendly and congruent with educational objectives is imperative to facilitate their

integration and enhance their efficacy in promoting student learning and assessment (Zhou et al., 2024).I n this polarized discussion, this study aims to create a more nuanced understanding of GenAI in learning and assessment in relation to the individual students' AI competencies, needs and expectations, as well as their actual intended use of different GenAI tools in their learning and assessment processes . Therefore, this study does not only aim to discuss potential chances and pitfalls of GenAI in learning and assessment but expands the current literature through a a cross-cultural analysis of individuals' dispositions as well as a nuanced analysis of AI-competence as a multi-faceted construct. Furthermore, most studies focus on ChatGPT as the singular tool that students might use. To achieve a comprehensive overview as well as investigating the manifold use cases of AI, a broad view of tools is taken to encompass relevant and specific application scenarios of GenAI tools in assessment as well as students' evaluation of these.

So, this international study aims to investigate the perception of HE student's both of AI competence than the impact of different GenAI tools in the context of learning and assessment. Given previous assumptions (Dai et al., 2023; Kim et al., 2021), it is hypothesized that students' AI competence varies across specific dimensions (Hypothesis 1a) and that students from different countries exhibit comparable levels of AI competence (Hypothesis 1b).

Further, we assume that GenAI tools in the context of HEIs are perceived differently concerning their expected support for learning and assessment (Hypothesis 2). It is expected that the students' AI competence will significantly influence the evaluation of the tools for learning and assessment support concerning the overall rating of the AI tools (Delcker et al., 2024) (Hypothesis 3).

Based upon the results of these hypotheses, another exploratory approach is taken to investigate students' intent to use different AI tools for application in assessment scenarios in higher education. We assume that students perceive different usage benefits for each GenAI tool (Hypothesis 4) and attribute different supporting factors on aiding the pursuit of learning or performance goals (Adesope et al., 2015; Schumacher & Ifenthaler, 2018b). This will be investigated through latent factor analysis and confirmatory factor analysis.

4.3 Method

4.3.1 Participants and sampling

The research was undertaken via an online survey and applied a convenience sample method by approaching students in HE classes, providing them the link and asking them to fill out the survey. The results were collected from a total of N = 223 students from one Australian (35.43%), one German (36.77%), and one Italian (27.80%) university. The average age of the participants was 24 years (SD = 7.61), with 22.42% of the students identifying as male, 76.23% as female, and 1.34% as non-binary. Most students (82.06%) studied at the undergraduate level. Ethics approval was obtained for this research at the participating universities.

4.3.2 Instrument

The survey used standardized items modified from previous instruments around the following themes: Student assessment practices and student beliefs about assessment methods, student understanding of AI, and student competence in using AI. All items were designed as statements with closed answers following a 4-point Likert scale (1 = do not agree to 4 = fully agree).

In the first section of the survey, participants completed the questionnaires based on Gibbs and Dunbar-Goddet (2007) and Pereira et al. (2017), concerning individual learning and assessment experience (15 items; Cronbach's α = .64).

In the second section, participants were presented with a series of videos showcasing various AI tools. They were then invited to share their perceptions regarding a range of factors, including the learning potential, the applicability of these tools in achieving specific goals, their acceptability, and considerations related to privacy, through an adapted version of a survey by Schumacher and Ifenthaler (2018a) (15 items per tool, Cronbach's α = .93).

In the third and last section, participants' general AI competence was assessed through a modular survey by Delcker et al. (2024) covering different dimensions of AI competence, with the selected sub-categories for this context being theory, laws and regulations, the impact of AI, and attitudes towards AI (18 items; Cronbachs' α = .84).

4.3.3 Materials

Participants were presented with a video introducing a GenAI tool in a specific use case related to higher education. All videos were structured similarly, commencing with a problem that was already familiar to the participants and the specific use case of the GenAI tool. For instance, in the case of ExplainPaper, the narrator explains their personal difficulty in reading complex texts for an essay assignment and the time required to look up highly specific and technical terms. The tool is then demonstrated in action through a screencast, which introduces the functionalities and shows how the narrator solved their problem using the GenAI tool. A total of six GenAI tools were included in this study:

1. ChatGPT (https://chat.openai.com/) is a large language model (LLM)-based chatbot developed by OpenAI. It uses its training on a large dataset of text and code to engage in conversational-style interactions. ChatGPT provides answers in a conversation format upon prompts given through the users by generating text, translating languages, writing various types of creative content, and answering questions in an informative manner.

2. DeepL (https://www.deepl.com/translator) is a machine translation tool that utilizes deep learning algorithms to deliver translations between multiple languages. It offers two main functionalities: direct text input for on-the-fly translation and file upload for translating entire documents. This capability caters for users with different translation needs, from short phrases to large documents. Users also can change the tone of voice to 'formal' or 'informal.'

3. ExplainPaper (https://www.explainpaper.com/) is a research paper comprehension tool. It uses a large language model (LLM) to improve user understanding of complex scientific concepts. It provides two main functionalities: an explanation functionality and a chatbot functionality. The explanation functionality allows users to upload a research paper (in PDF format) or paste a link to it. ExplainPaper then uses its LLM to generate a simplified explanation of the paper's content, potentially including a gist or a more detailed outline (depending on the subscription plan chosen). In addition, the chatbot function allows users to highlight specific terms or passages within the uploaded paper. ExplainPaper's LLM then acts as a virtual reading

companion, providing clear explanations for the highlighted elements and fostering a more interactive and engaging reading experience.

4. PaperDigest (https://www.paper-digest.com/) helps streamline scientific literature reviews. It goes beyond simple summarization by offering a range of functionalities to improve research efficiency. A key feature is the ability to summarize research articles. Users can enter a DOI or upload a PDF, and PaperDigest extracts the paper's key points, providing a concise overview of the research and its key findings.

5. Quillbot (https://quillbot.com/) is a multifaceted writing tool that includes paraphrasing as a core feature. It is aimed at users who want to improve the clarity, conciseness and overall quality of their writing. Beyond basic paraphrasing, Quillbot offers different modes, such as 'Fluency' and 'Formal', to tailor the paraphrased text to a specific tone or style. This versatility allows users to achieve their desired writing results, whether simplifying complex sentences, replacing synonyms or maintaining a formal register.

6. Tome (https://tome.app/) helps to simplify the creation of presentations. Users provide a text prompt outlining the desired presentation topic. Tome then generates a first multimedia draft with content, images, and potentially different slide layouts. This approach allows users to focus on refining the core message and content while Tome does the initial work of gathering information, visual design and structure.

These tools were explicitly selected as they allow for usage in many scenarios, encompassing the broad range that GenAI in online assessment can have, including translation, summarizing, paraphrasing and generation of content (Delcker et al., 2024). Furthermore, while they all implement some form of GenAI, they have different functionalities and use case scenarios. By investigating these tools, this research on the one hand allows for a comprehensive overview of GenAI in assessment as well as a nuanced differentiation of different application scenarios. By collecting data about different tools, we aimed to better understand GenAI use and preferences among participating students.

4.3.4 Procedure and data analysis

A data collection protocol was created to ensure a similar data collection process for all three participating HEIs. An online platform was put into place, along with information about data privacy and ethics, as well as a cover letter detailing the extent of the research. The data collection tools were shown following brief one-minute video clips that demonstrated possible use cases for each of the following GenAI tools by students—ChatGPT, DeepL, ExplainPaper, PaperDigest, Quillbot, and Tome. Lastly, the participants provided their demographic data, including their study course, gender (male, female, or non-binary), and age (number of years). The process of gathering data took about 45 minutes. During storage and analysis, all data were anonymized under standard research data protection procedures. The data were cleaned and combined for descriptive and inferential statistics using R statistics version 4.3.0. All effects were tested at the .05 significance level, and effect size measures were computed where relevant.

4.4 Results

4.4.1 Students AI' competence

Concerning hypothesis 1a, ANOVA revealed significant differences in dimensions of AI competence, $F(3, 891) = 48.33$, $p < .001$, $\eta 2 = .140$. Tukey-HSD test discovered significant differences for the four dimensions, i.e., the highest AI competence dimension attitude ($M = 3.16$; $SD = .49$) differed significantly from the dimension impact ($M = 2.95$; $SD = .51$), regulations ($M = 2.81$; $SD = .62$), and the lowest AI competence dimension theory ($M = 2.58$; $SD = .47$), $p < .001$ (see Table 4 – 1). Further pairwise comparisons revealed significant differences between all AI competence dimensions.

Thus, Hypothesis 1a is accepted, indicating that the dimensions of AI competence vary considerably.

Table 4 – 1 Means of artificial intelligence competence dimensions across the higher education institutions

SD in parentheses ($N = 223$)

	Artificial intelligence competence dimensions			
	AI Theory	AI Regulations	AI Impact	AI Attitudes
AUS	2.56 (.49)	2.85 (.55)	3.01 (.49)	3.01 (.50)
GER	2.63 (.44)	2.79 (.66)	3.01 (.41)	3.27 (.48)
ITA	2.56 (.49)	2.81 (.64)	2.81 (.61)	3.21 (.60)
All	2.58 (.47)	2.81 (.62)	2.95 (.51)	3.16 (.49)

Note. AUS = Australia; GER = Germany; ITA = Italy

Regarding hypothesis 1b, ANOVA indicated no significant difference in AI competence between students from the three participating HEIs, $F(2, 222) = 2.49$, $p > .05$, $\eta2 = .022$ (see Table 4 – 1).

Therefore, hypothesis 1b is accepted, with students from different countries exhibiting comparable levels of AI competence.

4.4.2 Expected support for learning dependent on tools

Concerning hypothesis 2, ANOVA revealed significant differences in expected support for learning and assessment between the six GenAI tools (ChatGPT, DeepL, ExplainPaper, PaperDigest, Quillbot, Tome), $F(5, 1337) = 29.51$, $p < .001$, $\eta2 = .100$. Tukey-HSD test suggests significant differences for the highest rated AI tool ExplainPaper ($M = 3.07$; $SD = .54$) and ChatGPT ($M = 2.69$; $SD = .55$), Quillbot ($M = 2.63$; $SD = .61$), Tome ($M = 2.51$; $SD = .68$), p < .001 (see Table 4 – 2).

Hypothesis 2 is, therefore, accepted. This indicates that the expected support of GenAI tools for learning and assessment is perceived differently.

Table 4 – 2 Means of AI tool's expected support for learning and assessment across the higher education institutions

SD in parentheses ($N = 223$)

	GenAI tool					
	Chat GPT	DeepL	Explain Paper	Paper Digest	Quillbot	Tome
AUS	2.71	2.81	3.07	2.96	2.58	2.49
	(.59)	(.69)	(.58)	(.61)	(.65)	(.70)
GER	2.62	3.05	3.07	3.00	2.65	2.48
	(.50)	(.63)	(.54)	(.59)	(.60)	(.70)
ITA	2.74	3.06	3.05	2.86	2.69	2.58
	(.56)	(.57)	(.51)	(.58)	(.58)	(.64)
All	2.69	2.97	3.07	2.95	2.63	2.51
	(.55)	(.64)	(.54)	(.60)	(.61)	(.68)

Note. AUS = Australia; GER = Germany; ITA = Italy

4.4.3 Influence of AI competence

A weak positive correlation could be found between the self-reported AI competence of the students and their average evaluation of the GenAI tools, $r = .32$, $p < .01$. A linear regression was conducted to analyze the relation between students' AI competence and their rating of AI-tools (see Figure 4 – 1). The level of AI competence significantly predicts the students' rating of the GenAI tools $\beta = .32$. The AI competence did explain a small but significant variance in the rating of the tools $R^2 = .1$, $F(1, 221) = 25.34$, $p < .01$.

Therefore, hypothesis 3 is accepted, with the level of self-reported AI competence influencing the overall expected support of GenAI tools for learning.

Figure 4 – 1 Influence of AI competence on the rating of tools
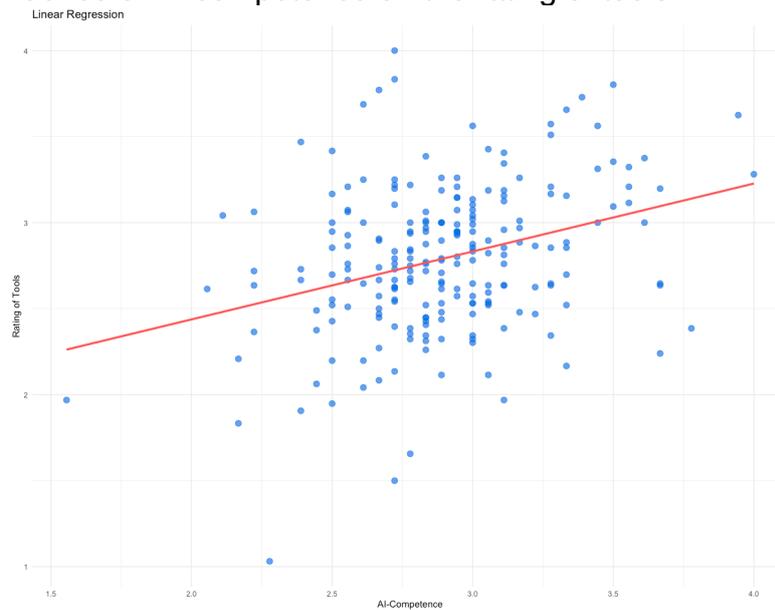
4.4.4 Analysis of specific benefits of tools

A confirmatory factor analysis was conducted to confirm that the items used in this study relate to the assumed latent factors aiding learning or reaching a performance goal. The average ratings across all AI tools were used in this analysis. The items used for relating to learning goals are 1.: 'If I used the AI tool shown in the video, I would gain a better understanding of the learning content', 2.: 'If I used the AI tool shown in the video, I would be able to analyze my learning results, 3.: 'Using the AI tool shown in the video would help me to achieve my learning goals'. For assessing performance goals: 1. 'If I used the AI tool shown in the video, I would achieve greater learning success', 2. 'If I used the AI tool shown in the video, I would optimize my learning process', 3.: 'If I used the AI tool shown in the video, I would get better grades.' The model shows a good fit. *CFI* = .977, *TLI* = .956, *SRMR* = .028, *RMSEA* = .128, according to the cut-off values postulated by Hu & Bentler (1999), which call for a CFI and TLI higher than .95 and an SRMR lower than .08. only the RMSEA is higher than the expected .06 (see Figure 4 – 2).

Figure 4 – 2 Confirmatory factor analysis of items
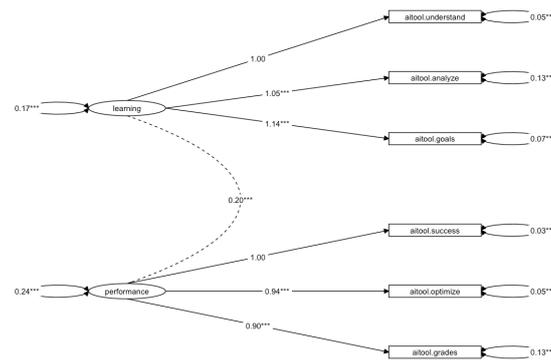
Accordingly, students were asked about their agreement with the specific impacts of the tools in their assessment processes. Concerning Tome, the highest agreement was found in the possibility of supporting the students in receiving better grades ($M = 2.94$, $SD = .79$) as well as for Quillbot ($M = 3.02$, $SD = .76$). ChatGPT's highest-rated possible support was found in optimizing the learning process ($M = 2.92$, $SD = .7$). The most highly valued component of DeepL was its assistance in understanding the learning content, ($M = 3.24$, $SD = .77$), which was also the highest for ExplainPaper ($M = 3.39$, $SD = .62$), and PaperDigest ($M = 3.14$, $SD = .71$). Following the highest perceived benefits as well as the results of the confirmatory factor analysis and the significant influence of the AI competence on the rating of the tools, a structural equation model was applied to the data to investigate in how far the tools can be grouped by an underlying factor based upon sharing the benefits identified and how far this is influenced by individual AI competence. They were grouped depending on how well the tools were rated on the scales, indicating support for performance or learning goals (see Figure 4 – 3).

