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Are trainee teachers less prone to implement new educational technologies than in-service teachers? Determinants of implementing a simulation-based environment

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Abstract
While the availability of digital tools presents new possibilities for teaching and learning in vocational education and training (VET), the implementation of these tools into classroom practice naturally falls to the teachers. This qualitative study explores the facilitating and hindering factors that VET teachers in the business domain perceive as influencing the implementation of an office simulation. The potential differing perspectives of trainee teachers and in-service teachers are also examined. For this purpose, an interview study including $N = 28$ vocational teachers (14 trainee teachers and 14 in-service teachers) was conducted. At the school level, peer support and adequate infrastructure are identified as drivers of implementation. At the individual teacher level, motivation and teaching experience, and at the learner level, the teachers' perception of motivation and digital skills of vocational students are identified as drivers. At the contextual level, the provision of workshops and time resources are considered crucial. Finally, the characteristics of the new educational technology tool itself are stressed (particularly instructional possibilities, authenticity, usability and collaborative nature). Regarding the comparison of trainee teachers and in-service teachers, a substantial overlap in terms of the aspects reported occurred. Surprisingly, the quantitative results indicate that the trainees perceive a higher level of barriers. We suggest supporting the implementation of educational technology by considering the interplay of teachers' perceived influencing factors and by addressing perceived barriers.

Keywords Technology implementation, Educational technology, Teaching practices, Simulation-based learning, Interview study, Vocational education and training

Introduction

The imperative for digital transformation within the educational sector, coupled with the increasing relevance of digital tools in the classroom, is driven by various demands. Particularly in vocational education and training (VET), this shift is intricately linked to the dynamic changes occurring in the professional landscape (Beer and Mulder 2020).

Within the business domain, the digitization of business processes is reshaping the skill requirements for VET students. As routine tasks in professional practice are increasingly automated or digitally supported, the focus of work shifts towards more complex tasks (Beer and Mulder 2020; Frey and Osborne 2017). Moreover, findings from an interview study with trainers and VET teachers within the commercial sector indicate that the ongoing digitalization of work settings increases the relevance of skills such as data management, digital communication, information research and evaluation, and technological proficiency (Geiser et al. 2021). This creates a need for digital learning environments that support authentic and complex work tasks to prepare learners for their future roles in office workplaces.

One approach particularly suited to this purpose involves the integration of simulation-based environments, which allow learners to engage with practice-oriented tasks within a business setting (Caruso 2019; Rausch et al. 2021) and provide a practical and immersive learning experience in a controlled educational environment (Plass and Schwartz 2014; Chernikova et al. 2020, 2023). Despite this potential, their use in vocational schools remains limited at present (Cattaneo et al. 2025a).

In mastering the digital transformation of education, teachers play a pivotal role (Seufert et al. 2018). They are faced with the challenge of implementing new technologies into their classrooms. However, the effective implementation of these technologies is not a straightforward process and is subject to various influencing factors such as how teachers perceive educational technology, personal experiences and environmental conditions (Drossel et al. 2017). To embed educational technologies effectively into regular teaching practice, it is crucial to understand the drivers and challenges perceived by teachers. However, the perceptions of these factors may be shaped by teachers' stage of professional development. In this context, the study of Teo (2015) on the acceptance of educational technology suggests that both pre-service and in-service teachers may be affected by similar factors, while their perceptions of certain aspects may differ due to their different professional contexts.

Beyond technology acceptance, teaching experience also appears to be related to the quality of technology integration. For example, findings by Cattaneo et al. (2025b) suggest that teaching experience shapes the quality of technology integration, as lower levels of teaching experience are associated with a higher frequency of passive and interactive technology-supported activities. Backfisch et al. (2020) show that the quality of technology-enhanced lesson plans differs between more experienced teachers, comprising trainee teachers and in-service teachers, and less experienced pre-service teachers. However, no significant differences were found between trainee teachers and in-service teachers. Therefore, it seems reasonable to explore different stages of teachers' careers and their perceptions of factors influencing technology implementation.

In the present study we focus on two groups: trainee teachers and in-service teachers. By understanding their specific challenges, tailored support measures can be developed according to their stage of professional development, ensuring the effective implementation of technology-enhanced teaching. The comparison between trainee and in-service teachers is theoretically grounded in differences related to career stage rather than to expertise per se.

Research on technology integration and teacher beliefs suggests that teachers at different stages of their professional development operate within distinct institutional

contexts and may differ in perceived pedagogical risk, professional autonomy, and contextual constraints, all of which can influence implementation decisions. Meta-analytic evidence indicates that professional learning and training related to technology integration systematically shape teachers' beliefs and attitudes toward technology use, thereby affecting their implementation intentions (Wilson 2023).

While the exploration of factors influencing teachers to accept and integrate technology in their teaching is not a new inquiry, the ongoing evolution of educational technologies and contexts demands further investigations in this field (Gräsel et al. 2020). Current studies are placing emphasis on the implementation of recent technologies in various educational contexts. Examples include the incorporation of emerging technologies such as VR and robotics (Campbell and Frawley 2024) or adaptive learning systems (Mirata and Bergamin 2023) within higher education settings, as well as the utilization of 3D printing in science classrooms (Cheng et al. 2024).

