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PAPER

Design Guidelines for Enterprise Software Training in Higher Education Based on Technology-Mediated Learning

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ABSTRACT

There is an increasing demand for a qualified future workforce in the enterprise software (ES) domain, for which students should be prepared. However, due to the complexity of ES, many lecturers lack the skills to practically integrate ES into their teaching activities. ES training must be investigated holistically to address this issue, integrating the perspectives of the involved actors. Therefore, the research field of technology-mediated learning (TML) offers valuable concepts. In this paper, we first identify and present five main concepts of TML performance based on related literature. Second, we present findings from a single-case study conducted within the global academic alliance program of the ES company SAP. The program's objective is to demonstrate the practical application of ES to students through lecturers. Unlike previous research, we consider the students' perspective and incorporate the viewpoints of lecturers and subject matter experts (SMEs) who train the lecturers to create a comprehensive overview. Based on the insights from TML literature and the case study, we present design guidelines for ES training that take into account TML concepts, actors' perspectives, and training aspects. Our findings highlight the universal applicability of TML in the practical context of designing ES training in higher education.

KEYWORDS

design guidelines, enterprise software, higher education, SAP, technology-mediated learning (TML), training

1 INTRODUCTION

Irrespective of their field of study, students are likely to encounter enterprise software (ES) in their future professional endeavors. The term ES, also known as enterprise systems, refers to application software utilized in businesses, such as enterprise resource planning (ERP) software [1]. After their studies, engineering students may need to operate a manufacturing execution system. A business student

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might prepare analyses of a company's data with the help of data warehousing and analytics software, while computer science students may later find themselves developing or customizing ES for use in a company's specific corporate environment. Due to the high demand for specialists capable of working with complex ES, students must prepare for this during their studies [2, 3]. That does not mean students must be trained in several specific company-branded ES solutions. On the one hand, they benefit from learning the fundamentals of ES, such as understanding how integrated business processes function and how company data can be prepared to extract insights. On the other hand, they benefit from the practical application of those learned skills [4]. However, due to its large-scale, real-time, and integrated use in organizations, ES is complex [1, 4].

Effectively designing courses on ES requires starting with the students' needs, the lecturers' skills, and the technical infrastructure. First, students benefit the most when seeking employment if they are trained to apply ES practically. They should be capable of understanding complex relationships and the underlying concepts of ES. Second, effective courses require lecturers to have the skills necessary to impart this knowledge [5]. Although lecturers are, in most cases, familiar with the concepts behind ES, such as integrated business processes and data analytics, they often do not know how they are applied in current practice or the newest ES solutions [6]. Last, students need the technical infrastructure, such as system access and user rights, to be trained practically in an ES, which is typically provided by representatives of an ES company. However, due to their corporate focus, these corporate representatives may lack the pedagogical and academic expertise needed to effectively impart knowledge about ES and underlying concepts to students. For instance, Shanneb's [7] usability evaluation of an SAP ERP training shows this limitation.

The demonstrated phenomenon reveals a gap between lecturers who prioritize teaching and research and ES companies that focus on advancing and profiting from ES. To address this gap, this study utilizes technology-mediated learning (TML) as a theoretical framework to develop design guidelines for ES training in higher education. TML is a setting where the learner's engagement with educational resources, peers, and instructors is facilitated by applying state-of-the-art information technologies (IT) [8]; in our scenario, these IT solutions are ES solutions. In the case of ES training, TML can increase the effectiveness of courses in two scenarios: "lecturer training" and "student training" (cf. Figure 1). *Scenario A* describes the setting where a subject matter expert (SME) in the respective ES solution acts as an instructor. An SME can be, for instance, a corporate ES product expert or someone else who focuses on ES training in general, not necessarily in an academic environment. The SME imparts practical ES skills to the lecturer, who assumes the role of a learner if not already enthusiastic about the latest ES technology. A lecturer specializes in a specific academic subject area, such as business processes, and teaches classes in that field. However, to effectively introduce students to an ES used for, e.g., business processes, the lecturer must be trained to apply the ES in order to convey its functionality to students. Thus, *scenario A* is followed by *scenario B,* where the same lecturer is in the role of an instructor teaching theoretical ES concepts (such as integrated business processes) and practical ES skills (e.g., in an ERP system) to students who are learners. The students may be graduates or undergraduates enrolled in a class (e.g., on integrated business processes) within their course of study (e.g., information systems). If alterations or innovations exist in the respective ES (such as new software releases), *A* will follow suit. Thus, there are three actors: the student, the lecturer, and the SME. While the student is focused on learning and the SME exclusively teaches ES, the lecturer can take on dual roles: learning ES and teaching it to the students. Thus, the term 'actor' refers to the individual or group of individuals responsible for producing a specific outcome. Figure 1 provides an overview of the three actors in the two scenarios. While the SME is closely connected to the corporate ES world and the lecturer is associated with the academic environment, such as teaching at a university, it is often necessary to involve both parties rather than solely relying on the SME to directly teach the students.

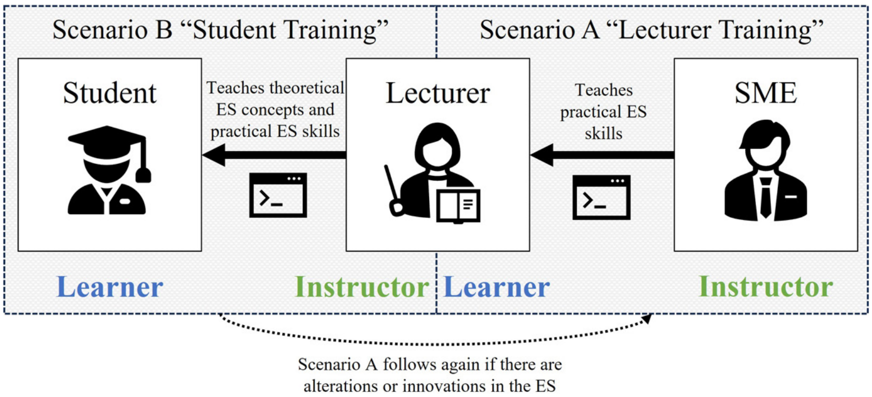

Fig. 1. TML scenario in the context of ES training

By applying the concept of TML to the context of ES training, the role changes become more apparent, as exemplified by the lecturer, who needs to learn and teach ES. Nevertheless, it raises questions about how these scenarios can be implemented. While students and lecturers are recognized actors, it is unclear who assumes the role of SME and trains the lecturer in the respective ES. Furthermore, resources must be specified, such as access to ES hosting, curriculum materials, and opportunities for peer interaction.