Figure 4 – 3 Structural equation model
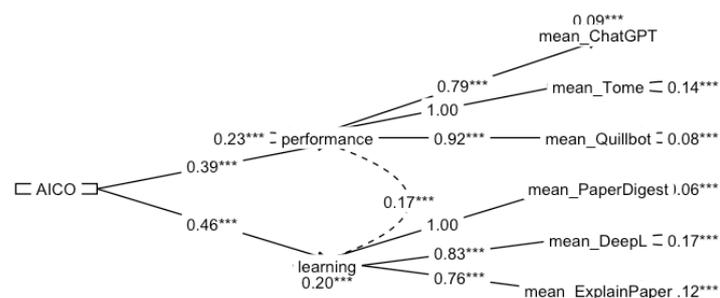
This model assumes that the tools with similar highest-rated aspects can be grouped in the overall evaluation by the students. Furthermore, this model assumes that the individual AI competence highly influences these latent factors in this context. The model has a good fit. *CFI* = .96, *TLI* = .931, *SRMR* = .044, *RMSEA* = .104.

Therefore, Hypothesis 4 is accepted, with ChatGPT, Tome and Quillbot being used for reaching performance goals and PaperDigest, DeepL and ExplainPaper for learning goals.

4.5 Discussion

Simply encountering AI and GenAI in the context of HEIs learning and assessment is not enough. Kasneci et al. (2023) emphasize that GenAI holds great promise for enriching student learning and teacher support but requires careful integration that addresses potential bias, privacy, security and ethical concerns, as well as ongoing human oversight and development of critical thinking. Thus, this international survey study investigated AI competence and students' perceptions of GenAI tool support in the context of HEIs learning and assessment. It underscores the importance of fostering a multifaceted understanding of GenAI in HEIs learning and assessment.

The findings support our first hypothesis (1a), revealing significant differences across the four dimensions of AI competence (theory, regulations, impact and attitude) (Delcker et al., 2024). Interestingly, the students showed the strongest AI competence in the 'attitude' dimension. This reflects a positive perception and enthusiasm for AI, i.e., that students are generally receptive to the potential of AI and its integration into various aspects of their academic experience (Chan & Hu, 2023, Stöhr et al., 2024;). This enthusiasm could be due to several factors: Students may be drawn to the innovative nature of AI and its ability to transform learning methods, access to information or even communication in educational settings (Almulla, 2024). In addition, positive portrayals of AI in the media as a powerful tool for problem-solving and progress could have contributed to students' enthusiasm (Rodway & Schepman, 2023).

However, it is important to recognize that enthusiasm alone does not equate to a comprehensive understanding of AI. Furthermore, these findings highlight a potential need to bridge the gap between students' enthusiasm and their understanding of

technical aspects, laws and regulations, as well as limitations of AI technologies. This is consistent with another important finding of this study, namely that students who report a higher AI competence also evaluate the support of AI for teaching and learning higher (Hypothesis 3), suggesting a need for providing students greater assistance in building AI competence to avoid generating an imbalance among them (Delcker et al., 2024). In addition, there were no significant differences in overall AI competence between students from the three participating countries, supporting hypothesis 1b. This suggests that students from the three participating countries demonstrated comparable levels of AI competence despite potential differences in their HEIs or differences in their exposure to AI technologies. Accordingly, the globalized nature of AI access in the participating countries might play a role. Students could gain exposure to similar information and perspectives on AI through online resources, social media, or international educational platforms. In addition, the increasing prominence of AI in popular culture and media may contribute to a more consistent level of general awareness of AI across geographical boundaries (Hsu & Ching, 2023). Furthermore, the specific dimensions of AI competence measured in this study (theory, regulation, impact and attitude) may transcend national contexts and reflect broader trends in how students approach new technologies.

Our second hypothesis (2) regarding GenAI tool support was also confirmed. Students perceived ExplainPaper, a tool that aids comprehension of scientific papers, as the most supportive for learning and assessment. This suggests a preference for tools that directly enhance understanding and critical thinking over those focused-on content generation or paraphrasing (ChatGPT, Quillbot) or translation (DeepL). Interestingly, Tome, a tool that generates presentation slides based on prompts, received the lowest expected support rating. Rather than relying solely on AI-generated content, this preference for comprehension-focused tools such as ExplainPaper may indicate students' desire to engage with complex information and form their own arguments. Effective presentations often depend on the presenter's ability to analyze information critically, synthesize key points and construct a compelling narrative (Jonassen, 2010). Tools such as ExplainPaper can support this process by facilitating the understanding of source material. However, AI-generated presentation slides, such as those offered by Tome, pose a risk in reducing students' engagement with the content and hindering the development of the critical thinking

skills needed to construct strong arguments (Spector & Ma, 2019). In line with this concern, it is even more important to investigate the advantages the students noticed with the specialized instruments for their learning processes and the underlying latent factors identified by the structural equation model.

As hypothesis 4 is accepted, students see the different tools as beneficial for different purposes in higher education. ExplainPaper, PaperDigest, and DeepL were considered helpful in assisting comprehension and highly correlated with each other in the overall rating. Tome and Quillbot were perceived as providing the most value in helping the students get better grades. ChatGPT, on the other hand, was estimated to help optimize the learning process. The structural equation model revealed that these three tools were highly correlated and loading to the same latent factor. These could indicate different possible applications to support different achievement orientations. Therefore, when researching the impact of AI tools on student learning, it is critical to distinguish between different types of AI tools as well as distinct features of generative AI and its use in the context of education. Furthermore, students' motivational dispositions are crucial in interacting with online learning tools (Schumacher & Ifenthaler, 2018b).

These results can create the basis for larger discussions on how we see students' usage of AI in assessment and what stakeholders in higher education want from assessment. This concerns the concept and expectations of individual goal orientation and the broader assumptions behind examining students (Urdan & Kaplan, 2020). When discussing the threat of students' cheating by using AI, we should consider how we view assessment and our assumptions about assessment and student motivation. If the discussion focuses on the fear of tools primarily designed to improve performance rather than students' focus on tools used to improve learning and understanding, we need to consider the different functions that assessment can have beyond certification to support learning (Black & William, 2018).

Overall, the discussion on AI tools in assessment must be conducted broadly and deeply and include students' perceptions and evaluations. This study highlights the uneven development of AI competence among students, with a positive attitude exceeding theoretical understanding. Additionally, students seem to value GenAI tools that support comprehension and critical thinking over those focused solely on content

creation. Future research could explore tailored interventions to enhance students' understanding of AI theory and regulations while investigating how GenAI tools can be effectively integrated into learning activities to promote deeper learning and critical thinking skills. The research results suggest that it is important to consider particular GenAI tools rather than grouping all GenAI tools together.

4.6 Implications

Various implications can be taken from this study's findings that could help advance psychological reflections and pedagogical practices in navigating these emerging frontiers in HEIs. The most striking finding is the disparity across the four dimensions of AI competence. While students have a positive attitude towards AI, their understanding of the underlying theory remains lower. This highlights the need for educational interventions that bridge the gap between enthusiasm and technical knowledge (Stein et al., 2024) and also between AI and GenAI use and digital competences (Svoboda, 2024). Curricula can be designed to integrate fundamental concepts of AI with practical applications, fostering a more nuanced understanding of this rapidly evolving field (Aler Tubella et al., 2023). These results form the basis for both practical educational actions as well as for research. In the future, it should take on a more nuanced examination and utilization of AI-competence, considering the differences between the dimensions and reflecting individuals' dispositions. Further, the study reveals a student preference for GenAI tools that support comprehension and critical thinking over those focused solely on content generation or translation (Janse van Rensburg, 2024). ExplainPaper, a tool aiding scientific paper understanding, received the highest expected support rating. This suggests that students value tools that enhance their ability to engage with complex information and develop critical analysis skills (Jonassen, 2010; Spector & Ma, 2019). Incorporating such tools into learning activities can encourage deeper engagement with course material and promote independent learning. However, while students perceive some GenAI tools as valuable, the relatively low expected support for GenAI tools like Tome, which generate presentation slides, suggests a need for a balanced pedagogical approach. GenAI tools should complement, not replace, the development of core academic competence (Mah & Ifenthaler, 2017, 2018). Pedagogical strategies should integrate GenAI tools thoughtfully, ensuring students develop critical thinking and the

ability to construct arguments independently (Walter, 2024). Regarding scientific research, the different appreciation of the tools as well as the different application scenarios should be investigated systematically. The opportunities and applications of the specific applications need to be investigated in detail and connected with the research on opportunities for transformation of assessment through GenAI (Xia et al., 2024).

4.7 Limitations and outlook

This study is not without limitations. Firstly, the findings may not apply to the general population of higher education students as they were based on convenience sampling from three participating universities, which may limit external validity (Campbell & Stanley, 1963).

Secondly, while the instruments adopted have been previously tested for reliability and validity (Delcker et al., 2024; Gibbs & Dunbar-Goddet, 2007; Pereira et al., 2017), further external criterion and mixed methods designs may provide more robust empirical insights into students' AI competence and related preference of GenAI tools for supporting learning and assessment. Accordingly, our current research is expanding to include samples from additional countries and adding a qualitative investigation focusing on students' and teachers' perceptions of AI competence and the pedagogical practices related to GenAI tools. Also, the level of school digitization reached by countries that have participated and will participate in future studies should be considered.

Thirdly, the students did not interact with the GenAI tools but were shown a screencast demonstrating the potential use of GenAI for their learning and assessment. This could impact the transferability from perception to performance. The study only provided insights into students' intent and did not include an actual experiment or use-case study.

In the future, it will be important to investigate if the ethical evaluation is a hindrance for students not to use the tools in actual practice. Furthermore, students' goal orientation should be connected to the different tools' usage and hypothesized purpose (Adesope et al., 2015). Therefore, AI research in HEIs should be further developed towards longitudinal research designs that can investigate possible developments in AI competence. Such designs could include different learning and

assessment situations using different GenAI tools. Tracking the potential development of AI competence over time and investigating the effectiveness of interventions would further contribute to the practical implications of GenAI in higher education.

In conclusion, while AI offers significant potential for higher education institutions, ethical considerations and responsible use are paramount. To promote digital education and to successfully integrates AI, universities must upskill educators, adapt teaching models, equip students with relevant skills, keep problematic technology use under control (e.g., smartphone overuse and addiction) and establish ethical guidelines for AI use (Karam, 2023). This proactive approach will ensure that AI is used effectively and ethically, driving positive change in higher education.

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5 Effects of teacher, peer, and self-feedback on student improvement in online assessment: The role of individuals' presumptions and feedback literacy

5.1 Introduction

Assessment is often historically understood as a way of certifying competences, with a strong focus in practice on summative assessment and grading students (Boud & Falchikov, 2005). Nonetheless, research shows that it holds much more potential and goes beyond the summative teacher assessment, which is employed frequently in higher education practice. Especially through means of online assessment, potentials can be elicited, such as personalization, adaptation, scaffolding, and many more (Kem, 2022). Additionally, online assessment allows for grading large groups and providing feedback in real-time (Heil & Ifenthaler, 2023). Practitioners are asked to actively engage in the assessment and feedback process beyond grading and consider supporting students in their learning process (Boud & Falchikov, 2005). Considering increased higher education enrollment and a lack of time by teachers to grade, different types of assessment and feedback need to be explored to ensure sufficient feedback for students, such as analytics-based feedback (Pardo et al., 2019), as well as peer- or self-feedback. Furthermore, students are generally not satisfied with feedback, and feedback should be provided using a dialogic approach (Nicol, 2014). The appreciation of feedback through students in higher education is even more split between the different modes, with students having a clear preference for actionable teacher feedback compared to other modes, such as peer feedback (Dressler et al., 2019; Tian & Zhou, 2020), of which students are critical, Empirical research highlights that peer assessment shows a reasonable accuracy (H. Li et al., 2016; Vuogan & Li, 2023), as well as a positive effect on learning progress, not only for the students receiving but also the ones providing it (L. Li et al., 2010).

This study focuses on online assessment and feedback, related individual feedback literacy, and students' acceptance of different feedback modes. This study aims to provide a comprehensive overview of students' acceptance of feedback modes, their implications for learning processes, and individual evaluations' effects on the learning process and essay quality.

5.1.1 Online assessment

Assessment is an essential part of learning and can be defined as a systematic method of sampling information about a learner's actions to draw inferences about the learning process (Baker et al., 2016). Formative assessment is characterized by its impact on the ongoing learning process (Black & Wiliam, 2009). Summative assessment can provide insights into an expected outcome or standard (Dixson & Worrell, 2016). Another difference is made between assessment *of* and assessment *for* learning, emphasizing their distinct effects on learning processes and outcomes (Wiliam, 2011).

Current practices in online assessment can be classified according to their mode, format, and type. The *mode* depends on the assessor, whether teacher, peer, automated, or self-assessment. The *format* can be either formative or summative, and the *type* encompasses all different kinds of assessment, ranging from quizzes to project-based work or essays (Heil & Ifenthaler, 2023). Further, the support through means of digital features in online assessment offers a wide range of possible pedagogical functions such as scaffolding, intelligent tutoring systems, automated feedback, and more (Kem, 2022). Additionally, assessment data collected in an online environment can be used to inform analytics-based feedback (Nouira et al., 2019). For assessment analytics, the data is used to analyze, predict, or visualize the learning progress or outcome for teachers and learners (Gašević et al., 2022). These solutions can be implemented through dashboards, for which, among others, assessment data can be used to reflect individuals' learning outcomes (Jivet et al., 2018). A systematic review by Kaliisa et al. (2024), which included $N = 38$ records, reflected the impact analytics can have on students' engagement in online environments. However, the results highlight the lack of reliable data regarding learning outcomes. Furthermore, they call for diversifying assessment methods that accurately measure learning to be used as a data basis for visualization of assessment data for learning analytics dashboards. Another systematic review, including $N = 39$ studies by Paulsen & Lindsay (2024), emphasizes the rising importance of theory-based analytics solutions based on pedagogical research. Additionally, the authors recommend that learning analytics should facilitate reflection through recommendations and feedback for learners.

5.1.2 Feedback

Feedback is the process of learners receiving information from various sources about their work, making sense of it, making judgments, and acting upon it in their learning (Boud & Molloy, 2013; Henderson et al., 2019). This ties in with the 'feed up, feed back, feed forward' concept by Hattie and Timperley (2007), which sees feedback for students as reflecting where they are, how they got there, and how they can achieve their goals. Even though one usually considers learners as feedback recipients, they must nonetheless actively participate in the feedback process (Winstone et al., 2017). A meta-review by Van der Kleij et al. (2019) reflected a historical shift from a greater focus on the provision of feedback to students toward a focus on their interaction with feedback. In recent years, the concept of feedback literacy has become more important when considering students' engagement with feedback. Feedback literacy is the capacity to act upon feedback received to improve learning processes (Sutton, 2012). According to Carless and Boud (2018), four key concepts build up students' feedback literacy: appreciating feedback, making judgments, managing affect, and taking action. Analyzing students' views in a focus group study on effective feedback, Molloy et al. (2020) identified that feedback-literate students should accept, process, and act upon feedback. Building upon these two frameworks, Dawson et al. (2024) developed a feedback literacy scale focusing on behavioral terms, consisting of five sub-components: Seek feedback, make sense of the information, use the feedback, be able to provide feedback to others, and manage one's affect towards it. Feedback literacy is essential in taking on the received feedback, particularly in online environments and with data-based feedback (Shibani et al., 2022; Tepgec et al., 2024).

Feedback should be of sufficient quantity and quality for students to further engage with it (Winstone et al., 2021), as research shows feedback to be more effective the more information it contains (Wisniewski et al., 2020) and that multiple sources of feedback foster learning (Henderson et al., 2019). In a systematic review with $N = 46$ publications, Banihashem et al. (2022) found that learning analytics can support feedback through visualization, data mining, text analysis, and social network analysis. They further call for systematically evaluating different feedback modes, such as peer and teacher feedback. In this vein, based on the different modes of assessment, different modes of feedback can be derived: teacher feedback, peer

feedback, and self-feedback (Ifenthaler et al., 2023). The data basis required for these modes allows for different ways of evaluation and, therefore, for different ways of using analytics to support learning processes.

5.1.3 Modes of feedback

Higher education practices focus on teacher feedback, with teachers providing feedback accompanied by grades (Winstone & Boud, 2022). Teachers are expected to have greater knowledge and competence, and therefore, students report a preference for feedback that can help with revision and a dislike for too generic feedback (Zacharias, 2007). Nonetheless, even in teacher-focused scenarios, feedback is a shared responsibility between teacher and learner as they must incorporate it into their learning processes (Carless, 2022).

The conceptual shift in the understanding of feedback processes and involving students more in the feedback process also led to increased integration of peer feedback (Winstone et al., 2022). Peer feedback refers to students providing feedback to peers (Topping, 2009). Peer feedback has been widely implemented in MOOCs (Huisman, Admiraal et al., 2018). A central stake in peer feedback is its effect on the assessor and the assessed, as the students providing feedback also learn through providing feedback (L. Li et al., 2010). Empirical research reflects no relationship between the perception of the adequacy of peer feedback and an increase in writing performance (Huisman, Saab, et al., 2018), while other studies report that students who perceive peer feedback as more useful might be more willing to revise their work (Misiejuk et al., 2021).

The term self-assessment is often used ambiguously by referencing automated assessment as well as assessing oneself. In the context of this study, it refers to students assessing themselves by comparing their work using exemplars or grading criteria to foster active engagement (Carless, 2022). Using exemplars can foster feedback literacy in students by allowing them to engage with high-quality work (Carless & Boud, 2018). Students should be able to assess their current learning process, their goals, and how to get there (Panadero et al., 2019). Self-assessment, therefore, refers to learners determining and applying assessment criteria and reflecting on their learning, leading to continuous self-reflection (Yan & Carless, 2022). In self-assessment processes, learners need to fulfill three steps: determine

assessment criteria, perform self-reflection, and perform self-assessment judgment and calibration (Yan & Carless, 2022).

Comparison of modes Studies directly comparing teacher and peer feedback among students highlight a clear preference for teacher feedback by students as reliance on teacher feedback in online environments compared to peer and automated was detected, even if it was more superficial (Tian & Zhou, 2020), as well as more confidence in teachers' judgment and a preference of teacher over peer to provide feedback, even if the performance improvement is higher in the peer condition (Mahvelati, 2021). This is also reflected in a higher preference for surface-level feedback provided by teachers, such as grammar or spelling, compared to meaning-level feedback by a peer provided on the content of the work (Dressler et al., 2019). Students appreciate teacher feedback and are critical of peer feedback, and the peer mode leads to a more complex engagement with the feedback (Cheng et al., 2023). This is further highlighted in a between-subject study by Martin and Sippel (2024), which showed that, after an intervention, the group receiving feedback from a teacher appreciated the feedback significantly more and also qualitatively used more positive descriptions than the group receiving peer feedback. Moreover, even if students have a positive attitude towards peer assessment, they might not identify its benefit as a learning aid and perceive it instead as an assessment tool (Wen & Tsai, 2006). Nonetheless, research shows that peer feedback can be productive and foster the skills and learning of the student providing the feedback. Furthermore, an earlier meta-analysis with $N = 48$ studies by Falchikov and Goldfinch (2000) identified an average correlation of $r = .69$ between peer and teacher assessment. A subsequent meta-analysis by Li et al. (2016) focusing on more digital assessment reported a Pearson correlation coefficient of .63 between teacher and student feedback (H. Li et al., 2016). Therefore, the ratings by the teachers and peers do not differ clearly. Furthermore, in a between-group study by Zhang and McEneaney (2020), the peer feedback group outperformed the teacher feedback group. Additionally, a meta-analysis by Vuogan and Li (2023) of $N = 26$ empirical studies focusing on L2 learners revealed that, although there was no difference in the learning improvement between peer- and teacher feedback, the effect sizes were higher for peer feedback. They also did not identify a difference between self- and

peer feedback. Their analysis calls for more research into directly comparing teacher, self-, and peer feedback. However, Zou et al. (2023) found no difference between the improvement based on peer or teacher feedback in a technology-enhanced setting. Regarding analytics-based feedback, Banihashem et al. (2022) advocate for a detailed analysis of peer and teacher feedback separately, considering their distinct impact on learners.

5.1.4 This study

The current literature indicates that the effects of different feedback modes in online assessment settings on learners, as well as the impact of learners' presumptions, have not been thoroughly researched. There seems to be a discrepancy between students' presumptions about feedback modes and the support these can provide, especially in online and analytics-enhanced learning scenarios. These concerns are becoming increasingly relevant, particularly in light of the need for assessment and feedback methods that are alternative to the teacher mode in higher education. Therefore, this needs to be researched in detail. Current research on feedback shows that students prefer teacher feedback. However, whether this is due to higher quality or better improvement is unclear. Psychological theories and evidence suggest that cognitive processes are supported by peer and self-assessment, and empirical research highlights that the grading can be equally sound in quality and effects on the learning process. While students might be more prone to engage with teacher feedback, the improvement is similar. The question remains how the acceptance of different modes of feedback ties in with the actual improvement of learning and which role factors, such as feedback literacy, can play. Based on the current literature, this study aims to get an in-depth insight into the effect that these different modes of online feedback can have on students' learning processes and their perception of the feedback.

RQ 1: How do students evaluate different feedback modes in an online assessment setting?

To investigate this research question, based on the results of existing studies that reflected a clear preference for teacher over peer feedback (Dressler et al., 2019; Mahvelati, 2021; Tian & Zhou, 2020), we assume that this is also replicated for peer and self-feedback, therefore:

Hypothesis 1: Students evaluate the usefulness of teacher feedback higher than that of peer and self-feedback.

RQ 2: What impact do different modes of feedback have on students' improvement in online assessment, and what is the role of feedback literacy?

Based on the research considering the quality of peer and teacher feedback (Falchikov & Goldfinch, 2000; H. Li et al., 2016; Vuogan & Li, 2023), we assume that:

Hypothesis 2a) The different feedback modes lead to similar improvement.

Additionally, research shows that feedback literacy is essential for students to use feedback (Carless & Boud, 2018; Tepgec et al., 2024). Therefore, we assume for all modes that:

Hypothesis 2b) Feedback literacy mediates the improvement of the essay quality.

RQ 3: What impact does the perception of the assessment mode have on students' improvement?

As research shows that the presumptions about peer feedback do not influence the improvement of learners (Huisman, Saab, et al., 2018), we assume this for all modes and therefore hypothesize that:

Hypothesis 3) Students' presumptions about a feedback mode do not influence their improvement through it.

5.2 Materials and methods

5.2.1 Participants

Sixty-two students initially participated in this study, of which $N = 59$ were eligible for data analysis. They all studied a Business and Economics Education course at a European university. Demographically, 20 identified as male and 42 as female, with non-binary status not stated. Their average age was 24 years ($SD = 2.68$). Ethics approval was obtained for this research at the participating university, and the students provided informed consent upon participation.

5.2.2 Procedure and materials

To eliminate inter-individual differences, this study uses a within-person design. The quasi-experiment took place over two hours, comprising two sittings, each lasting one hour, a week apart. To recreate a realistic assessment scenario for

the students, both parts of the experiment took place in a computer lab at the university under the supervision of the researchers. The environment of the experiment was a development instance of the learning management system (LMS) of their university, which they were already familiar with but received anonymous dummy accounts to log in. In the first sitting, students logged into the LMS and received access to a course with a clear structure referring to the different stages of the experiment. All these steps were carried out simultaneously by all participants under the guidance of the researchers. The content of this course was vegan diet, its definitions, regulations, and effects on health.

First Sitting

1. **Pre-survey:** As a first step, they filled out a pre-survey. This included their perceptions about the different feedback modes in aiding their learning processes before the actual interaction in the experiment. These items were based on Schumacher and Ifenthaler (2018a) and adapted to fit the context of online assessment (average α = .9). All items were assessed on a five-point Likert scale. Furthermore, the students' feedback literacy was assessed using the instrument by Dawson et al. (2024), which was assessed on their six-point Likert scale (α = .78).

2. **Pre-test:** Next, ten multiple-choice and single-choice items concerning students' prior knowledge about veganism were administered. For this quiz, students received automated feedback from the LMS.

3. **Learning phase:** After assessing their prior knowledge, the students received study materials on a vegan diet to engage with for 15 minutes and were allowed to study individually, as they also would for an exam.

4. **Essay 1:** Then, they were instructed to write their first essay, answering the prompt: "Is a vegan diet generally harmless to health? In a short essay, weigh the possible risks and ways of counteracting them."

5. **Peer feedback:** After finishing the first essay, the students received two essays that their peers wrote and were asked to provide feedback. To support students in providing feedback to their peers, they received a rubric (Xie & Zhang, 2024), which was based on the works by Mathias and Bhattacharyya (2018) on grading short-form essays on the four different aspects: content,

formalities, sentence flow, and organization. For each aspect, the students could provide points from one to five. Each of the different possible grades was provided a description, which value to attribute to them, with the distance between each level being assumed to be equal.

6. **Essay 2:** Ultimately, they were asked to write a second essay, this time with the prompt, "A friend of yours would like to follow a vegan diet but is unsure whether she can trust the products labeled as vegan in the supermarket. In a short essay, explain what needs to be considered when shopping vegan in the supermarket and what the vegan labeling means." After writing the second essay, the first session was over.

Second Sitting

1. **Receive feedback & revise**: In the second sitting, one week later, the students first received feedback from the teacher on the second essay they wrote the previous week on vegan labels in the supermarket, after which they reworked it. The feedback included ratings according to the provided rubric and the respective average in the group, as well as open comments on the essays. They also received feedback from two peers on the first essay focusing on the possible risks of a vegan diet, of which they were provided the individual assessments as well as the average and the comparison to the group. The peer feedback was anonymous (Panadero & Alqassab, 2019). In both cases, it was processed graphically and thus made available to the students in the form of bar charts. Examples can be found in Figure 5 – 1 and Figure 5 – 2.

Figure 5 – 1 Example of teacher feedback

Dear students, this is the feedback you received from the teacher on Essay2: 'Explain in a short essay what you have to consider when shopping vegan in the supermarket and what the vegan declaration means?'.

This table shows the average rating of the individual aspects in the entire course course, as well as your rating in comparison.

	Your Rating	Average Rating
Content	3	3
Organisation	3	3,33
Formalia	4	3,17
Sentence Fluency	4	3,67

Open Comments

- The essay is successful. Some aspects are mentioned in terms of content. However, there is no explanation of the awarding of the V-label or mention of other possible labels.
- Formally, the text contains a few (1-3) spelling and grammatical errors.
- The organisation is successful, but a stronger common thread and a clear summary would aid understanding.
- The sentence flow is well organised. However, the repetition of terms hinders the reading flow somewhat.]

Figure 5 – 2 Example of peer feedback

Dear students, this is the feedback you received from your fellow students on Essay1: 'Is a vegan diet basically harmless to health?'.
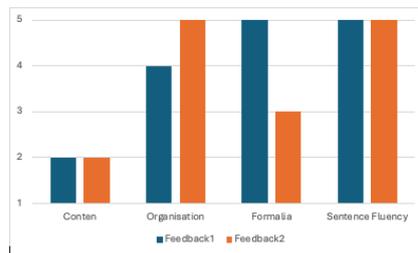
This table shows the average rating of the individual aspects in the entire course, as well as your rating in comparison.

	Your Rating	Average Rating
Content	2	3,5
Organisation	4,5	3,83
Formalia	4	4,25
Sentence Fluency	5	4,42

Open Comments:

Reviewer1	Reviewer2
• Open comments	• Open comments

2. **Essay 3:** The students were then asked to write a third essay answering the prompt: "Your relatives are a bit confused about all the different types of diets. Explain in a few sentences the different vegetarian/vegan diets and how they differ. "

3. **Self-assessment:** After finishing the essay, they were provided an exemplar for self-assessment (Carless & Boud, 2018). After engaging with the exemplar, the students reworked and re-submitted their essays.

4. **Post-survey:** The students completed the post-survey, asking for their evaluation of the assessment modes, and answered the Motivated Strategies for Learning Questionnaire (MSLQ) by Pintrich et al. (1991).

5. **Post-test:** The students completed a quiz-based posttest, encompassing the same multiple-choice and single-choice questions as the pretest, and received automated feedback.

After completing the experiment, two independent graders rated all the essays based on the same rubric. As the value for the essays was on a continuous scale from 4-20, the inter-class correlation was used to calculate the inter-rater reliability with an average of .64, which can be considered moderate reliability.

5.3 Results

5.3.1 Preliminary analysis

The data was preprocessed using PyCharm and further analyzed with R. Regarding the descriptive analysis of the grades provided to the participants, the average points awarded by the teachers on essay two ($M = 15.12$, $SD = 1.64$) was significantly lower than the points provided by the peers on essay one ($M = 17.05$; $SD = 1.61$) during the course, $W = 443$, $p < .001$. Nonetheless, a significant correlation could be found between the peers' average grades and the subsequent raters' rating, $r = .43$; $p = .002$. The two peers deviated from each other on average by $M = 2.1$ ($SD = 1.65$).

5.3.2 Research question 1: How do students evaluate different feedback modes in an online assessment setting?

The respective values regarding the evaluation of the different modes by the students can be found in Table 5 – 1. To identify the difference in evaluation between the different modes in the pre- and post-test, a two-factor repeated-measure Analysis of Variance (ANOVA) with the conditions of *time* and *mode* was conducted.

ANOVA

The normal distribution of the data in all levels was confirmed through the Shapiro-Wilk test (all p > .05). The independence of observations was assumed based on the repeated measures design. Further, the sphericity was tested using the Mauchly's Test. Due to it reporting a significant deviation from sphericity for the mode ($W = .86$, $p = .013$) and interaction ($W = .85$, $p = .01$), the Greenhouse-Geiser corrections are reported for mode and the interaction effect. A significant effect of the mode could be found, $F(1.75, 101.66) = 6.93$, $p = .002$, $\eta^2 = .11$, which can be considered a medium effect. Yet, no effect was found for time, $F(1, 58) = .25$ $p = .622$ or the interaction $F(1.74, 101.06) = .17$, $p = .979$. The post-hoc analysis revealed that a significant difference was found between teacher feedback and peer feedback in the pre-test, $t(58) = 3.5$, $p < .001$, $d = .47$, and the post-test, $t(58) = 4.25$, $p < .001$. $d = .53$.

The graphical representation can be found in Figure 5 – 3.

Table 5 – 1 Mean rating of feedback according to students
SD in parentheses

Mode	Pre	Post	Increase
Peer	3.69 (0.65)	3.71 (0.61)	0.02 (0.64)
Teacher	3.97 (0.55)	4.01 (0.51)	0.02 (0.64)
Self	3.77 (0.67)	3.77 (0.71)	0.03 (0.47)

Figure 5 – 3 Evaluation of the assessment modes by students pre- and post test

Evaluation of Modes Pre and Post
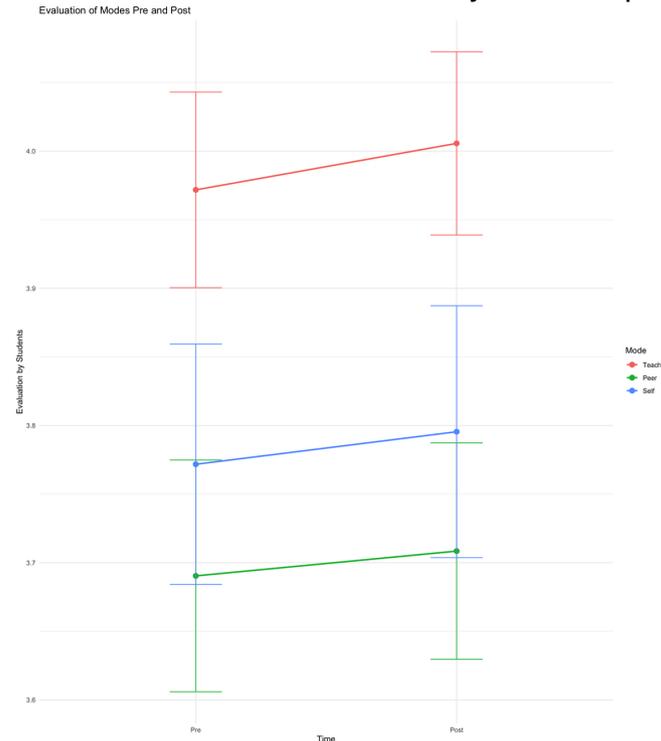
Hypothesis 1 is therefore partially accepted, with teacher feedback being significantly higher evaluated than peer feedback.