So far, research on TML performance has mainly focused on four areas: the predisposition, structure, process, and outcome quality of TML [9]. However, research on TML lacks the actors' perspectives, which are essential for contexts such as ES training. Students or learners are paramount in many studies [cf. 10, 11], but the perspective of lecturers and SMEs, if needed, is often neglected. Yet, the latter two perspectives are essential, as a TML scenario must be set up and facilitated. Second, many studies examine the TML scenario in depth, but the aspect of training for setting up this TML setting is often missing. For instance, game- and simulation-based scenarios for teaching students, as mentioned by Strong et al. [6], Schefer-Wenzl and Miladinovic [12], Kersánszki et al. [13], and Shanneb [7], require significant effort and skills in preparation and implementation for lecturers. The same goes for virtual learning environments [14]. Training is a crucial aspect of practice. Amoako-Gyampah [15], for example, identified training as one of the critical success factors after conducting a case study on an ERP implementation project in a company. This critical success factor is also confirmed in the engineering education literature. For instance, Holik et al. [11] explicitly highlight teacher training in digital skills. However, they focus on the method of *how* educational content is taught instead of a technological solution, such as ES, which *is* the content being taught.

Addressing the absence of actors' perspectives and the training aspect, we apply the concept of TML while considering the viewpoints of various actors—students, lecturers, and SME—in the context of higher education ES training. Accordingly, we raise the following research question:

How can ES training for use in higher education be designed based on the principles of technology-mediated learning?

We conducted a single-case study to address the research question regarding the design of ES training in higher education from a TML perspective. It operates within the context of the global academic alliance program established by the company SAP to equip students for employment within their ecosystem after completing their studies. Besides providing unique insights into various ES training courses, this case study considers the perspectives of all three key actors: students, lecturers, and SMEs. It also examines the resources needed to convey ES solutions, such as software access, curriculum development, and teaching materials.

We present the results in three morphological boxes, as the method allows for illustrating structural interrelationships between objects, phenomena, and concepts [16]. Based on TML literature and the case study results, the first morphological box displays the four TML concepts, with the actors' perspectives as a fifth concept. It demonstrates the ES training entities that we mapped to the TML concepts. The second and third morphological boxes highlight the perspectives of the actors' activities in ES training, learning about ES, and teaching ES. Thus, one box presents the ES learning factors and characteristics for learners (i.e., students and lecturers learning about ES). The other box displays six ES training variations and their characteristics for the role of instructing actors (i.e., lecturers and SMEs teaching ES). Based on our results, we derive design guidelines for ES training in higher education that first consider the TML concepts, second consider the actor's perspective, and third consider training aspects. In a nutshell, we outline the factors that instructors need to consider when designing an ES training course at a higher education level.

This study contributes to TML and ES training research by integrating the theoretical concept of TML into the practical context of ES training. Our findings contribute to theory by applying TML in a specific setting. Next to addressing Bower's call for a more in-depth investigation of TML settings and their design [17], we emphasized the perspectives of the actors involved in the TML concept with this approach. Our design guidelines emphasize the importance of providing effective ES training, addressing the need for skilled personnel while they are still in higher education before entering the job market.

The results have practical implications for teaching settings, especially for lecturers who want to complement their teaching with practical skill transfer by providing access to state-of-the-art ES. Also, representatives of ES companies can benefit from gaining insights on how their ES solutions can be effectively and sustainably integrated into higher education teaching by empowering lecturers through SMEs.

The remaining paper is structured as follows: First, we will provide an overview of the related work in the field of TML. Second, we will present the design of our case study, followed by the data collection and analysis process. Third, we outline our results, namely the perspectives of students, lecturers, and SMEs on ES training and the morphological boxes. In the discussion section, we will present the design guidelines for ES training based on the results before concluding the paper.

2 RELATED WORK

Originating from educational psychology, TML emerged through an examination of technology's impact on learning [8]. However, due to the emergence of the internet and various technical devices and applications, it is no longer necessary to distinguish between learning with and without technology. Instead, the focus is on *how* learning with technology (i.e., TML) can appear, including its impact on learners or how TML can be designed in various settings [8, 17]. Thus, research on TML is interdisciplinary as it impacts various research areas such as education, psychology, information systems, and human-computer interaction. This is why there is no single TML theory but many different approaches to conceptually modeling a TML theory. One example is the study by Gupta and Bostrom [18]. They developed a conceptual model for a TML meta-theory based on the Adaptive Structuration Theory by DeSanctis and Poole [19], illustrating the reciprocal interaction between actors and structures to generate new outcomes. For TML, learners influence structures (such as technology or learning capabilities) and vice versa. Thus, TML aims to consider all components in a setting where technology mediates learning. In the example of this paper, these components would include the student, the lecturer, the SME, the ES, and related resources such as curriculum materials and system access.

However, multidisciplinary TML research and various approaches to theory building have led to mixed results regarding the actual effects and performance of TML [18]. Thus, Söllner et al. [9] reviewed literature published on TML and identified four key concepts: predisposition quality, structural quality, process quality, and outcome quality. The four key concepts constitute the main factors that influence the performance of TML. Thus, they also play a significant role in our study examining the design of ES training. Furthermore, we argue that actors, such as students, lecturers, and SMEs, also play an essential role in TML performance. In our ES context, for example, the term "lecturer" can be associated with the act of teaching. Therefore, in summary, there are five concepts for assessing TML performance. These are briefly introduced in Table 1, as they play a significant role in integrating the literature on TML with the case study results of this paper.