5.3.3 Research question 2: What impact do different feedback modes have on students' improvement in online assessment?

The respective values regarding the evaluated essays in the different modes can be found in Table 5 – 2.

ANOVA

The normal distribution of the data in all levels was confirmed through the Shapiro-Wilk test (all p > .05). The independence of observations was assumed based on the repeated measures design. Further, the sphericity was tested using Mauchly's Test, which did not find a significant deviation from sphericity for either the mode (W = .99, p = .847) and the interaction (W = .99, p = .785). A two-factor repeated measures ANOVA with the conditions *time* and *mode* revealed a significant effect of time and, therefore, the increase between pre- and post-essay quality, $F(1, 51)$ = 15.7, $p <$ .001, η^2 = .24, which can be considered a large effect. Neither the effect of the mode, $F(2, 102)$ = 2.48, p = .089, η^2 = .05, nor the interaction effect was significant, $F(2, 102)$ = 1.87, p = .159, η^2 = .04. The post-hoc pairwise comparison under the time condition revealed a significant increase from pre- to post-test in the

peer condition, $t(51) = -3.81$, $p < .001$, $d = .52$, which can be considered a medium effect. The graphical representation can be found in Figure 5 – 4.

Hypothesis 2a is therefore rejected, with peer assessment being the only condition in which the increase was significant.

Table 5 – 2 Mean evaluation of the essays assessed by the independent assessors SD in parentheses

Mode	Pre	Post	Increase
Peer	14.32 (1.96)	15.28 (1.73)	0.96 (1.82)
Teacher	15.15 (2.02)	15.46 (1.81)	0.31 (1.8)
Self	14.96 (2.03)	15.36 (2.06)	0.39 (1.87)

Figure 5 – 4 Quality of essay in modes pre- and post test
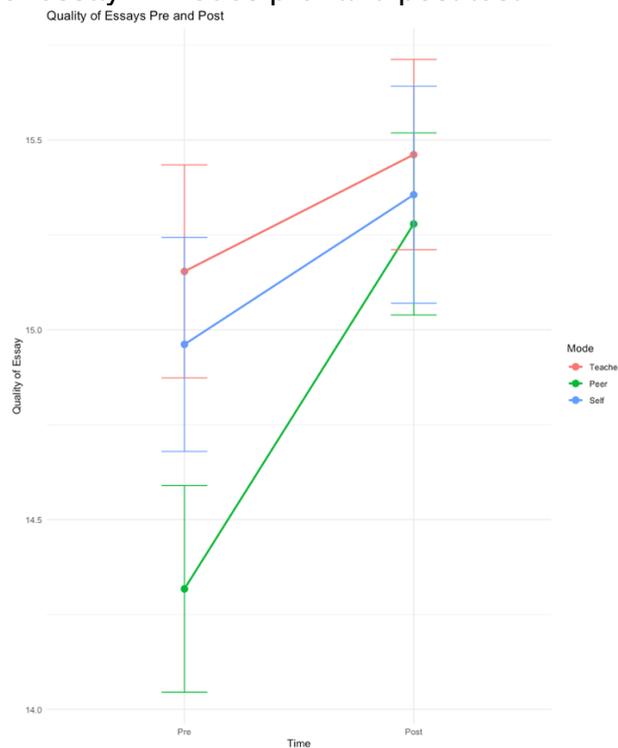
A subsequent mediation analysis revealed a partial mediation of the time condition by the feedback literacy of the participants. The effect of time on the essay quality was significant, $b = .55$, $p = .011$, and the indirect effect of feedback literacy on the essay quality, $b = .67$, $p = .017$. The graphical representation can be found in Figure 5 – 5.

Figure 5 – 5 Mediation analysis of feedback literacy on the increase in essay quality

Hypothesis 2b is therefore accepted, with feedback literacy mediating the effect of pre- and post-conditions on the quality of the written essay.

5.3.4 Research Question 3: What impact do the presumptions about the assessment mode have on students' actual improvement?

Considering the effect of the presumption that students have on the actual improvement in essay quality, three linear regression analyses were conducted. A linear regression could find no influence of the pre-acceptance of peer feedback on the actual improvement, $R^2 = -.02$, $F(1,50) = .03$, $p = .844$. $\beta = -.03$. The same result was found for teacher feedback, $R^2 = -.02$, $F(1,50) =. 02$, $p = .898$, $\beta = .02$, as well as for the self-feedback condition, $R^2 = -.01$, $F(1, 50) = .61$, $p = .438$, $\beta = .11$.

Hypothesis 3 is therefore accepted, as there was no significant effect of the presumptions about the feedback modes on the quality improvement.

5.4 Discussion

The results of this study tie in with pre-existing research and add new insights into the practice of online assessment by comparing different modes as well as the attitude of students towards feedback and the effect of feedback on their learning. Our results regarding RQ1 reflect a higher teacher feedback evaluation by the students compared to peer feedback. This ties into previous findings regarding the acceptance of teacher, peer, and self-feedback (Dressler et al., 2019; Tian & Zhou, 2020). Additionally, these results highlight that even the interaction with the feedback does not change these assumptions. Therefore, ways of addressing this issue need to be developed that go beyond students interacting with peer- and self-assessment.

The assessment of the peers correlated significantly with the subsequent evaluation of the raters, which supports the quality of peer assessment, which has been reflected in previous meta-analyses (Falchikov & Goldfinch, 2000; H. Li et al., 2016). This underlines the value that peer assessment can bring to higher education. Another interesting implicit result is that the students did not evaluate the self-feedback significantly worse than teacher feedback, perhaps because exemplars are considered feedback that the teacher provides, and the disregard stems from not trusting their peers and evaluating them as less competent than the teacher (Zacharias, 2007). This should be systematically investigated in future research.

Our results regarding RQ2 shed light on multiple different aspects. First, there seemed to be an effect of the feedback on the quality of the essays, with further analysis revealing the peer condition being the only one showing a significant improvement. This is an important result reflecting peer feedback's effectiveness (Mahvelati, 2021). The mediation showed that the individual feedback literacy significantly but partially mediated this effect. This ties in with previous research emphasizing its role, as feedback uptake somewhat depends on individual feedback literacy (Carless & Boud, 2018; Tepgec et al., 2024). Practitioners should, therefore, aid students in developing feedback literacy, especially considering the dimension of seeking and using feedback (Dawson et al., 2024). This could be achieved through implementing formative feedback practices, including iterative and dialogic praxis (Vaughan & Uribe, 2024).

The results regarding RQ3 underline the presumptions that arise from RQ1 and RQ2. We found no impact of students' presumptions of the modes of feedback on the actual increase through the type of feedback. This ties into the results by Huisman, Saab, et al., (2018), reflecting that the acceptance of feedback does not predict how well students will actually benefit from it. Furthermore, this effect is expanded not only for peer feedback, but also for teacher and self-feedback. Consequently, the results of this study shed light on the importance of systematically investigating learners' progress beyond their subjective evaluation. The results show that their rating of the feedback modes differed significantly, with peer assessment being the lowest evaluated. Therefore, students would have reported peer feedback as less effective than teacher feedback, even though it was the only condition that

showed significant improvement (H. Li et al., 2016). Even if students might not evaluate peer feedback as supporting their learning process, it might still do. Therefore, the effect of feedback on learning processes needs to be visible and understandable for students, especially in monitoring their self-regulated learning. If used effectively, this could be achieved through implementing feedback practices, metacognitive reflection, and analytics-based implementations (Viberg et al., 2020). Fostering awareness and acceptance of feedback in practice is still a remaining issue, so students might be more motivated to engage with it (Misiejuk et al., 2021). Practice would benefit from supporting the role of feedback beyond justifying grades and highlighting its relevance (Winstone & Boud, 2022).

5.5 Implications

An open question remains in the underlying processes that lead to the discrepancies between the actual improvement and the subjective evaluation. One insight of this study is that the grading provided by the teacher was significantly lower than that of the peers. Maybe the more critical feedback by the teacher leads the students to believe that it was more detailed and, therefore, would support them more in their learning, as research shows that more critical feedback can impact performance. Actionable feedback is perceived more positively by students (Zacharias, 2007). Furthermore, students might prefer teacher feedback because it is connected to their grades. Therefore, the feedback is considered a justification of grades (Winstone & Boud, 2022), or they might evaluate teachers as competent counterparts (Zacharias, 2007). Clear recommendations for practitioners in higher education and researchers can be derived based on the results of this study. Practitioners should employ peer- and self-assessment in online learning scenarios as an alternative to teacher assessment. Furthermore, in this study, the three modes were separately discussed but can also be fruitfully combined in engaging in discussion with teachers and peers in a dialogic way, engaging with exemplars (Carless et al., 2018; Nicol, 2014). Students should receive support in developing feedback literacy to benefit from the feedback provided in online learning environments and actively engage with assessment (Tepgec et al., 2024).

The results of this study also call for investigating students' actual learning rather than solely their perception of certain types of feedback, as these appear to

differ. Additionally, research should be conducted on overcoming the negative assumptions regarding assessment modes that are not teacher-led. An open question remains in investigating how the different modes of feedback influence other factors such as motivation, self-regulated learning, or feedback literacy and how this could affect the evaluation as well as the learning progress of students. Motivational factors and their role and interplay with improvement must be investigated in future research, and guidelines must be developed for educational use in practice.

5.6 Limitations

Nonetheless, this study has multiple limitations that must be considered. The students already provided their peers' feedback, which might have led them to have higher scores in their second essays (L. Li et al., 2010). Furthermore, the sample size is limited, and due to technical issues, not all students could participate in all conditions. Moreover, all participants stem from the same university. Ultimately, there were no incentives in this scenario for students to perform well, and the authenticity of the study must be evaluated critically.

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6 University teachers' expectations for successful implementation of online assessment in higher education: A convention-based analysis

6.1 Introduction

Assessment plays an important role in educational processes, particularly in higher education, but the conceptualization of assessment as a mere way of certification is inadequate to fully elicit its potential (Boud & Falchikov, 2007). Hence, assessment needs to be considered beyond the scope of grading (Winstone & Boud, 2022). Using means of online assessment allows for this change by opening up possibilities that are not feasible in traditional scenarios, such as adaptive learning, immediate feedback, grading larger cohorts, and assessing factors of learning processes such as engagement or motivation (Heil & Ifenthaler, 2023). However, online assessment needs to be employed safely, accepted, and successfully to elicit this potential. In this context, university teachers play a vital role. Not only are university teachers central in supporting competence developments in students and adaption to digital change (Poenaru, 2022), but successful implementation of online assessment also calls for intuitional change as well as including all stakeholders in decision-making as institutional culture has to be considered a crucial factor in the effective implementation of digital tools (Macfadyen, 2022). In the same vein, in the context of managing digital change in HEIs, staff readiness is next to technological and organizational readiness, which is a central factor. Open communication is crucial for successful implementation, as well as removing barriers for individuals and decreasing resistance through the involvement of all stakeholders (Ifenthaler, 2020).

In this context, the sociology of conventions provides a tool to understand dynamics and decision-making in the context of institutions with a specific focus on the actors and their compromises in larger decision-making processes. Conventions are understood as conflicting, implicit assumptions that shape how individuals take decisions in their realm.

In order to better understand how stakeholders in educational change, particularly digital learning and teaching, justify their reasoning and how these concerns and desires can be addressed, conventions are used as a framework. This approach allows the identification of reasoning principles for and against online

assessments dependent on larger convictions of university teachers. The results of this study help in supporting the transition processes towards online assessment by considering university teachers' concerns and identifying potentials as well as defining clear expectations from HEIs.

6.2 Background

6.2.1 The sociology of conventions

The concept of 'conventions' refers to a multitude of rules and norms guiding individuals in their approach to their surrounding world (Knoll, 2015), which are different justification orders that can co-exist but are mutually exclusive (Jagd, 2004). Following this, actions are not made on an individual cost-benefit evaluation but instead based upon larger guiding principles that are understood as culturally established logics of coordination, and help situational coping with uncertainty (Knoll, 2015). This uncertainty is especially prevalent in social situations where disputes between actors occur (Jagd, 2007). By reducing uncertainty through conventions, individuals evaluate in the realms of their own uncertainty, and conventions can provide them with a framework to take decisions (Diaz-Bone, 2018b). Therefore, actors act according to how they evaluate quality, and they do this in the form of conventions, as one cannot evaluate quality outside of them. Furthermore, it is important to consider that as conventions are cultural concepts, they are prone to constant historical change (Jagd, 2007)

The original six conventions conceptualized by Boltanski and Thévenot in 1991 find their roots in different philosophical schools of thought that each span their own world, based on which the conventions arise. Shortly after postulating the six conventions, the ecological (or green) polity was added as a seventh convention, focusing on ecological integrity and preservation of the natural environment (Lafaye & Thévenot, 1993). Then, in 1999, Boltanski added the so-called 'project-based world'. This additional world, which lays the basis for the further project-convention established itself through changes in relationships from a world of family and friends to a network (Boltanski & Chiapello, 2006).

Therefore, nowadays, there are eight major conventions to be considered (Diaz-Bone, 2018a). Each of these conventions is a different coordination principle

and evaluates quality on a different measure of worth. A short overview can be found in Table 6 – 1.

Table 6 – 1 Overview of conventions

Own representation after Diaz-Bone (2018a), Boltanski and Thévenot (2007), and Imdorf and Leemann (2023)

	Measure of worth	**Objective**
Civic convention	Collectivity, Solidarity	Justice and the common good
Industrial convention	Efficiency, Productivity, Expertise	Development, Standardization
Domestic convention	Character, Hierarchy, Tradition	Loyalty, Trust, Moral
Inspired Convention	Innovation, Creativity	Passion, Creation
Market convention	Money, Value	Competition, Exchange
Convention of fame	Image, Prestige, Fame	Reputation
Project convention	Network, Flexibility, Mobility	Fulfillment of Projects
Ecological convention	Ecological Integrity	Preserving the environment

Coordination must be shaped by the multitude of conventions and challenges actors face to reflect their realms of reference (Imdorf & Leemann, 2023). Changes are understood as compromises between actors based on different evaluation standards of quality (Leemann & Imdorf, 2019). As conventions only provide the framework of decision-making, people can take the same action, which is grounded in different justifications, and the conventions are used as coordination principles (Hägi, 2019).

In the context of conventions, institutions are considered to be guided by the action and coordination of individual actors (Diaz-Bone, 2018b). Organizations in any form must constantly cope with tensions between different orders of worth (Jagd, 2004) and rationalities that might shift depending on the situation (Jagd, 2011). Therefore, institutions must be evaluated as incomplete and as individual actors taking actions based on conventions as their guidance. Following this, there is no

best way of doing something but rather a multitude of conventions that influence the individual actors (Diaz-Bone, 2018b).