Table 1. Five concepts for assessing technology-mediated learning performance based on related literature

TML Concepts	Definition	Examples and References
Actors' Perspectives	The actors' perspectives address the various parties involved in the TML process. Specifically, it examines whether the publication investigates the learning process from the point of view of a student, user, instructor, or organization.	Consideration of the student's perspective [20–22] → Research gap: scarcity of focusing on all participating actors in a TML setting further strengthens the need for a holistic investigation of TML
Predisposition Quality	The predisposition quality captures the overall attitude towards TML. It thus covers the importance of the learning material, self-efficacy, technological readiness, self-regulated learning, and intrinsic value, as perceived by the students [9]. It is also a widely recognized factor that influences TML.	User responses to IT that can be, for instance, rather engaged or deviant [23]
Structural Quality	Structural quality relates to system quality, trainer style, and quality of the information [9]. The model in [9] further lists the learning environment, study material, trainer quality, and IT system quality as second-order constructs.	Quick and easy access to technology and the time independence for the use of that technology [24]
Process Quality	Process quality in TML focuses on influencing factors like the degree of interaction and support. It captures aspects such as exercise quality, influences that depend on the learner group, such as mutual support and similarity of previous knowledge, transparency of the training process, and the degree to which the course matches student or user expectations [9].	Commonly recurring themes are gamification approaches [25–27] and teamwork dynamics [28, 29]
Outcome Quality	Outcome quality can be divided into two subcategories: learning success or performance and student/user satisfaction [9]. It is primarily considered in publications that take a more quantitative approach to TML research.	Gamification outcome constructs, such as learning performance and perceived usefulness [30], or, e.g., context-relevant graphics that improved the students' understanding of their task [31]

Extant literature predominantly takes a quantitative approach to designing TML frameworks or measuring their performance. This assertion is also supported by [9], who collected data from TML vocational software training participants. However, while student questionnaires provide a broad overview of the learners' perspective, they are one-dimensional and subjective. Furthermore, while such a questionnaire may identify some factors influencing TML, it is limited to a predetermined set of questions and lacks an overall process perspective. Thus, it is less helpful in identifying misalignments and communication gaps between the actors learning about the technology and those teaching it. Therefore, it is even more essential to consider each actor and their role in the TML process. Conflicting actor goals can then be identified, and the overall process perspective can be improved. That is why our study focuses on a qualitative approach that considers the perspectives of students, lecturers, and SMEs in the context of ES training.

3 DESIGN OF THE CASE STUDY

This section outlines our methodology. Within a case study setting, we investigate TML in the context of ES training in higher education. The case study concerns SAP University Alliances (SAP UA), a global academic alliance program initiated by the company SAP to prepare students to use and work in their ecosystem after their studies. Educational service providers (ESPs) act as intermediaries between the ES company and the universities in the SAP UA program. The ESPs provide hosting services, develop SAP-based ES curricula, and offer services such as ES system and curriculum support and lecturer training [32, 33]. This context represents a unique case, as SAP UA has an extensive university partner network and a wide range of ES education offerings, such as ERP and analytical ES solutions. SAP ES is used worldwide in higher education teaching, so several thousand students apply SAP ES every semester during their studies [34, 35]. Besides this, the SAP UA program has remained resilient for over 25 years [36] and is well-established compared to the academic programs of other ES companies. Also, it is well represented in education and other fields of research [cf., e.g., 37, 38].

Hence, we chose a single-case study design following Yin [39] for a period of six months, from November 2021 to April 2022. The method of conducting ES training in higher education is the focus of analysis in the case study. The three main actors, the student, lecturer, and SME, constitute the units of observation.

4 DATA COLLECTION

To answer our research question on how ES training can be designed for use in higher education regarding the principles of TML, we decided to examine several different SAP ES training courses for either students or lecturers within our case study. This approach allows for a wide range of diverse ES training courses. Along with the various ES training courses, we selected a range of data collection methods. We utilized the following sources of evidence as data: *documentation* such as ES curriculum materials, an event calendar of ES training courses for lecturers in the SAP UA program, and *archival records* in the form of a practical ES course evaluation. *Direct observations* were also incorporated from SAP UA community events, as well as *participant observations* in training sessions where lecturers received instructions from SMEs on how to use the ES in their subsequent teaching activities with students. We consciously chose both formats—observation and participation—to take different perspectives as observers of the happening and participants, respectively. ES training activities in higher education were identified through conducting semi-structured *interviews*. Note that the training on which we based our collection of curriculum materials, evaluations, interview partners, and observational and participant insights is offered continuously (i.e., both before and after our case study duration). As researchers, we accompanied the training but did not offer it ourselves. In the following, we provide more details on the collected data.

4.1 Documentation and archival records

We used the ERP curriculum *"Introduction to SAP S/4HANA using Global Bike,"* created by an ESP, as a data source for the documentation. Global Bike is a fictional bike manufacturer that serves as a model company. The curriculum imparts students with procedural knowledge about integrated business processes in an ERP context. Besides slides for a general understanding of SAP S/4HANA and the Global Bike context, the curriculum contains materials for various ERP modules, such as sales and distribution and production planning and execution.

We reviewed the curriculum material independently and assessed the practical components in an SAP S/4HANA system. Each module's content is divided into slides, exercises, and case studies. Slides provide the necessary background for understanding the basics of processes such as production planning and execution in companies. Exercises that need to be performed practically in the ERP system utilize multiple screenshots with questions for students to answer upon completing each exercise. The curriculum details recommend completing the exercises before moving on to the more extensive case studies. These case studies guide students through an entire process within the system, such as an integrated order-to-cash cycle. Each case study step is subdivided into a task, a description, and the name of the employee who would conduct this step in real life to make the practical example more relatable to the real world. After completing a case study, a challenge is presented without any accompanying screenshots or step-by-step instructions. However, this challenge describes a scenario similar to the one in the case study, with several adaptations to make it more challenging for the students. In solving the challenge within the system, students are independent and must apply their knowledge from the case study to the new context.