6.2.2 Conventions in education

As conventions encapsulate and influence all areas of life, stakeholders in education are also tremendously guided by the conventions they are prone to use for evaluation. According to Imdorf and Leeman (2023), one can distinguish seven conventions, which follow a different concept of the common good and understanding of education. Accordingly, these are the original conventions defined by Boltanksi and Thévenot (2007), but minus the added ecological convention, as this, thus far, has not been applied in the educational sector. In the theory by Boltanksi and Thévenot (2007), higher education is seen as a compromise between the civic world on the one hand and the industrial world on the other, especially in the certification of competencies needed for industry and public spending towards education for the industry (Boltanski & Thévenot, 2007). Further, they show that schools are in the tense field between the civic and domestic world by educating students to be citizens, while character-building is also expected. Over the last few years, this has been challenged by the market order, with a shift towards competition between individuals and institutions (Schneijderberg, 2020).

In the context of educational governance and institutions, the theory of conventions has already shown potential for analysis. Graß and Alke (2019) call for a convention-based analysis of educational governance as the sociology of convention provides a theoretical frame to analyze daily interactions and as routine coordination of actors' choices and evaluation in transformations. Hedtke et al. (2017) argue that a conventionalist view also allows for analyzing the interaction between actors and different educational situations and materials as situational evaluations. These situations can be seen as units of analysis. Among them are, for example, digital devices, classroom seating, but also assessments (Hedtke et al., 2017).

6.2.3 Online assessment

Assessment is a crucial part of learning processes and can be defined as a systematic method of sampling information about a learner to draw inferences about their dispositions (Baker et al., 2016).

Support through digital features in online assessment offers a wide range of possible pedagogical functions such as scaffolding, intelligent tutoring systems, automated feedback, and more (Webb & Ifenthaler, 2018). OA can also improve processes by enabling personalization and adaptivity of learning processes, such as creating more personalized feedback (Heil & Ifenthaler, 2023). Similarly, it can be used as part of an approach to analyze students' learning behavior and provide them with feedback on their learning process, providing assessment in combination with learning analytics feedback (Tempelaar, 2020). Data that is collected in the assessment process can be analyzed and support automated feedback and visualization and, therefore, help learners in their ongoing processes (Gašević et al., 2022; Ifenthaler et al., 2023). It is imperative to acknowledge that the effective implementation and adoption of online assessment, and more specifically, assessment analytics, necessitates a paradigm shift in how we currently assess in higher education. It might call for a change from an assessment of learning to an assessment for learning (Macfadyen et al., 2014).

University teachers' opinions and acceptance of online learning environments play a significant role in effectively using and implementing these scenarios (Herodotou et al., 2019). Cultivating their agency in co-designing, especially assessment-based interventions, is important to build trust and lead to fruitful outcomes. Specifically, a successful implementation on an instructional level requires their involvement (Shibani et al., 2020). This significance is underlined by the findings of a qualitative study with $N = 31$ faculty personnel conducted by St-Onge et al. (2022). After a shift to emergency remote teaching, the university teachers were considerate in implementing strategies that support students and are well pedagogically aligned. The reported requisites for better integrating digital resources and assessment practices in their institutions were guidelines by universities, as well as administrative and human resources, especially IT support. These findings align with the themes identified by a systematic review by Brady et al. (2019), with $N = 65$ journal articles reflecting university teachers' needs for technology-supported assessment. They identified resources required by the institutions as support through policies, resource and time allocation, financial investment, training, and an ease of integration with existing systems and ongoing time. The need for time and ease of

use is also reflected in the quantitative study by Kuikka et al. (2014) with $N = 48$ university teachers, which reported challenges such as the availability of support, a need for additional time for e-exam creation, as well as usability and reliability of the system. Therefore, the participating teachers, among others, reported a need for support and training on didactical implementation of online assessment, a simplicity of interfaces and accesses, and elaborate functions such as automatic evaluation or immediate feedback to be provided. Alruwais et al. (2018) also identified challenges, including a need for competence in using it, resulting in a need for training, technological infrastructure, accessibility of technology, and a challenge in assessing group projects. The challenges identified for online assessment relate to general challenges of digital change in universities. To implement this successfully, it is important that innovations in HE align with the institutions' priorities and the expected impact as well as investment are clearly defined (Palmer & Giering, 2024).

Assessment needs to be crafted in adherence to fairness criteria, including similar treatment of all test-takers, no measurement bias, access to measuring construct, and a valid interpretation (Zlatkin-Troitschanskaia et al., 2019). Furthermore, educational technology must be implemented ethically, following the 'Do no harm' concept. This emphasizes that additional educational technology should foster benefits and mitigate deficits (Spector, 2016). It is essential to consider possible inequity between students due to different recourses, such as devices or internet connection (Amrane-Cooper et al., 2024).

Overall, OA bears manifold potential to support learning processes in HE. However, to fulfill this potential, university teachers need to be seen as key players, and support must be provided to ensure successful implementation. This also includes insurance of an ethical and privacy-compliant use in practice

6.2.4 This study

This study aims to get a more in-depth view of university teachers' decision-making and the compromises and evaluation of changes. The present study employs the framework of conventions to shed light on the different orders of justifications university teachers follow in educational decision-making. Furthermore, as institutions play a significant role in guiding and supporting the implementation of digital systems

and data analysis, the conventional viewpoint is taken, that decisions in institutions are made up of individual actions. Considering the conventions followed by the university teachers, their role and viewpoints on institutional impact will be considered, as well as their expectations from the institution in support and guidance. The focus is on digital education, specifically online assessment and assessment analytics. Based on the impact of the individual rationales of choice that teachers follow to design and develop learning environments, the following research questions emerged:

1. Which conventions do university teachers report concerning the common good of education?
2. Which reasons for and against using online assessment can be derived based on different conventions?
3. What expectations do university teachers have of the HEI and themselves to provide for fruitful implementation of online assessment?

6.3 Method

6.3.1 Materials

The approach for this research was a qualitative interview study with teaching staff at HEIs. Based on the literature and the guidelines by Mayring (2016), an interview guide was developed to be implemented in a semi-structured one-on-one interview format. A pilot study with $N = 3$ university teachers at a higher education institution was conducted to validate the concepts and effectiveness of the interview guide. Several adaptations were made iteratively with respect to the feedback of the pilot participants.

The final guide comprises four blocks. The first block focused on the university teachers' teaching experience and pedagogical convictions, followed by a block asking for their wishes regarding change in higher education. The next block investigated further the conventions the teachers follow regarding higher education. The questions were developed based on the work by Imdorf and Leeman (2023), who, among others, defined the central aspects that characterize and distinguish conventions as the common good, educational objectives, and natural relationships. Accordingly, the teachers provided their views and convictions about these aspects.

As the research states that individuals can follow multiple conventions (Diaz-Bone, 2018a), the participants were asked to break down their three main rules and norms. Finally, the last part was focused on online assessment. The questions asked about the university teachers' expectations were provided with an additional link to their previously stated conventions. They were asked to elaborate on how online assessment could support the common good, that is, the university teacher's conviction, or which barriers it could create.

Convenience sampling was then used to reach university teachers interested in participating in this interview study. They were informed about the data security and sent an information document to be signed. A few days before the interview, they also received the interview guide, in case they would like to prepare themselves.

6.3.2 Participants

In the final study, $N = 33$ university teachers took part. They were, on average, 33 years old ($SD = 7.84$). Of them, 14 identified as female and 19 as male, with non-binary not stated. The participants were spread across nine different higher education institutions, all of them in Germany. Their faculties ranged from Education Science over Business and Economics to Engineering, with most of the participants working as research assistants ($N = 29$), two as professors and two as lecturers. Their experience in teaching was, on average, five years ($SD = 8.1$), ranging from half a year to forty years. All of them taught a course last year. When describing their approach to teaching and didactics, they were asked to focus on the previous class they taught. In general, the pedagogical education differed greatly, with some starting their teaching position without any or only some formal didactical training. In contrast, others had a degree in a pedagogical field ($N = 16$).

6.3.3 Analysis

The interviews had an average length of 34 minutes and 33 seconds. For the purpose of analysis, they were transcribed using f4 software and with the help of a research assistant. Further, a deductive coding scheme was developed. The university teachers' conventions were analyzed based on the central concepts of the

common good, educational objectives, and natural relationships as defined by Imdorf and Leemann (2023).

6.4 Results

6.4.1 Research question 1

Which conventions do university teachers report concerning the common good of education?

Participants were asked to identify their perceived conventions, what they consider the common good, that is created by higher education for all of society. They were asked to name three aspects, but not all participants adhered to this, and many mentioned fewer or mentioned aspects that can be summarized under one convention. The predominant reported conventions that university teachers pursued regarding higher education as orders of justification were the industrial ($N = 27$), as well as project ($N = 22$) and civic ($N = 19$) conventions. As examples concerning industrial, one university teacher would mention the contribution of higher education to society as "[…] professionalization of students in various fields, i.e., the training of specialists and managers in the future." (Interview 15), for the project convention: "[…] the ability to think in complex connections and, above all, to communicate, communication skills" (Interview 13) and the civic: "[…] that you enable people to participate in society, exactly, so to a certain extent education is terribly important in order to help move things forward." (Interview 21). The least mentioned were inspired ($N = 8$), market ($N = 4$), domestic ($N = 2$), and convention of fame ($N = 1$). Even though not indicated by Imdorf and Leeman (2023), two of the interviewees also reported the ecological convention by describing the main order of justification for education as educating people to combat the climate crisis.

6.4.2 Research question 2

Which reasons for and against using online assessment can be derived based on different conventions?

After they expressed their initial general thoughts on challenges and benefits, the participants were invited, according to their aforementioned conventions they followed according to the common good of higher education, to articulate their view on the role online assessment could take on to support the common good of these

conventions or which barriers they could create, making it more difficult to achieve the ultimate goal of this convention. The results for all conventions can be found in Table 6 – 2**.**

Table 6 – 2 Arguments for and against online assessment based on conventions

	Pro	Contra
Civic	- Assessment formats with a critical approach - Reflection of own social responsibility through reflective assessment - Collaborative online exams	- Lack of human contact - Different equipment of students can create disadvantages
Industrial	Promoting professional expertise through: - Simulation tasks - individual feedback - Teamwork - Practical relevance of the examination and realistic media use - Formative examinations	- Less specialized learning through automatic evaluation - Digital skills tested rather than specialized knowledge
Domestic	Promoting personal development through engagement with AI	Human contact necessary for personal development
Inspired	- Interesting type of examination - Interdisciplinary tasks	- Difficult to visualize passion online - Lack of room for development - Lack of opportunity for enthusiasm
Market	Better employability through the promotion of expertise	Certification also possible without online exams
Fame	Image enhancement of university through close-knit support	Loss of image due to possible fraud
Project	Promoting soft skills through: individualized feedback	Exams generally the wrong way to assess soft skills

Pro	Contra
• Promotion of reflection through timely feedback and transfer tasks • Problem-solving skills through research tasks • Critical thinking through source checking	• Problem solving by writing down by hand

6.4.3 Research question 3

What expectations do university teachers have of the HEI as well as themselves to provide for fruitful implementation of online assessment?

Independent of the individuals' conventions, the prerequisites and expected support by the educational institution were manifold. University teachers expected their institutions to provide the technical infrastructure as well as support in maintaining it ($N = 20$). For example, they said: "[…] the technical equipment and all of this has to run via the university. If they have any programs like this. For fraud protection or something, everything has to go through them." (Interview 6) or "Well, the university's responsibility must be to ensure that the infrastructure is there, that it works, that I don't have to worry about it." (Interview 12). Additionally, they also saw the role of the institution to provide the legal framework for secure online assessment (N = 9) as well as professional training for university teachers to use it ($N = 7$), as one participant stated: "[…] and appropriate training measures would also be needed. So, whether it's video tutorials or a workshop where teachers are trained in how which tool works in this environment" (Interview 22). The university teachers saw their own tasks as actually organizing and planning out the content of the exam ($N = 11$) "Yes, well, the responsibility of the people who carry it out should be to set the exam, to think about what questions to ask, how to organize the content" (Interview 22), as well as aligning the digital exam and the course they teach to fit each other, as one person stated: "[…] and the teacher definitely has the task of setting the exam in such a way that it is suitable for the format. In other words, to pick out specific content that is important and that can be tested particularly well and not simply convert a written

exam to online" (Interview 20) ($N = 8$). Furthermore, they saw their responsibility in preparing students for the exam ($N = 5$).

6.5 Discussion

As the transformation of the culture of an institution is needed for effective implementation of online assessment (Macfadyen et al., 2014), and institutions are made up of compromises between actors (Leemann & Imdorf, 2019), the individual concerns and orders of justifications of university teachers are crucial to identify guidelines in how to develop sound and accepted implementation guidelines for online assessment. At the same time, staff readiness and the involvement of university teachers are key factors in successfully implementing analytics-based solutions (Ifenthaler, 2020).

Regarding conventions, this study showed that a majority of the participants see the industrial as an order to pursue a common good, followed by the project and civic convention. These empirical findings allow for a discussion of existing assumptions. Gonon and Zehnder (2016) emphasize the relevance of market and civic conventions in the analysis of education. The shift towards market convention (Schneijderberg, 2020) could not be replicated in this study. While many participants focused on education for industry, they were more concerned with students developing relevant competencies and not certification for employability. This is in line with the research by Graß (2018) and the predominance of industrial conventions, highlighting the shift towards relevance of economic views on education, as well as the theoretical considerations by Boltanski and Thévenot (2007), that see higher education as a trade-off between civic and industrial convention, with civic also being a predominate convention mentioned by the participants. The mentioning of the ecological convention by two of the university teachers also sheds insights into future research on conventions in education. As Imdorf and Leeman (2023) did not include it in their original framework, it might be beneficial considering an inclusion of the ecological convention in future. Furthermore, the results align with previous research and allow for a more nuanced understanding of their origin. For example, the potential the university teachers identified concerning fostering skills and development for the project convention ties in with previously found possibilities of aspects of online assessment supporting

learning (Heil & Ifenthaler, 2023; Ifenthaler et al., 2023). Furthermore, considering the industrial convention, participants mentioned fostering specific competence development through online assessment and increasing the authenticity of assessment through more elaborated features (St-Onge et al., 2022). On the other hand, the concerns the university teachers regarding the civic convention tie in with research, such as the potential disadvantages of students concerning their equipment (Amrane-Cooper et al., 2024) or the difficulty in grading group projects (Alruwais et al., 2018).

Table 6 – 3 presents a synthesized overview of RQ1 and RQ2, forming an empirical validation of the work of Imdorf and Leeman (2023) with a specific focus on HE and showing the relationship between common good per convention and their expectations of OA.

Table 6 – 3 Summary of university teachers' convictions and evaluations regarding the common good of higher education and online assessment

	Common Good of HE	**Online Assessment**
Industrial	Competence development	Authentic assessment
Project	Soft-skill development	Transfer tasks
Civic	Responsible citizenship	Collaboration and critical evaluation
Inspired	Passion, creativity	Engaging assessment
Market	Employability, competition	Certification of competences
Domestic	Character development	Critical discourse with AI
Fame	Self-presentation	Increased reputation

The results of this qualitative study add the analytical approach to identify university teachers' individual convictions and frameworks of justification based on larger guiding principles in their decision-making process. Different challenges, concerns, and expectations regarding digital tools in education can be derived based on these conventions. For example, stakeholders focusing on industrial conventions might be supportive of online assessment due to the possibility of these applications to enhance professional learning. In contrast, another university teacher guided by the civic convention might be critical due to the concern that a disadvantage between

students can arise, if they have different technological equipment. Simultaneously, the same person, in different circumstances, might be in favor of online assessment, as it might provide opportunities to encourage reflection about social responsibility.

The expectations from the HEIs formulated by the university teachers in this study tie in well with previous research, especially concerning the need for technological equipment and further education for the successful implementation of online assessment (Brady et al., 2019; Kuikka et al., 2014; St-Onge et al., 2022). The participants formulated clear expectations regarding OA, technological environments, and further education that they did not see as their own responsibility but that should be taken care of by the institutions. University teachers expect their institutions to remove barriers as well as have clear communication and support, which are central pillars of change management, as staff need to be ready for the effective implementation of analytics (Ifenthaler, 2020) and HEIs should foster the definition of clear goals and communicate accomplishments transparently for successful innovation (Barger et al., 2022). Due to the expectations expressed by the university teachers, it is evident that the participants clearly understand their role in the pedagogical implementation of the online assessment. They also acknowledge the university's responsibility to ensuring the ethical and secure execution.

6.6 Limitations

A clear limitation that cannot be completely ruled out can be found in the self-selection bias as well as a possible courtesy bias, with the participants expecting the researcher to want to hear positive aspects about their research topic. Furthermore, nearly all participants came from Germany and worked at a German institution. Therefore, a cultural bias cannot be ruled out. To generalize this study on all stakeholders in higher education institutions, this research should expand and include other groups such as students (Tzimas & Demetriadis, 2024) or instructional designers (Muljana & Luo, 2021) as well as participants from other countries and educational systems.

It is also important to consider that depending on which perspective was taken, participants might point towards different conventions, according to the concept of context-dependency and flexibility of conventions mentioned by Diaz-Bone (2018a). Therefore, the results cannot be considered universal. Furthermore,

the didactical education of the participants differed greatly and might have shaped their convictions and expectancies as well as knowledge about the concepts discussed in this study. Future research should investigate this more systematically.

6.7 Conclusion and implications

The implications that can be drawn from this study are manifold and allow for a more nuanced and deeper conversation about the conceptualization and implementation of online assessment in the context of higher education. Depending on the realm and convictions in which individual stakeholders take decisions, different approaches can be developed, and a multitude of chances, but also obstacles, can be created through the means of online assessment. When having an open discussion about the implementation of these tools, the identified concerns and chances can build the foundation for a framework by first assessing what the individual realm of evaluation of the individual's taking decision is. Building on this, one can assess how online assessment can create opportunities or barriers and how an implementation can be fruitful in achieving compromises between actors and conflicting conventions. Through this framework, it is possible to bring the unspoken outwards and discuss based on a mutual understanding of what drives the involved stakeholders. In addition, the results of this study tie in with pre-existing research on expectations and needs for a successful implementation of online assessment while extending this into actionable requirements. The results of this study allow for structured concerns expressed by university teachers and an understanding of where these concerns come from. Furthermore, the expectations of HEIs expressed by the participants provide guidelines for a successful implementation in practice.

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7 Discussion and future research

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The conceptual foundation of this thesis highlights the need for learning-oriented assessment and explores how digital tools could aid this process, while also addressing the new challenges these tools pose. The central results of each study, along with a discussion of those results, can be found in the respective chapters. In this chapter, the findings of this thesis will be summarized according to the research questions and foci introduced in the introduction of this thesis. This chapter aims to synthesize the results and answer the broad questions posed in the thesis, placing them in the context of central research findings. Furthermore, this chapter will draw future research perspectives based on the results of this thesis, while addressing its limitations.

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7.1 Summary of findings

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7.1.1 RQ 1 Analysis of wishes and needs for online assessment in higher education

The first research question of this thesis is: "*What expectations, challenges and needs do teachers and students in higher education express regarding online assessment and how do their perceptions and dispositions influence their engagement with online assessment?*" For these questions, the results from the empirical Studies 2, 3, and 4 are in focus.

Considering the results from Study 4, the needs of teacher regarding online assessment build upon their expectations of higher education. As referenced in Table 6 – 2 the expectations of teachers regarding online assessment are authentic assessment; transfer tasks; collaboration and critical evaluation; engaging assessment; a certification of competences; critical discourse with AI, and increased reputation of the institution. Considering the identified dual purpose of assessment as well as the potential that assessment holds in adapting higher education learning (Winstone & Boud, 2022), those different purposes were also reflected in the results of the studies in this thesis. Specifically, the teachers highlighted in the industrial convention the need for assessment to equip learners for a future workplace (Boud & Falchikov, 2006). A focus on certification could not be replicated, but rather on competencies for the labor market. They perceive the potential benefits of online

assessment in fostering skills considered 21st-century skills, such as problem solving, critical thinking (Boitshwarelo et al., 2017; Hu et al., 2025; Vlachopoulos & Makri, 2024). The results from this study reflect the needed support by higher education institutions (Brady et al., 2019) for technical, legal, and further training support. These demands can also be reflected from not only the teachers' but also a student's perspective, which were in focus in Studies 2 and 3.

The results of Study 2 regarding the needs and expectations of students regarding AI in assessment reflect that there are differences between their attitudes and knowledge, considering individual AI-competence and an influence of the individual competence on the evaluation of the usefulness of GenAI tools. Therefore, the results from Study 2 highlight the influence that AI-competence can have on the evaluation of the usefulness of GenAI tools and the demand for students to gain better competence in dealing with tools in higher education practice (Delcker et al., 2024). Therefore, it is evident that further training of students is needed (Zhao et al., 2024). Specifically, as this challenge will get even greater considering the changes to assessment through GenAI as reflected in the conceptual foundation of this thesis (Chiu, 2024). It is important to not create even greater imbalance between learners as already exists (Amrane-Cooper et al., 2024), therefore students need to be educated on what GenAI entails, how it works, which risks it poses and how it can be usefully implemented in practice (Delcker et al., 2025). There is also a need for a trustworthy implementation (Aler Tubella et al., 2023). Furthermore, they evaluated the different GenAI tools differently based on their intended purposes, some more useful for learning support, others for passing exams. Therefore, the needs of students might also be on more nuanced understandings of GenAI in assessment. The results from Studies 2 and 4 highlight the need for more further training, which is also supported by the results of Study 3, considering feedback literacy, as the results reflect the need for feedback literacy for students to benefit from feedback in online assessment (Carless & Boud, 2018; Tepgec et al., 2024). Furthermore, there is a need to support learners in accepting alternative assessment modes. The results of Study 3 show that students expect teacher feedback to be the most beneficial (Dressler et al., 2019; Zacharias, 2007), highlighting the challenge in students using the alternate assessment modes. The needs of students might be reflected through the effect that peer assessment had on the improvement of quality. Accordingly,

students might need alternate assessment modes, even though they do not expect them to be beneficial to their learning. Overall, the results regarding research question one focus on the need for further education for students and teachers as well as assessment aligned with learning goals.

7.1.2 RQ 2 Design of online assessment in higher education

Building upon the identified needs and wishes as well as the results from the empirical research, design guidelines for online assessment can be derived. Accordingly, the second research question is: "*How can online assessments be effectively designed to support student learning in higher education?* " The results from this thesis allow for multiple insights into designing effective online assessment in higher education. Considering the proposed steps in the introduction of this thesis, several recommendations for practitioners can be derived. When designing online assessments and assessment environments, a wide range of options is at their disposal, from which they can choose which to employ and how to use them. The results from Study 1 allow the creation of a design classification, aiding in crafting an online assessment. As the systematic literature review points out, there are multiple different ways in which the different design aspects can be combined. Table 7 – 1 provides an overview.

Additionally, based upon different combination possibilities, several indicators for assessment analytics can be derived, such as rubric-based for teacher and peer feedback or more quantitative for automated quizzes (Ifenthaler et al., 2023).

Table 7 – 1 Design possibilities in online assessment

Format	Mode	Type
• Formative • Summative	• Teacher • Self • Peer • Automated	• Quiz • Essays • Portfolios • ….

In addition to providing an overview of possible design choices, the results reflect the beneficial factors of online assessment design that can inform future decisions. Especially formative assessment can have a positive impact on learning

outcomes in higher education (Black & Wiliam, 2009; Panadero et al., 2019). It is usually implemented in self and automated assessment and can be considered as a tool for students to reflect on their learning and how they can achieve their goals (Shute, 2008). Therefore, when designing an online assessment, formative assessment should be an integral aspect of the design choice. Additionally, pre-defined criteria, more practice-oriented assessment as summative assessment and formative assessments that support learning through active engagement, should be chosen, as the systematic review highlights. Regarding the design of online assessment, the methodology and results of Study 3 build heavily on the categorization developed in Study 1. The identified separation between different modes is applied, and the effects on learning support the findings from Study 1. The study highlights that peer feedback can be supportive for students to improve their writing. According to Carless (2007), learning-oriented assessment needs to be designed deliberately and support active learning, learner engagement, and feedback. This is reflected in the results in 3, highlighting the effects of designing peer and self-assessment as alternative to teacher assessment, in order to support student learning. When designing online assessments, Study 1 highlights the benefits of providing rubrics in peer and teacher assessment as a guidance for central success factors, as well as developing clear guidance for students in peer assessment. As research also points out the effects of assessment for and assessment as learning (Yan & Boud, 2021), this can underline the role that assessment can have next to evaluating outcomes, which should be considered when designing it. It is important to point out that Study 3 focused on the human-centered modes of assessment, excluding automated assessment, which needs to be further investigated in another research project.

7.1.3 RQ 3 Development and implementation of online assessment in higher education

The third research question focuses on the practical implementation of online assessments in higher education by asking, "*How can online assessment be developed and implemented in higher education to support learning*". In terms of implementation, the results of this thesis align with existing research and prompt new questions. As all four studies address this overarching theme to some extent, they

are all important for answering this question. One of the central research questions in Study 1 is: "What are the success factors for accepting and using online assessments in higher education?" The central results are, among others, clear communicated criteria in the assessment process, which is highlighted by research especially considering peer assessment (Fleckney et al., 2025), as well as instructional support. This ties into the results reflected in Study 4, which indicate that teachers see themselves as responsible for implementing the examinations, supervising the content, and aligning the material to fit the new format. This creates new challenges as research highlights the need for supporting teachers in developing pedagogical and technological knowledge (Viberg et al., 2024). Furthermore, they expected ongoing technical support from the university as well as continuous contact persons during implementation.

Combining the results of Study 3 and current research: when implementing different modes of assessment, other modes should be implemented next to the teacher, as peer (Double et al., 2020) and self-assessment (Brown & Harris, 2013; Panadero et al., 2017) are seen to support student learning. For peer feedback to elicit its full potential, students should be further educated on this topic and policies adjusted accordingly (Fleckney et al., 2025), which is also reflected in the results of Study 1. Self-assessment should not be implemented for measurement purposes, but rather for improving learning (Boud, 2013). Accordingly, the different dimensions of self-assessment are to be considered (Nieminen & Boud, 2025). Additionally, students should be supported in developing feedback literacy (Tepgec et al., 2024). According to the literature, this could simultaneously be achieved through engaging with exemplars, thus providing self-feedback, or engaging with peer reviews (Carless, 2022). This furthermore highlights the need for alternative assessment modes as this can create a reinforcing circle as well as aiding students in taking up teacher feedback. Even though peer assessment could theoretically also be implemented offline, the online medium provides benefits such as scalability and efficiency (Babik et al., 2024). Technological advancement also supports the implementation of formative assessment in practice (Spector et al., 2016), which was highlighted as beneficial for many aspects of learning in Study 1. An open question remains in which order and in which combination these assessment modes can be implemented in practice, and how a successful online assessment environment covering all

aspects could be developed. As Study 3 did not include the automated assessment mode, Study 2 can support the research at this point. The results of Study 2 highlight how and which GenAI tools can be implemented to support learners in practice to support learners by supporting deeper engagement with materials, as research shows that students should receive feedback as ongoing learning support (Winstone et al., 2022), this can be designed in automated assessment through GenAI by scaffolding learning support. Application scenarios of GenAI that go beyond mere text generation, such as summarizers, paraphrasers, or explanation tools can support students and should be considered as being implemented into assessment practices as described in the results of Study 2. While Study 2 focused on GenAI tools to support the learning process, it is important to consider the potential for misconduct by students, given that work could be passed off as their own through GenAI (Xia et al., 2024). The practice of proctoring assessments is under debate, especially regarding the ethical concerns surrounding it (Coghlan et al., 2021). Research reflects that assessment should be implemented in a way that it is not solvable by AI (Chiu, 2024; Cotton et al., 2024). Rather, a design should be chosen that is supported by integrating tools that summarize materials or provide further explanations through textual analysis. This underlines the differentiation needed for high-stakes summative assessment and grading on the one side, next to alternative, learning-oriented methods as pointed out in the results of Studies 1 and 3. Considering the development and implementation of analytics-based solutions, reframing the understanding of assessment in the institution and including all stakeholders into the discussion seem to be crucial factors (Macfadyen et al., 2014) as approached in Study 4.

The results from Study 3 show that students' opinions about modes and their actual learning tend to differ. This raises potential questions about the results of Study 2, which focused on students' evaluations of the GenAI tools, and how these evaluations compare to students' actual learning with them. Furthermore, the results from Study 2 reflect the need for teachers and administration in higher education to gain knowledge and competence about different types of GenAI tools, their pitfalls and potentials, as well as ways that students can be supported by providing them with fitting types of tools. Additionally, students should be supported in developing feedback literacy (Tepgec et al., 2024) as well as AI competence (Delcker et al.,

2024). Therefore, strategies should be implemented that demand student engagement. The individual responsibilities of stakeholders, considering the implementation of online assessment, can be found in Table 7 – 2

Table 7 – 2 Responsibilities of stakeholders for a successful online assessment

Students	Teachers	Institution
• Partaking in further training • Engagement with alternate formats and modes of assessment • Critically evaluating the use of GenAI tools	• Partaking in further training • Creating assessment tasks that support learning • Implementing assessment in practice • Provide guidance for peer- and self-assessment	• Providing technical and legal infrastructure • Ongoing support • Clear communication • Providing further training opportunities for teachers and students

7.1.4 RQ 4 Evaluation of online assessment in learning processes

The fourth research of this thesis reads: "*How do aspects of online assessment in higher education influence students learning processes"* The results from the studies in this thesis highlight several factors of online assessment that influence students' learning processes. Especially Studies 1, 2, and 3 provide insights into the effect that certain online assessment features can have on students' learning.

The results of Study 1 highlight that the use of formative assessment influences aspects of the learning processes such as motivation, self-regulation (Panadero et al., 2019), and the final learning outcome. The results from Study 2 reflect that different AI tools have different effects on learning processes and that the students are aware of the different application scenarios. When used correctly, and in order to support learning by allowing for feedback and aiding in the learning process, AI tools can facilitate the process (Cai et al., 2025; Xia et al., 2024). However, the

individual AI competence seems to be a central factor in the rating of the tools. The question remains how the intended use of the tools influences the actual usage (Venkatesh, 2022).

The results from Study 3 point out the positive effect on improvement, which especially peer feedback can have (Double et al., 2020), and how the individual feedback literacy influences the uptake of the feedback (Tepgec et al., 2024). Furthermore, the results highlight that the individual presumptions regarding the feedback mode did not influence the improvement. Therefore, students might be unaware of certain benefits for their learning or may not be interested in exploring different feedback modes. In general, Studies 1, 2 and 3 highlight that the design of online assessments can have a significant impact on learning processes, provided that they are not simply implemented using existing summative teacher assessment practices on an online platform. Furthermore, individual learner characteristics, such as feedback literacy or AI competence, can support or hinder these processes. Future research should explore other individual factors such as self-regulation, motivation etc.

7.2 Implications of this thesis

Based on the results and conceptual foundation of this thesis, several implications can be drawn. Implications can be derived for theoretical and practical purposes alike.

7.2.1 Theoretical implications

The theoretical assumptions concerning learning-oriented online assessment should be further expanded based on these finding. This thesis builds strongly upon the concept of learning-oriented assessment (Carless, 2007), formative assessment (Black & Wiliam, 2009), assessment for learning (Wiliam, 2011) and instructional design aspects such as constructive alignment (Biggs, 1996).

The results of this thesis position the concept of learning-oriented assessment in an online setting and evaluates its potential. Since learning-oriented assessment requires active student engagement with the assessment and feedback, the results of this thesis provide approaches that build on this concept. First off, online assessment as evaluated in Study 1 can aid in implementing formative assessment as well as

foster developing assessment that supports students' engagement with criteria. Since online assessment provides a solid foundation for various approaches, the assessment process can encourage learner engagement. The results of Study 3 emphasize the positive impact that these additional approaches can have on student performance. Similarly, the results of Study 1 highlight the effect that formative assessment has on learning outcomes but also on factors influencing the learning process. Therefore, this thesis calls for research on how different modes and formats can be incorporated into online assessments to provide a more unified perspective. Considering the concept of constructive alignment, online assessments can help bridge the gap between students' experiences of learning, the online medium and learning goals.