In addition to the case study and the challenge, the curriculum includes supporting materials for the lecturer. These materials offer guidance on setting up the SAP S/4HANA system, addressing potential issues, monitoring students' progress, and assisting students with the challenge if necessary. In addition, a datasheet is provided, summarizing the master data, organizational units, and employees involved in the case study. Also, there are blank spaces where students can enter the document numbers created in the SAP S/4HANA system. As the curriculum provides comprehensive material for twelve modules, lecturers can incorporate it into an entire semester of teaching, depending on the depth to which they want students to explore the topic of integrated business processes. Additionally, other curricula, such as customization in SAP S/4HANA, can be completed using the same system access. Moreover, lecturers can implement their scenarios in the SAP S/4HANA system, regardless of the curriculum material provided.

As another data source, the *event calendar* displays ES training sessions for lecturers in the SAP UA program. These sessions are primarily conducted by ESP employees or other SMEs twice a year, in March and October. During the ES training month in our data collection period (i.e., March 2022), the calendar displayed 15 events, showcasing the wide variety of courses available through the SAP UA program.

For the archival records, we conducted an *assessment of a hands-on master's student course on SAP S/4HANA application development*. The students collaborated in groups and primarily worked remotely based on their teams' preferences. Within this evaluation, we only considered questions related to TML for the analysis. The first question was about the students' perceived skill acquisition. This question pertains to TML through the concept of self-efficacy, which can be utilized to assess learning outcomes [21]. The second and third questions addressed organizational issues and asked about the course's compatibility with the digital environment and the effectiveness of digital tools (such as Moodle, Zoom, BBB, Panopto, etc.) for students working on their SAP S/4HANA application development tasks. We separately summarized the main positive and negative concepts from the open-ended questions in the evaluation.

Afterward, we uploaded all three data sets and archival sources into the qualitative data analysis and research software Atlas.ti. Where a download was impossible, as was the case with the event calendar, we took a screenshot and uploaded it to Atlas.ti for later analysis.

4.2 Direct and participant observation

In addition to collecting data on the curriculum material, we participated in an online awareness session for a business simulation game competition on SAP S/4HANA to gather *direct observation* data. The session aimed to inform the lecturers in the SAP UA program about an upcoming event in May 2022: a business simulation game competition on SAP S/4HANA. It provided initial information to enable the lecturers and student teams to compete with each other using SAP S/4HANA software to make business decisions within a fictional game scenario. During the online session conducted as a webinar, the number and identities of other participants were concealed.

As a foundation for making business decisions, two SMEs leading the session presented information slides and insights from the business game in the system. We observed this offering as the competition revealed an entirely different aspect compared to the previously examined SAP S/4HANA introductory curriculum. The competition was structured as a serious game to teach the fundamentals of ERP and business analytics, departing from the conventional course format. Thus, the game requires students to develop creative skills and procedural knowledge. We wrote memos documenting the observed details and our thoughts throughout the session.

Additionally, we *participated* in a lecturer training session about SAP Signavio, an ES for process mining and business process modeling. Three SMEs, including two employees from an ESP and one SAP product specialist, conducted this session for lecturers, equipping them to instruct their students on SAP Signavio. Therefore, SAP Signavio is a practical example for teaching students business process modeling and the fundamentals of process mining. Additionally, we took observational notes and memos here. During this session, one of us actively participated with the lecturers. This active participation enabled us to get into the position of the lecturers.

We compared and discussed the memos and notes from both sessions before uploading them to Atlas.ti for further analysis, as detailed in Chapter 5.

4.3 Interviews

To understand the various actors' perspectives, our goal was to collect personal insights into their viewpoints instead of analyzing ES training solely based on materials or numbers. Thus, as a third source of evidence within our case study approach, we conducted thirteen semi-structured *interviews*, each lasting approximately 45 minutes. We recorded all spoken data, transcribed it, and uploaded it to Atlas.ti.

We grouped the interviewees according to the observation units into three categories: students, lecturers, and SMEs. For each group, we selected a random subset of individuals who participated in one or more ES trainings related to SAP solutions, based on availability. Since many aspects mentioned by the interviewees recurred after the 3rd or 4th interview for each respective actor, we conducted four interviews remotely with students, five with lecturers, and four with SMEs. We conducted the interviews according to the guidelines in [40]. To conceptualize qualitative interviews, Myers and Newman [40] propose a dramaturgical model that views the interview situation holistically, encompassing its beginning and end, rather than just focusing on the script.

We primarily derived questions from the five concepts for assessing TML performance (cf. Chapter 2). An overview of the main question topics in the interview guideline can be found in Figure 2. For example, under the topic "structure of lecture/training" related to the TML concept of "structural quality," we asked lecturers and instructors the question, "How would you describe a typical teaching unit in your ES course?" Note that due to the overlapping roles of the lecturer, who can act as a learner in lecturer training (*scenario A*) and as an instructor in student training (*scenario B*), some questions were the same for two actors. However, each interviewee related their experiences to the course they personally attended; otherwise, we would not have been able to cover various perspectives and different ES courses.