As Study 2 pointed out, AI tools can have different implications considering learning orientation. This thesis therefore calls for a more nuanced evaluation of AI tools in the context of assessment research. Not all tools and application scenarios should be collectively categorized and evaluated under a single application. Furthermore, the results of this thesis highlighted the conceptual relevance of feedback literacy and AI competence in students learning from assessment in digital learning environments. These elements must be incorporated into subsequent evaluations of online assessment and contemplated as potential mediators when assessing students' learning in online assessment scenarios. Another aspect that this thesis brings towards educational theory is the discrepancy between students' assumptions and their actual learning. Solely assessing students' perceptions' is therefore not sufficient. Furthermore, the need to investigate assessment and feedback as separate practices that build upon each other but have different purposes (Winstone & Boud, 2022). This separation must be kept in mind in research. Possible reluctance toward peer and self-feedback based on the lack of impact of peer and self-assessment for grading should therefore be critically questioned.

The results of Study 4 establish conventions as a guiding principle in teachers' evaluation of online assessments in higher education. This expands upon previous research that called for the involvement of all stakeholders by providing a basis on which teachers' preferences can be considered, evaluated, and classified.

Considering the lack of transmission of educational theory onto assessment practices, it should be impertinent that not only theoretical but also concrete practical implications are derived based on the insights gained in this thesis.

7.2.2 Practical implications

This thesis has many practical implications and aims to support higher education practitioners, particularly regarding the main focus of learning support through assessment. Overall, it calls for a re-evaluation of existing assumptions about assessment when applied in an online setting, as well as using the momentum of online methods to adopt new assessment approaches (Amrane-Cooper et al., 2024). These affect multiple stakeholders and position them differently. However, all of them need to work together to achieve the promised potential. While greater decisions must be made by the institutions, new demands are placed on teachers and students to act and react accordingly. The respective implications are outlined below.

Institutions: Considering institutional decision making, current assessment practice should be re-evaluated, leading to a change in understanding the purpose of assessment and moving away from an overreliance on summative assessment (French et al., 2024) as well as assessment of learning. This should not lead to a complete replacement of summative exams, but rather considerations of alternative design options and a positioning of assessment as a means to support learners. Accordingly, to allow for continuous improvement of learners, assessment should not be considered an end-of module approach, but overarching learning goals implemented (Carless, 2007). The definition of learning-oriented assessment calls for learner engagement with feedback and assessment criteria (Carless, 2007), which is reflected in the results of this thesis. Learning-oriented assessment and assessment for learning should be part of the design and implementation process, as well as modes of assessment that support learners' engagement. This could be applied in practice through clearly formulated criteria, guidance of students, GenAI-tools to support learning, as well as implementing peer and self-assessment. This might require adapting policies considering peer assessment as well as a cultural change (Fleckney et al., 2025).

Considering the expectations and needs of stakeholders regarding online assessment can be the first step in creating a unified view of the challenges to be addressed and subsequent guidelines in the specific institution. Given the amount of data generated by online assessment, as well as the application possibilities of analytics in the context of assessment (Caspari-Sadeghi, 2023), it is important to also make use of the data (Komljenovic et al., 2025) and combine assessment with analytics (Gašević et al., 2022). Furthermore, the insights of this thesis highlight that AI competence and feedback literacy should be considered as competency goals in curriculum plans in higher education that would lead to a stronger implementation in the courses. It is up to the institution how this is incorporated into curricula, whether through extra modules, additional courses or within existing learning practices. Further education on online assessment should also be available for teachers, as they asked for in Study 4. This should encompass technological as well as pedagogical aspects (Viberg et al., 2024). Teachers act as central agents in practice by designing and implementing online assessment in practice and engaging with learners as reflected in the results of Study 4. The call for learning-oriented online assessment therefore also poses significant implications for teachers in practice

Teachers: Especially the results of research questions two and three considering the design and implementation of online assessment in higher education can help practitioners develop online assessment for practice. Design features of online assessment and application scenarios of GenAI for students, as well as alternate assessment modes as developed in Study 1 and evaluated in Study 3, can help to create different assessment strategies. This is not only theoretically justified but also reflected in teachers' wishes for alternative assessment methods, as Study 4 shows. Another practical implication in this context is the need to support students' feedback literacy. If this is also implemented as a competency goal in curricula as asked for from institutions, it could be achieved through engagement with peer and self-assessment, as well as learner engagement (Carless, 2022). When implementing peer assessment, as Study 1 highlights, teachers need to guide students by providing rubric or rater training (H. Li et al., 2020). Not only feedback literacy but also the call for more AI competence, if introduced into curricula by institutions, adds requirements for teachers by considering these skills as to be taught and which might be heterogeneously distributed among the students.

Teachers also need to be aware that students might use tools for study success and better grades as reflected in the results of Study 2 and not for the intend of improving their learning process.

Rather than considering online assessment as a different way of implementing existing summative practices through an online medium, it should be considered as a means of facilitating learning rather than grading. Therefore, teachers should apply formative online assessment in practice (Spector et al., 2016). Teachers also expect more from assessment, such as authentic or transfer tasks, which digital technologies can improve by promoting disciplinary learning, fostering workplace readiness, supporting personal growth, and improving assessment delivery (Hu et al., 2025). To fulfill this potential, teachers need to be open to these developments and implement them.

Students: Students should be at the center of the feedback processes and actively engaged with it. As feedback practice often lacks the dialogical aspect (Nicol, 2014) and feedback is central in learning processes, it should not be implemented as a transmission of information accompanying a grade at the end of an unit (Winstone & Boud, 2022). Simultaneously, students also need to actively engage with the feedback in order to benefit from it (Carless, 2015). Students should be motivated to engage with other modes of assessment and the effectiveness clearly communicated to them. Depending on the requirements of their task, they should also evaluate different AI tools for their intended use, as Study 2 shows. They should also avoid engaging with them if they do not feel competent enough to use them effectively, even if they expect higher grades and rather engage in further training. In light of the goal of employability in higher education, which was introduced in Chapter 1 as an important factor for students by Cachia et al. (2018), and further identified by teachers in Study 4, there is a need to address competence-promoting and authentic assessment. Subsequently, it is essential to prepare students for the digital world through engaging them with realistic assessment scenarios (Bearman et al., 2020). However, for these approaches to be effective, the challenge remains in the need of students' active engagement.

Overall, considering practical aspects, this thesis emphasizes existing problems with current assessment practices, such as an overreliance on summative assessment as well as a lack of authenticity and a generalization of AI tools. It also

positions online assessment as a potential vehicle to address these challenges, if all stakeholders are willing to actively engage with it.

7.3 Limitations

This chapter would be incomplete without acknowledging the limitations of this thesis in answering the proposed research questions, as well as identifying areas for future research. The limitations of the individual studies can be found in the respective papers, therefore, the limitations in this paragraph are focused on the overarching research questions and the construction of this thesis.

A limitation regarding research question one, the wishes and needs of stakeholders, is the lack of qualitative data regarding students' experiences and wishes for online assessment. Furthermore, the expectations from the HE institutions are considered and offered, but not the opportunities, limitations, and expectations teachers and students might have of more global institutions such as governments, funding institutions, etc., as these policies might also have a great effect on the practices in higher education (Mao et al., 2019). This needs to be investigated in future research. Additionally, the focus of this thesis was on learning-oriented assessment. While this is an important issue in higher education (Carless, 2007; Winstone & Boud, 2022), assessment also fulfills the role of certification. How to combine these purposes in practice by adhering to policy and curricula expectations while supporting learners, is a challenge yet to be addressed beyond the scope of this thesis.

The limitations of research questions two and three lie in the lack of practical application and the fact that the focus is on the state of research, survey questionnaires and a laboratory quasi-experiment. This applies both to the design as well as implementation. Implementing and evaluating the derived design proposals in higher education practice would further enhance the significance of these results.

Research question four was addressed in the scope of the thesis but needs to be addressed more broadly by covering aspects such as intrinsic motivation, self-regulated learning and other factors that could furthermore influence students learning. This range is broad and therefore this remains the most open research question with the need for more thorough investigation.

Furthermore, even though Studies 1 and 2 focused on a more international target group, by including international research and the participants in Study 2 studied in three countries, Studies 3 and 4 include mainly German participants, therefore, the results might reflect a cultural bias. This limitation could restrict the generalizability of the results and, at the same time, requires further investigation in international research. Based on the limitations of this research, as well as the small scope that could be aimed for, multiple future research perspectives can be elicited. Furthermore, the results from this study also shed light on new questions in the research field and provide the basis for future research perspectives.

7.4 Future research perspectives for online assessment in higher education

The studies in this thesis have focused on specific aspects of online assessment, therefore, a comprehensive overview and guideline in how to implement online assessment to create learning-oriented assessment would be a next step by including further design possibilities. Automated feedback must be investigated more in-depth, as it was found in Study 1 as one of the central design features and is also shown to support learners by other research (e.g. Cai et al., 2025; Lee & Moore, 2024). AI can not only aid learners but also teachers considering the design of higher education assessment, such as using GenAI to create rubrics, generating assessment, etc. Additionally, the role of instructional designers and their opinions regarding online assessment fall short in this thesis (Martin et al., 2025). An open question remains in how feedback literacy and AI-competence tie in to each other and how different aspects of these two competences may balance, support, or even hinder each other and ultimately how they can both be fruitfully combined and supported. Additionally, to further transform assessment practices, the combination of GenAI, analytics, and peer and self-feedback should be investigated systematically (Banihashem et al., 2024; Schumacher, 2023). The results of Study 3 should be expanded and include empirical research on formative assessment and summative assessment, combining different modes with different formats. Feedback literacy influences the improvement, but research shows that the interaction with different feedback modes also influence the building of feedback literacy (Carless & Boud, 2018), this effect should also be evaluated systematically. Other factors, such as the effects assessment for learning has on motivation (Pat-El et al., 2024) or self-

regulated learning (Panadero et al., 2019) should be included in this research. Also, when discussing feedback literacy, it is also important to consider the individuals' abilities in evaluative judgement (Panadero et al., 2019). Aspects of authenticity in higher education assessment should furthermore be covered in more detail, as there is an increase in research (Hu et al., 2025) as well as new opportunities through online assessment, that have not been explored to an extent in this thesis.

The main research questions of this thesis are theory and research focused. Future research should therefore build on these results and focus more on the practical implications emerging. An open question remains in how learning-oriented assessment can be developed in practice by practitioners. Considering the ADDIE instructional design model (Molenda, 2003), the steps of development and implementation are currently not covered in practice in this thesis. Future research could focus on the concrete development of online assessment environments supporting the identified needs and providing concrete materials, guidelines, or even tools, as well as how to design further training for higher education teachers. An important question that stems from the results of the Studies, especially Study 3, is: How can the tools and modes that are supporting learning, such as e.g., formative peer assessment be implemented and accepted by learners? As research shows that (online) assessment research is often not grounded in theory (Buckley, 2024; Nieminen et al., 2023), the challenge remains in how the insights of this thesis make their way into practice. Next to the more global challenge of transferring research into practice, the case of assessment faces additional challenges in external expectations, that often hinder the evolvement of existing assessment practices (Norton et al., 2013). Consequently, the lack of a governance and institutional perspective in this thesis, calls for research into how to adapt top-down processes and change assessment practices long term. Focusing on adapting the greater goal of assessment could address the persistent resistance against change in higher education assessment (Deneen & Boud, 2014). Considering teachers' expectations and wishes as proposed in Study 4 might create a first step, as well as creating recommendations for an assessment that serves a different purpose next to a certification of competences (Boud, 2000). Furthermore, next to the resistance, the lack of training poses a challenge. Teachers in higher education need competence in

order to develop formative assessment (Schildkamp et al., 2020), and online assessment (Viberg et al., 2024).

The results of this thesis suggest the need for a larger-scale research project on online assessment that addresses the following research questions:

1. How can the policy-level goals of assessment in higher education be aligned with learning-oriented online assessment?

2. What success factors are needed for the implementation at an educational policy and institutional level?

3. How can further education for teachers and students on assessment for learning be designed and implemented in higher education?

4. How can effective online assessment environments be developed and combined with existing learning management systems?

5. How can resistance to change be addressed in all stakeholders?

This should ideally lead to creating guidelines and materials for practitioners, the design of further education programs for teachers and students, the development of safe and learning-oriented assessment environments, and ultimately, the implementation of assessment beyond certification in higher education practice. This could help achieve the goal that has been proposed in competence-oriented and learning accompanying assessment.

7.5 Conclusion

This thesis is based on theoretical works concerning online assessment and educational technology in higher education. The aim was to gain insight into the successful design and implementation of online assessments in higher education. Overall, the findings of this study suggest a profound change in our approach to assessment in higher education, utilizing the tools provided by online assessment to achieve this goal. In order to answer the main research question: "How can assessment practices that support learning in higher education be implemented through online assessment?" as short as possible: by prioritizing learning. Successful implementation hinges on the stakeholders and their conception of good assessment practices in higher education. Therefore, considerations about online assessment must be re-evaluated to take into account not only the use of technology but also previous convictions about the pedagogy behind institutional and curricular decisions.

It is also important to consider that learning-oriented assessment alone will not solve all issues in higher education, and that developments must be accompanied by structural changes. These changes should be performed at all different levels and therefore, aspects of educational policy, curricula, and instructional design need to be further researched in the future. While changing assessment policy is a significant undertaking, it will have a profound impact on practice.