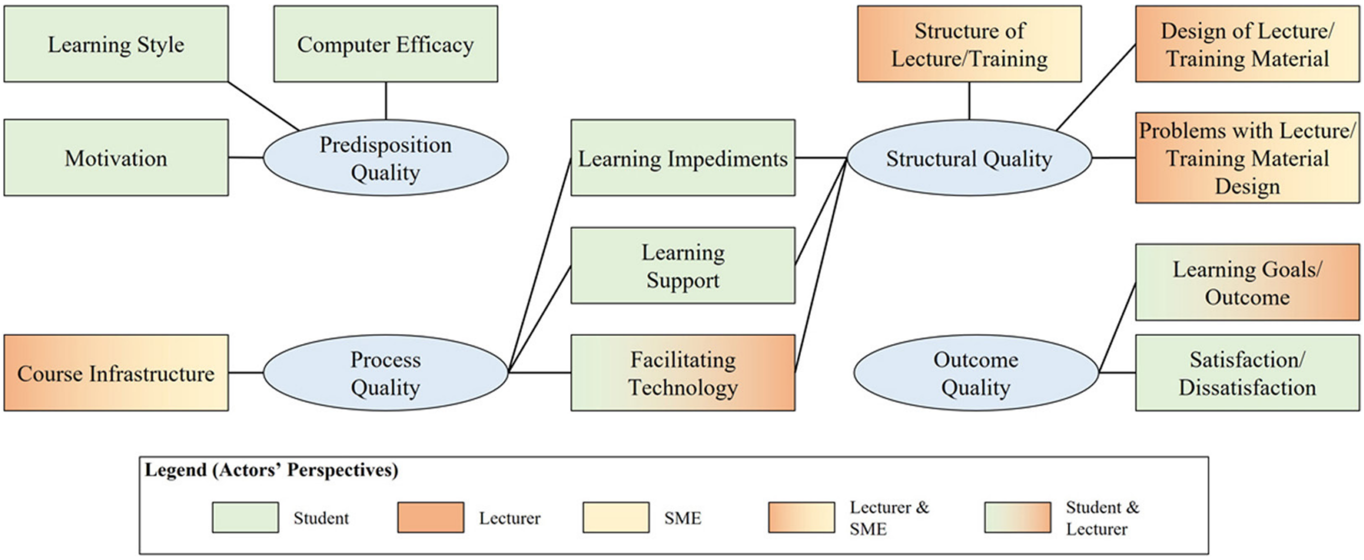

Fig. 2. Overview of main question areas for the interview guideline

Table 2 provides an overview of the described sources of evidence. All the data collected has a unique reference code for later reference in the rest of the paper.

Table 2. Overview of used sources of evidence

Sources of Evidence	Data Description	Reference Code(s)
Documentation and Archival Records	ERP curriculum "Introduction to SAP S/4HANA using Global Bike"	DAR1
	Event calendar showing ES training offerings for lecturers	DAR2
	Evaluation of a practical master's student course on SAP S/4HANA application development	DAR3
Direct and Participant Observation	Awareness session for a business simulation game competition on SAP S/4HANA	DPO1
	Lecturer training session on SAP Signavio	DPO2
Interviews	Students	IST1 – IST4
	Lecturers	ILE1 – ILE5
	SMEs	ISM1 – ISM4

5 DATA ANALYSIS

This section describes the analysis of data and sources. As mentioned in Chapter 4, we uploaded all documents, archival records, observation and participation notes, and memos to Atlas.ti. Interviews were transcribed into written format and uploaded as well. From then on, we utilized Atlas.ti as a unified platform to compare, discuss, and analyze various data sources and harmonize our perspectives within our research team. The analysis process was carried out as follows: We applied the three-step coding process proposed by Gioia et al. [41], which leads from first-order concepts to second-order themes, and finally, aggregate dimensions. The data analysis was structured in three steps.

The aggregate dimensions were already determined, as the five TML concepts guided us through the analysis process. These aggregate dimensions included three actors: students, lecturers, and SMEs, representing their perspectives on TML. In addition, these were the factors for the remaining four TML concepts: predisposition, structural, process, and outcome factors. We intentionally selected the deductive approach because we viewed TML as a concept that we aimed to enrich with detailed information from the case of ES training in higher education.

With the five TML concepts in mind, we coded all material using first-order concepts (e.g., indicating that courses were conducted in a hybrid, in-class, and remote format). Afterward, we gathered, discussed, and sorted the first-order concepts into second-order themes (e.g., the concepts of conducting a course in a hybrid format, in-class, or remotely were grouped under the theme "teaching style"). We mapped these second-order themes again with the TML concepts as aggregate dimensions. For example, the theme "teaching style" is related to the actors' perspectives as lecturers and SMEs. Table 3 displays a segment of the final codebook containing exemplary text passages and their corresponding codes.

Table 3. Extract of the code book

Text Passage	1st Order Concept	2nd Order Theme	Aggregate Dimension
Issues with the integrated development environment, as reported in the evaluation of the SAP S/4HANA application development course [DAR3]	Technical Problems	Demotivational Factors	**Actors' Perspective: Student**
"There are students who dial in, and students who are the class, sitting in the classroom […]." [ILE2, translated]	Hybrid	Teaching Style	**Actors' Perspective: Lecturer**
Teaching case of a fictional woman working with SAP Signavio [DPO2]	Storytelling	Engagement	**Outcome Factors**

For structuring and making sense of the large number of codes and the final representation, we utilized the morphological method proposed in [16]. The morphological approach focuses on developing and implementing fundamental methods to detect and evaluate structural and morphological interrelationships among objects, phenomena, and concepts. The findings can be explored to form real-world representations. The morphological analysis is especially suited to non-quantifiable and multidimensional problems [33], so we considered this approach appropriate with TML for ES training in higher education.

Thus, we created a morphological box based on the findings from the TML literature and the case study, representing the dimensions of the five TML concepts: actors' perspectives, predisposition, structural, process, and outcome factors, against the background of ES training in higher education.

Since our study focuses on the actors' perspectives of TML, two additional morphological boxes were created based on the three aggregate dimensions of the actors' perspectives: *student*, *lecturer*, and *SME*. These two additional morphological boxes represent the factors and variations, along with their characteristics, related to the roles of the learner (represented by the actors *student* and *lecturer*) and the instructor (represented by the actors *lecturer* and *SME*), respectively. The factor column in the box represents second-order themes, whereas the characteristics of these factors represent first-order concepts. Figure 3 provides an overview of the steps described for data analysis and preparation for the morphological boxes, which serve as input for deriving design guidelines.