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Declaration about the use of Artificial Intelligence

The author used DeepL to translate and rephrase sentences. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

Appendix

Table 8 – 1 Overview over publications in systematic review

Authors	Year	Format	Mode	Type	Feedback	Course	Country	Domain	Level
Abbakumov et al.	2020	Formative	not clear	Assignment items included in video & questions on interest	Not clear	online	Belgium	(Neuro)economics	not clear
Acosta-Gonzaga & Walet	2018	Formative	Automated	Mathematical exercises	Support based on mistakes, hints to the correct solution	blended	United Kingdom	Mathematics	undergraduate
Admiraal et al.	2015	Formative & Summative	Automated (Quiz) Self & Peer (Essay)	MC-quizzes & essays	Based on rubric	online	Netherlands	Law, terrorism	not clear
Amhag	2020	Formative	Self	Written reflection & Portfolio	Not clear	blended	Sweden	Vocational teacher education	graduate
ArchMiller et al.	2017	Summative	Peer & Teacher	Homework using R	Based on rubric	blended	United States	Statistics for ecology	graduate

Ashton & Davies	2015	Summative	Peer	Writing exercise	Based on rubric	online	United States	Creative writing	MOOC
Azevedo et al.	2022	Formative & Summative	Automated & after overview by teacher	Quizzes	Not clear	not clear	Portugal and others	Mathematics	graduate
Babo et al.	2020	Summative	Automated	MC-quizzes & PBL-project	Not clear	blended	Finland/Portugal	Information systems	undergraduate
Bacca-Acosta et al.	2020	Formative	Automated	Practice exam questions	Corrective	not clear	Colombia	Efl; psychology	undergraduate
Bekmanova et al.	2021	Formative & Summative	Automated	Quizzes & Work assignments & Exam	Not clear	online	Kazakhstan	Education	graduate
Birks et al.	2016	Summative	Teacher	E-Portfolio	Not clear	not clear	Australia	Nursing/midwifery	undergraduate &postgraduate
Bohndick et al.	2020	not clear	Self	Questions on self-control	Bogus	not clear	Germany	Multiple	multiple
Carnegie	2015	Formative & Summative	Automated	MC-Questions & Short answer-Questions	Hints if wrong, explanation if correct	blended	Canada	Mammalian physiology	undergraduate
Carpenter et al.	2017	Formative	Automated	Quizzes	Corrective	blended	United States	Biology	undergraduate

Caspari-Sadeghi et al.	2021	Formative	not clear	Student-Generated Questions	Not clear	online	Germany	Mathematics	undergraduate/graduate
Chaudy & Connolly	2018	Summative	Automated & Teacher	Game (Quizzes, Quest)	Multiple possibilities	online	multiple	Multiple	multiple
Chen et al	2018	Formative	Automated	Open Answer Questions	Corrective	blended	United States	Physics	undergraduate
Chen et al	2021	Formative	Peer	Tests & Oral assignments	Based on evaluation form	online & blended	China	EFL	undergraduate
Chew et al.	2016	Formative & Summative	Case 1: Peer & Teacher Case 2: Peer	Case 1: Essays as part of Portfolio; Case 2: Final coursework	Based on Rubric	not clear	United Kingdom	Not clear	postgraduate
Davis et al.	2020	Formative & Summative	Automated	Quizzes	Immediate	online	United States	Management	not clear
Dermo & Boyne	2014	Formative & Summative	Automated	Analyze data & MC-questions	Not clear	not clear	United Kingdom	Biomedical science	undergraduate

Elizondo-Garcia et al.	2019	not clear	Peer	not clear	Case 1: unstructured feedback guide Case 2: structured based on Rubric	online	United States & other students	Disaster preparedness/ energy	MOOC
Ellis & Barber	2016	Summative	Automated	Questions	Detailed	blended	United Kingdom	Pharmacy	undergraduate
Farrelly & Kaplin	2019	Formative & Summative	Teacher (optional)	Portfolio (written reflection, multimedia capabilities)	Comments on Portfolio	blended	United States	Education science	undergraduate
Faulkner et al,	2013	Formative & Summative	Self	Case 1: open ended problem (Portfolio), Case 2: Weekly Exercises (Portfolio)	Reflection	blended	Australia	Engineering & law	undergraduate & postgraduate
Filius et al.	2018	Formative	Peer	not clear	Dialogue	online	Netherlands	Epidemiology	graduate

Appendix

Filius et al.	2019	Formative	Peer	Multiple	Audio	online	Netherlands	Multiple	MOOC & SPOC
Foerster et al.	2018	Formative	Automated	Quizzes	Corrective	blended	Germany	Statistics	undergraduate
Formanek et al.	2017	Summative	Peer (Essays)	Quizzes & Essays	Written	online	United States	Astronomy	MOOC
Fratter & Marigo	2018	Pre-class	Self & Automated	Game containing Questions on language proficiency	Histogram about proficiencies	blended	Italy	Italian language	not mentioned
Gamage et al.	2019	Formative & Summative	Automated	Excel-based Assignments & Quizzes	Customized: explanation for common mistakes	online	Australia	Engineering	undergraduate
Gámiz Sánchez et al.	2014	Formative	Self & Automated	Quizzes (multiple-choice, blank-filling and crossword-type tests), questionnaires & exams	Points	blended	Spain	General accounting	undergraduate

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				(multiple-choice)					
García Peñalvo et al.	2021	Format ive & Summ ative	Teaching team	Modeling excercises, Questions & final project	Suggestio ns & Comments on each milestone of the project	online	Spain	Software engineering	undergraduate
Gleason	2012	Format ive & Summ ative	not clear	Homework assignmen t & Quizzes, final exam (multiple choice questions)	Not clear	blended	United States	Mathematics	undergraduate
Gonzalez-Gomez et al.	2020	Format ive	Teacher	Interactive activities inside videos	Suitable or not suitable	blended	Spain	Science	undergraduate
Guerrero-Roldan et al.	2018	Format ive & Summ ative	Automated & Teacher	multiple-choice, blank-filling and crossword-type tests	Indications about errors & guidelines for solving them	online	Spain	Engineering	undergraduate
Hains-Wesson et al.	2014	not clear	Self	Portfolio	Reflection	blended	Australia	Multiple	multiple

Hashim et al.	2018	Formative & Summative	Self	multiple	Not clear	online	Malaysia	Language learning	MOOC
Hay et al.	2013	Formative & Summative	Teacher	Practical skill demonstration via video	Video format	blended	Australia	Medicine	undergraduate
Herzog & Katzlinger	2018	Formative & Summative	Peer & Teacher	Scientific Paper writing	Based on Analysis Grid & verbally	blended	Germany & Austria	E-Business ; scientific writing	undergraduate & graduate
Hickey & Rehak	2013	Formative	Teacher & Peer	Wiki-Portfolio entries reflecting	Discussions by students and teachers	online	United States	Education science	graduate
Hughes et al.	2020	Formative	Automated	Quizzes	Elaborative	blended	Australia	Nursing	undergraduate
Huisman et al.	2018	Formative & Summative	Peer (Essay) & Automated (Quizzes & final exam)	Quiz (Multiple Choice), Essays, final exam	Based on Rubric	online	Netherlands	Terrorism and Counterterrorism	MOOC
Hwang et al.	2015	Formative	Self	Journaling about Programming	Not clear	online	Taiwan	Programming	undergraduate

James	2016	Summ ative	not clear	MC-Quizzes, short answer constructe d responses and longer, short essay length constructe d responses.	Not clear	online & blended	Australia	Psychology	undergraduate
Jarrott et al.	2011	Format ive	Teacher	Portfolio	Written	not clear	United States	Human development	undergraduate & graduate
Kim et al.	2021	Format ive	Teacher	Multiple tasks	Elaborate	online	United States	Multiple	undergraduate
Kristanto	2018	Format ive	Peer	Applied calculation s	Corrective & suggestive	blended	Indonesia	Statistics	not clear
Kücheman n et al.	2021	Summ ative	not clear	multiple tasks	Performan ce	online	Switzerland/G ermany	Physics	undergraduate
Kühbeck et al.	2019	Format ive	Automated	Quiz	Not clear	blended	Germany	Pharmacology	undergraduate
Law	2019	Format ive	Teacher	Essays	Based on Rubric (written)	blended	United States	Marketing	undergraduate

Li & Gao	2016	Formative & summative	Peer	Creating lesson plans	Based on Rubric (written)	blended	United States	Teacher education	undergraduate
Li et al.	2010	Summative	Peer	Creating teaching plans	Based on Rubric (numerical and written)	blended	United States	Teacher education	undergraduate
Liu & Lee	2013	Formative & Summative	Peer	Research project	Based on evaluation standards	blended	Taiwan	Statistics in education and psychology	graduate
Liu et al.	2018	Formative & Summative	Peer	Letter writing	Based on Rubric (written)	blended	China	Business writing	undergraduate
López-Tocón	2021	Formative	Automated	Quizzes	Delayed corrective	blended	Spain	Physical chemistry	undergraduate
Luaces, et al.	2017	Summative	Peer & Teacher	Essays	Based on Rubric (numerical)	not clear	Spain	Computer science	undergraduate
MacKenzie	2019	Formative	Automated	Interactive activities	Corrective	not clear	United States	Marketing	undergraduate
Mao & Peck	2013	Formative (Papers) &	Automated, Peer & Teacher	Papers & Quiz	Case 1: Teacher only sores on draft,	online	United States	Energy/sustainability	undergraduate

		Summative (Quiz)			Case 2: Self-assessment based on rubric, Case 3: Peer assessment based on rubric (written)				
Martin et al.	2019	multiple	multiple	multiple	Multiple	blended	United States	Multiple	multiple
Mason & Williams	2016	Formative	Self	Portfolio	Not clear	blended	Australia	Paramedic	undergraduate
McCarthy	2017	Formative	Peer, Tutor only in class	Project	Based on principles, at least 50 words, dialogue	not clear	multiple	Design	undergraduate
McCracken et al.	2012	Formative & summative	Self, Peer & Teacher	Multiple (professional skills, practice, wiki, problem-solving)	Multiple	not clear	Canada	Dentistry and other	undergraduate & graduate
McNeill et al.	2012	Formative &	Teacher	quiz, discussion,	Not clear	multiple	Australia	Multiple	multiple

				Summative					
				wiki, blog, portfolio, virtual world					
McWhorter et al.	2013	Formative	not clear	Portfolio	Not clear	blended	United States	multiple	undergraduate & postgraduate
Meek et al.	2017	Formative & Summative	Peer (Essays) & Automated (Quizzes)	Quizzes & Essays	Corrective (Quizzes), Based on rubric (written) (essays)	online	United Kingdom	Biomedical	MOOC
Milne et al.	2020	Formative	Teacher	Essays	Based on Rubric (written)	online	Australia	Nutrition	undergraduate
Mora et al.	2012	Formative & Summative	Automated	Multiple choice quiz	Not clear	blended	Spain	Engineering	not clear
Nguyen et al.	2017	Formative & Summative	Automated & Peer	Multiple tasks	Multiple	online	United Kingdom	Multiple	undergraduate
Nicholson	2018	Formative	Teacher	Portfolio	Comments on Portfolio	blended	United Kingdom	Academic skills	undergraduate
Ogange et al.	2018	Formative	Automated, Peer & Teacher	Quizzes ,Essay, ePortfolio, Reflection,	Comments , Summary on Areas of	online & blended	Kenya	Science & business	undergraduate

				Discussion, Wiki etc.	Improvement, Comments from Peers				
Ortega-Arranz et al.	2019	Formative & Summative	Automated & Peer	Quiz & Translation	Gamified / reviews	online	Spain	Translation in business and economics	MOOC
Pinargote-Ortega et al.	2021	Summative	Peer	Diagram exercises	Based on Rubric (numerical and written)	blended	Ecuador	Software engineering	undergraduate
Polito & Temperini	2021	Formative	Self / Automated	Programming Problems	Gamified / leaderboard/ learning analytics	not clear	Italy	Programming	undergraduate
Qian et al.	2017	Formative	Peer & Teacher	Practical project	Comments (from peer & Teacher) based on Rubric	online & blended	Germany	Business administration	not clear
Reilly et al.	2016	Formative	Automated (Quiz & Essay) & Teacher (Essay)	Quizzes & Essays	Based on Rubric (written)	online	United States	Pharmacy	multiple
Rogerson-Revell	2015	Formative	Peer & Teacher	E-tivities	Written review	online	United Kingdom	Linguistics	graduate

Ross et al.	2018	Summative	Automated	Quizzes	Corrective	online	Australia	Accounting	undergraduate
Sampaio-Maia et al.	2014	Summative	Peer	Wiki, collaborative entries	Written review	blended	Portugal	Microbiology	multiple
Sancho-Vinuesa et al.	2018	Formative	Self/Automated	Quizzes	Corrective	online	Spain	Mathematics	undergraduate
Santamaría Lancho et al.	2018	Formative	Automated	Open Ended Questions	Graphic representation of accuracy of answer	online	Spain	Economic history	undergraduate
Sarcona et al.	2020	Formative	Teacher	Essays	Audio & written	blended	United States	Dietics	undergraduate
Scalise et al.	2018	Formative	Automated & Teacher	Questions	All groups: worked solution Case 1: more Feedback on progress	blended	United States	Chemistry	undergraduate
Schaffer et al.	2017	Formative	Automated	Quiz	In Form of a Report	not clear	United States	Psychology	not clear
Schultz et al.	2021	Summative	Teacher	Multiple	Multiple	not clear	Australia	Multiple	undergraduate

Sekendiz	2018	Formative	Peer	Business Plans	Based on criteria (written), constructive	not clear	Australia	Sport management	undergraduate
Senel & Senel	2021	Formative	Teacher	Take-home	Based on Rubric	online	Turkey	Statistics	undergraduate
Shaw et al.	2019	Summative	Self & Automated	Multiple choice questions	Explanation for correct answer, wrong answer: Retrieval Cue	blended	Canada	Psychology	undergraduate
Stratling	2017	Formative	Automated	MC-Questions	Corrective & diagnostic	blended	United Kingdom	Business economics	graduate
Sullivan & Watson	2015	Summative	Peer	Essays	Narrative	online & blended	United States	Corporate strategy	undergraduate & graduate
Taghizadeh et al.	2014	Summative	Self/Automated	Quiz	Diagnostic	blended	Iran	EFL	undergraduate
Tawafak et al.	2019	Summative	Teacher	not clear	Numeric	blended	Oman	Computer science	multiple
Tempelaar	2020	Formative	Automated	Quiz	Learning-analytics feedback	blended	Netherlands	Business	undergraduate

Tenório et al.	2016	Summative	Peer	Essays	Based on Criteria (written & numeric)	online	Brazil	Mathematics	undergraduate
Thille et al.	2014	not clear	Case 1: Automated, Case 2: possibilities for teacher, Case 3: not clear	Case 1: simulations, quizzes and virtual laboratories, Case 2: Programming assignments, Case 3: Question & Quiz	Case 1: tailored	not clear	United States	Multiple	multiple
Tsai	2016	Summative	not clear	Questions	Points	blended	United States	Computer literacy	undergraduate
Tucker et al.	2014	Formative	not clear (Quiz) & Peer (Art)	Quizzes & Art Project	Based on Rubric (written)	online	United States	Art	MOOC
Tucker	2014	Summative	Self & Peer	Project tasks	Holistic score on team member & score on performance & score in	not clear	Australia	Multiple	undergraduate

					comparison to team					
Turner & Briggs	2018	All cases: Formative & Summative	Teacher & Automated	Case 1: essay & short answer, Case 2: essay questions & interactive tasks Case 3: exam questions	Not clear	blended	United Kingdom	Psychology	undergraduate
Vaughan	2014	Formative	Self & Peer	Portfolio & Wiki	Not clear	blended	Canada	Multiple	undergraduate
Wadmany & Melamed	2018	Summative	Peer	Educational project	Qualitative & quantitative	online	Israel	Education technology	MOOC
Wang & Wang	2012	Formative	Teacher	Portfolio	Comments on Portfolio	not clear	United States	Business	undergraduate
Wang	2019	Summative	Peer	Discussion	Constructive criticism	online	United States	Education science	graduate
Watson et al.	2017	Formative & summative	not clear	Case 1: Quizzes, Case 2: Quizzes,	Not clear	online	United States	Multiple	MOOC

Wells et al.	2021	Format ive & Summ ative	Automated	Case 3: Quiz & project, Case 4: discussion, quiz. project not clear	Not clear	online	Australia	Computing	undergraduate
West & Turner	2016	Summ ative	Tutors	not clear	Video & written based on rubric	not clear	Australia	Education	undergraduate
Wilkinson et al.	2020	Format ive	Automated	Quiz-Games	Corrective	blended	United Kingdom	Anatomy	undergraduate
Wu et al.	2014	Summ ative	Self & Peer	Research project	Based on Guidelines	blended	Australia	Engineering	undergraduate
Xian	2020	Format ive	Automated & Teacher	Writing exercise	Comments on Writing	not clear	China	English	undergraduate
Xiao & Hao	2018	Format ive	Peer & teacher	Portfolio	Based on Rubric (written)	blended	China	Business English	multiple
Yang, et al.	2016	Format ive & Summ ative	Automated	Mathemati cal exercises	Detailed on recommen ded topics	not clear	Taiwan	Calculus	not clear

Yeh et al.	2012	Formative & Summative	Peer & teacher	Question generating	Corrective	not clear	Taiwan	EFL	not clear
Zhan	2021	Summative	Peer	E-Journal	Based on Rubric	online	Hong Kong	Social science	undergraduate
Zong et al.	2021	Formative	Peer	Essays	Based on Rubric	not clear	United States	Multiple	undergraduate

Curriculum Vitae

Appointments

Since September 2021 **Research Assistant**
Economic and Business Education -
Learning, Design and Technology,
University of Mannheim

Professional preparation

2021 **Master of Science**
Cognitive Science
University of Osnabrück

2019 **Bachelor of Arts**
Education Science/Educational Management
Albert-Ludwigs-Universität Freiburg

Teaching activities

Since 2022 Supervising Bachelor Theses
Empirical Methods
Educational Management II

Since 2025 Digitally Supported Learning Culture