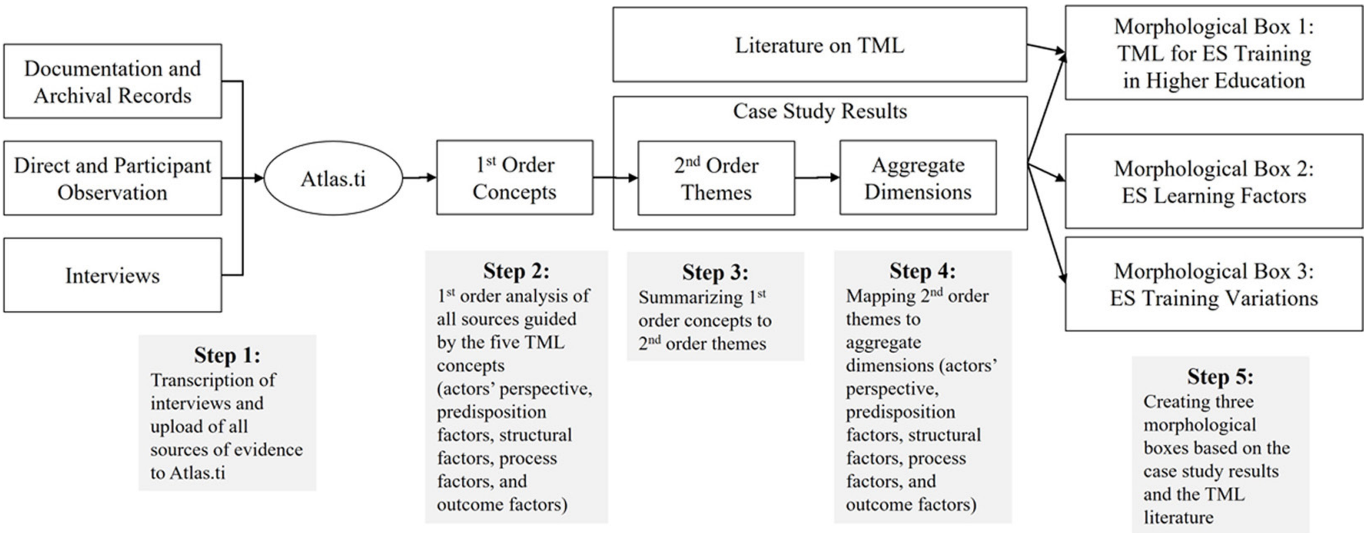

Fig. 3. Overview of the data analysis process

6 RESULTS

This section presents the actors' perspectives regarding TML in ES training. The perspectives are based on the interview data and provide insight into how the actors experience their roles in ES training in higher education. The aspects representing the perspectives are marked in italics and summarized as open codes. Based on these codes, we developed the morphological boxes presented later.

6.1 Student perspective

The interviewed students were enrolled in an ES course focused on project-based work with industry partners. The latter provided real-world problem statements and posed as customers for the students. They also supported students with any ES problems that arose during the project.

From the students' perspective, we identified six main aspects. The *learning structure* refers to the method of learning employed by the students and includes aspects such as course format, level of detail, and provided infrastructure. Moreover, *motivational factors* were identified, such as working with an industry partner, and factors related to predispositional qualities, namely computer self-efficacy and practical learning style. The *technology tools* used in the learning process constitute the next aspect. This includes the ES environment, learning platforms, and video conference tools. Students' self-reported *learning elements* can be divided into general course content, project-specific knowledge, and soft skills. The *challenges* identified included a high workload and time management problems. Finally, *support* is provided by the team, lecturers, and industry partners, as well as in the form of technological support. This support is referred to in the following quote regarding support as perceived from a student's perspective:

> *"But you knew you always had feedback. This [the student's project] is heading in the right direction; it is promising. That means it won't end up as a disaster [i.e., the students do not know what to do]."* [IST1, translated]

6.2 Lecturer perspective

Each lecturer interviewed held a unique ES course based on SAP solutions, each with its own learning goals and teaching methods. We identified five main aspects. The first aspect, *teaching style*, refers to the approaches and techniques used in ES training activities in higher education. It contains hands-on experience, which was deemed of great value in almost all observed courses, as reflected in the following quote:

> *"And as I mentioned, with enterprise software, I can demonstrate it. I don't just talk about it theoretically; I can also show it to them [the students]. They [the students] can do it themselves and experience it firsthand. And that's the major advantage of it."* [ILE2, translated]

A second important aspect is the *learning goals*, which constitute a significant part of the motivation behind the course design. Here, for example, understanding user navigation in an ES requires knowledge of the basics and the theoretical foundations of the underlying process. The lecturers paid special attention to the *integrated technologies* in the context of TML. In most cases, these results were comparable to those of the students. However, in addition to easy-to-access ES, lecturers also require tools and technologies such as quiz and accounting software, recording equipment, and devices or consoles to administer the ES. With one exception, the courses took a hybrid approach, with one even operating asynchronously. The asynchronous components of the course primarily involved theoretical knowledge, allowing students to learn at their own pace within a specified deadline. With TML, it is possible to digitally enhance learning materials, which is considered a significant *advantage* by lecturers. However, one *challenge* that comes with teaching ES is its sheer complexity.

Teaching the basics and explaining the connections between ES modules can be challenging. The fast-changing nature of ES intensifies this complexity. Furthermore, the situation worsens when the student group and the students' prior knowledge are diverse. In this case, the lecturer must adapt to the students' various learning styles and paces to navigate through an ES curriculum. One course mainly had students from vastly different backgrounds, such as medicine and agricultural sciences. Therefor, it is crucial for the lecturer to have an appropriate level of background information.

6.3 SME perspective

The SMEs we interviewed worked as employees of the ESP or for SAP consulting firms. They are regularly booked to train lecturers in the SAP UA program. Here, we identified four important aspects of their perspective. First, *integrated technologies* play a crucial role here as well. However, the focus is not just on the communication tools or the virtual setting but also on the extended ES environment. Even though lecturers might provide their students with the web-based version of an ES, they often need to access tools or consoles for configuring the ES beforehand. For these additional tools, SMEs must train the lecturers and develop easy-to-follow instructional materials. *Training characteristics* refer to the primary design aspects of ES training workshops. In this context, the content and learning objectives of the training were important. A typical learning goal was to empower lecturers to conduct courses independently, as articulated in the following quote:

> *"And why do they [the lecturers] attend this course? Because they have to teach. This means that they not only have to comprehend the exercises, but they also need to understand the background and be able to explain it [to their students]."* [ISM1, translated]

SMEs also face several *challenges*, such as the lack of attention from lecturers. In many cases, it is not feasible for a lecturer to participate in comprehensive ES training due to time constraints, as the lecturer is primarily focused on teaching. On top of that, *lecturer characteristics* are reflected in their level of motivation and previous experience in applying ES. Like lecturers, who must adapt to their students' different paces and knowledge levels, SMEs must also adjust to the knowledge levels and time constraints of the lecturers attending the ES training.

6.4 Morphological boxes for ES training

The results in Chapters 6.1 to 6.3 provide insight into the actors' perspectives on ES training in higher education. These influences guided our creation of the three morphological boxes presented below.

The morphological box in Table 4 provides a high-level overview of ES training in higher education using TML. It shows the five TML concepts, four of which (predisposition, structural, process, and outcome factors) were taken from the TML literature [9]. In this study, we introduced and emphasized a fifth concept, actors' perspectives. For each of the five TML concepts, we identified entities. These originate from TML literature. On the other hand, the entities were either proven or enriched with additional entities identified during the data analysis process of the case study. Thus, they depict the entities relevant to ES training in higher education.

Table 4. Morphological box visualizing an overview of technology-mediated learning for enterprise software in higher education

TML Concept	Entities			Sources
Actors' Perspectives	Student	Lecturer	SME	Case study data
Predisposition Factors	Attitude towards technology			Case study data and references [9, 10, 18, 20, 22, 42]
	Cognitive ability			
	Learning style			
	Motivation: general interest & relevance			
	Personal innovativeness			
	Self-efficacy			
	Self-regulation ability			
Structural Factors	Digital learning environment			Case study data and references [9, 18, 24]
	Faithfulness of use			
	Information quality			
	IT system's quality			
	Lecturer support			
	Practical relevance			
	Quality of learning material			
Process Factors	Attitude of learning peers			Case study data and references [10, 18, 25, 27–29, 42–44]
	Communication tools			
	Consistency across course			
	Degree of interaction			
	Ease of use of system			
	Expectation confirmation			
	Gamification			
	Teamwork			
Outcome Factors	Ability to transfer knowledge			Case study data and references [8, 10, 20, 21, 26, 30, 31, 45]
	Engagement			
	Retained knowledge			
	Satisfaction			
	Self-efficacy			

The morphological boxes in Tables 5 and 6 are based on the TML concept highlighted in this paper: the actors' perspectives. Thus, they result from the interview data of the case study. Table 5 presents the morphological box of learning factors and their corresponding characteristics for actors who are learning ES (students and lecturers). Note that this morphological box does not claim to be complete. Instead, it shows characteristics of ES learning that should be investigated before designing a course. Additionally, it provides potential example values.

Table 5. Morphological box representing enterprise software learning factors

Enterprise Software Learning Factors	Characteristics			
Learning Style	Theoretical learning preference	Practical learning preference	Combination of both	
Motivational Factors	Relevance for future work	General interest in ES	Real practical experience	Personal connections
Demotivational Factors	Limited information online	Technical problems	Too high workload	Infrastructure limitations
Course Learnings	Basic ES understanding	ES development abilities	Soft skills	Project-specific knowledge

Table 6 presents the morphological box on ES training variations and respective characteristics for actors instructing ES (lecturers and SMEs). These variations may be extended depending on the ES training context. Additionally, they provide insights into the main teaching methods that SMEs or lecturers should take into account when developing an ES course in higher education.

Table 6. Morphological box representing variations in enterprise software training

Enterprise Software Training Factors	Characteristics			
Training Style	In-class	Hybrid	Remote	
Synchronicity Level	Fully synchronous	Hybrid	Fully asynchronous	
ES Efficacy Level	Theoretical knowledge about ES	ES practical competency (navigation & transactions)	ES project development ability	
ES Access	Cloud-based	Remote desktop access	On-premise installation	
Progress Checking	In-class quizzes	Homework submissions	Presentations	Exams
Support Style	Live assistance (remote or on-site)	Written communication	Ticketing system	

7 DISCUSSION

7.1 Design guidelines for ES training

Based on the case study and TML literature results, we have developed guidelines that instructors (i.e., lecturers and SMEs in their role of instructing a course) should adhere to when designing ES training in higher education. They are marked in bold. We classified them into the three main areas where we see improvement in current ES training practice and TML literature: Guidelines with (1) consideration of the TML concepts, (2) consideration of the actors' perspectives, and (3) consideration of training aspects.

1. **Consideration of the TML concepts:** When designing an ES training course in higher education, instructors should consider the four conventional TML concepts and their characteristics regarding ES training (cf. Table 4). This involves **respecting the predisposition factors**, such as learners' motivation, attitude towards technology [7], and learning style [22]. Further, **structural factors need to be considered**. For instance, the quality of the IT system [24], as seen in our SAP UA case, and the maturity of newly introduced software like SAP Signavio. Furthermore, instructors should **investigate the appropriate process factors.**

Examples are potential gamification aspects [27] that can be integrated to make ES learning more playful and interactive, or peer learning activities [10, 43]. Lastly, the **outcome factors that should be considered** when making statements on the effectiveness of the ES training include learning outcomes and learner satisfaction [20, 45].

2. **Consideration of the actors' perspectives:** Besides considering the four conventional TML concepts for assessing ES training performance [9], our results indicate that practitioners should **pay special attention to the actors' perspective**. In the SAP UA example, the actors include students, lecturers, and SMEs. In the ES training setting, the lecturer may act as a learner or instructor. On the one hand, this creates the need to **respect ES learning factors** (refer to Table 5). That means that instructors should pay attention, for instance, to the learning style of the learners. For example, if it is more oriented towards theory, as might be the case in an introductory university class with several hundred students, or towards practice, as in the case of a hands-on seminar or project course with only a few students. On the other hand, **factors related to ES training need to be considered**. As shown in Table 6, the instructor needs to decide, for example, on the training style and the level of synchronicity in the learners' class. With ES, different training and synchronicity settings automatically require different settings for accessing the ES solution and monitoring the learners' progress. Also, the support style needs to be adapted, for example, by implementing a ticketing system when the ES course is conducted remotely and fully asynchronously.
3. **Consideration of training aspects:** Concerning the variations in ES training, it is crucial to **train lecturers before instructing ES students**. Most current publications focus on teaching students, providing teaching strategies [46–48], or developing teaching tools [49, 50]. Only a few studies, such as the one by Hassan et al. [51], emphasize the significance of faculty training, although without a specific emphasis on ES. The COVID-19 pandemic revealed the need for lecturers to be adequately trained and equipped [52–54], although this refers specifically to the supporting software that enables remote teaching, not the teaching software itself. Even though students are the next-generation workforce, they rely on lecturers to convey ES skills. These, in turn, depend on the **supply of easy-to-access ES and appropriate curricula, services, and training**, not least because of the complex and fast-changing nature of various ES. As presented in the SAP UA case, ES training in higher education is strongly influenced by the educational ecosystem of universities, software firms, and intermediaries such as ESPs, as referenced in [55]. In our example, the curricula on SAP solutions are created by ESPs and not by SAP since the ESPs exclusively focus on SAP curricula, training, and hosting. The ESPs specialize in implementing SAP solutions in academic settings, whereas SAP primarily focuses on selling SAP software for commercial use.

7.2 Limitations and future research

Our study is not without limitations. There are diverse ES teaching goals; each investigated course relates to a different ES focus area and teaching method. Since the interviews in the case study were limited in number and focused on specific cases, the morphological boxes cannot provide a complete overview. Instead, they are intended as a guide to be extended with additional factors and characteristics, if necessary. Also, we consciously chose a single-case study design to have a more in-depth look into the phenomenon but acknowledge the difficulty of replicating and generalizing the selected method. Another limitation is the impact of the COVID-19 pandemic, which had consequences for teaching. Although the interviews attempted to differentiate between TML practices affected by the pandemic (e.g., in-class formats) and those that were not (e.g., pandemic-independent remote settings) by explicitly asking what would change if the pandemic had not led to consequences like the rising demand for remote learning and teaching content, there is still potential for bias.

In both its breadth and depth, this topic offers several avenues for future research. The ES training courses we examined and their various learning focuses are just the tip of the iceberg. For example, additional ES training course options or individuals participating in ES training could be identified. This also implies that the factors and characteristics for ES training and learning, as well as the guidelines for ES training, can be applied, modified, and expanded based on non-SAP ES. Examining our guidelines and gaining experience in ES training outside the SAP universe would be interesting. Also, we encourage future research to explore the complex interrelationships between TML and ES training further by focusing on a single course. In this way, the more varied perspectives of students, lecturers, SMEs, and other stakeholders, such as the ES provider or university purchasing ES access for teaching purposes, can be explored using a quantitative approach. The possibility of engaging in the learning experience and following the course step-by-step should also be taken into consideration. Another fruitful research area is the shift towards a fully cloud-based environment provided directly by the ES company and not via an ESP, especially for complex ES, such as ERP systems. However, apart from cost, a notable disadvantage is the increased frequency of releases in cloud-based ES [56]. Especially when screencasts guide students through the system, the effort required to keep the recordings up-to-date is significant and may not be sustainable for some lecturers. This is why future research on ES cloud development and other process change implications would be relevant.

8 CONCLUSION

This study focuses on the applicability of TML research for designing ES training in higher education. To achieve this goal, we reviewed relevant literature on TML concepts and conducted a case study. We present three morphological boxes that depict the TML perspective, as well as the ES learning and ES training perspectives. Based on the results, we developed design guidelines for ES training in higher education by considering (1) the TML concepts, (2) the perspectives of the actors involved, and (3) training aspects.

We have made several contributions to the field of ES in conjunction with TML. The morphological boxes and derived design guidelines provide practical guidance for substantiated TML concepts beyond theoretical aspects. Practitioners, i.e., lecturers and SMEs, can develop new ES training courses based on the findings presented in this paper. Common pitfalls can be avoided by following the guidelines and practical examples from the SAP UA case. The paper assists in comparing ES training approaches, as there are various methods of teaching available, depending on the content and organizational structure of the course. These aspects include the time frame, scope, and anticipated number of students or lecturers to be trained in ES. With that, we aim to assist practitioners in promptly identifying alternatives and exploring different approaches. For example, they can experiment with the level of synchronicity or closely examine the outcome quality of their ES training.

Our findings highlight the applicability of TML in the practical context of designing training for ES in higher education settings. The findings empathize with the association established in [9] through a quantitative study of vocational software. Nevertheless, as highlighted and confirmed in this paper, the actors' perspectives are crucial for TML. Furthermore, these actors' perspectives show that training all involved actors is essential for TML. Future research can build on our findings and those related to the significance of a lecturer's technical expertise [57], as well as the role of educational ecosystems and their actors [58, 59], in maximizing the potential and effects of ES in higher education.

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