Yet it is unclear which conditions foster the implementation of a simulation-based learning environment in teaching practice. Given the crucial role of technology, particularly of simulations, in bridging the gap between the workplace and the classroom within vocational education (Schwendimann et al. 2015), our particular interest in this study lies in exploring the implementation of an office simulation in vocational education within the business domain. We seek to explore teachers' perceived determinants on the implementation of an office simulation, including an interest in potential differences between trainee teachers and in-service teachers. The aim of this study is not to evaluate simulation-based learning as a pedagogical approach in general, nor to conduct a technical assessment of the software, but to explore how teachers make sense of a specific office simulation and its potential implementation within their instructional and institutional contexts. More precisely, by conducting semi-structured interviews, we address the following research questions:

1. What facilitating and hindering factors do VET teachers (trainee and in-service) perceive as shaping their intentions to implement an office simulation in their teaching practices?
2. How do trainee teachers and in-service teachers differ in their perceptions of these facilitating and hindering factors?

These insights may contribute to an understanding of how to support the implementation process for new educational technologies and inform tailored support measures aligned with the distinct phases of teacher development.

Theoretical foundation

Simulation-based learning and teaching

Simulations present simplified representations of a segment of reality. Within a controlled educational environment, students engage with real-world tasks. This provides diverse learning possibilities, enabling students to enhance essential workplace skills such as critical thinking and communication (Plass and Schwartz 2014). Notably, a meta-analysis in the higher education context underscores the high effectiveness of simulations in facilitating the learning of complex skills across different domains (Chernikova et al. 2020). Among other findings, it is evident that a heightened level of authenticity, indicating the extent to which the simulated environment mirrors reality (Gulikers et

al. 2004), is associated with greater effectiveness (Chernikova et al. 2020, 2023). Simulation-based learning can be implemented in both non-digital and technology-enhanced formats. While non-digital simulations rely primarily on role play and analogue materials, technology-enhanced simulations employ digital environments that shape interaction, task execution, and feedback processes. Technological features can support a closer approximation of real-world conditions and enable a wider range of practice opportunities. Depending on the design, learners may, for example, interact with virtual people or objects (Chernikova et al. 2020).

In the business domain, computer-based business simulations are gaining increasing relevance. They provide an environment for experimentation, valuable insights into digital business processes, and opportunities to learn from errors in a safe learning setting while receiving immediate feedback (Caruso 2019). In addition, online business simulations can offer an authentic platform for team-based learning, thereby enhancing learner satisfaction (Lohmann et al. 2019). However, it may come with certain challenges, such as the complexity of the software and the time required for teachers to acquaint themselves with it before implementing it in the classroom (Caruso 2019). In addition, the efficacy of simulations also depends on how these are implemented (Plass and Schwartz 2014).

Scenario-based simulations represent a specific type of business simulations, which focus on specific areas or processes within a company. The typical procedure involves "reading the case scenario, making decisions, analysing and reflecting on the feedback and results, and debriefing the experience" (Caruso 2019, p. 284).

The present study focuses on a technology-enhanced, computer-based office simulation in which technology constitutes a core element of the instructional design rather than a mere delivery medium. Key technological affordances include interface-based task processing, the integration of standard office software, and structured process guidance aimed at approximating authentic workplace practices. To clarify which design considerations, among others, guided the development of the investigated office simulation, these are described below.

1. The simulation-based environment should enable to replicate complete professional work process, challenging learners with multifaceted activities and tasks that involve problem-solving challenges (Jonassen 2000). To support the work on such complex learning tasks, various information and additional small exercises can also be provided (according to the 4 C/ID model, Kirschner and van Merriënboer 2008) in the office simulation.
2. As authenticity plays a role in the learning effect (Chernikova et al. 2020, 2023), the design of the environment can resemble a realistic business setting. Because authentic office work is predominantly performed through interaction with computers and digital systems, a 2D interface more closely reflects real-world conditions; therefore, this design was chosen over an immersive 3D virtual simulation.
3. To support learners, their individual learning needs can be addressed. Different types of learning prompts can be used for this purpose, e.g. they can be cognitive and metacognitive in nature and can directly trigger certain activities or be used as feedback (Wirth 2009). For example, the use of prompts can support self-regulated learning (Wirth 2009; Wong et al. 2021). Ideally, such prompts are personalized to learners' needs and triggered by their observable actions within the learning environment

rather than delivered in a static or generic manner (Thomann and Deutscher 2025). To enable this adaptive support, the office simulation was designed to incorporate a rule-based AI system that generates prompts contingent on learners' behavior.

4. To facilitate the creation and sharing of instructional materials, educational technology innovations should include authoring environments (particularly in the context of authentic project-based learning, see Rees Lewis et al. 2019). Following this suggestion, simulation-based environments should enable teachers to customise and develop tasks to suit their instructional needs. Accordingly, the office simulation serves both as an instructional environment and as an authoring and dissemination platform for simulation-based teaching materials.

Determinants of implementing technologies in educational practice

In the evolving educational practice, educational technologies play a significant role in transforming and enriching teaching and learning processes. Several models have been developed in the past to elucidate the integration of technology. In the following, selected models are briefly outlined (for an overview of different models of technology integration, see also Niederhauser and Lindstrom 2018). A widely utilized model to explain the adoption of digital technologies is the Technology Acceptance Model (TAM) (Davis 1989). The TAM-model emphasizes the relevance of individuals' attitudes in shaping their intention to use digital technologies. According to Davis (1989), the perceived usefulness and the perceived ease of use are pivotal to the acceptance of technology and the intention to use it. Although the model was not originally developed for educational contexts, it has been applied to explain teachers' acceptance of technology (e.g., Scherer et al. 2019; Antonietti et al. 2022). Building on the TAM, the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) takes additional influencing factors into account to provide a more comprehensive understanding of technology acceptance. Therefore, anticipated performance and effort constitute crucial determinants influencing usage intention, as well as social influences. Additionally, facilitating conditions, referring to an individual's perception of a supportive organisational and technical infrastructure, influence the usage. These relationships are further moderated by specific factors (Venkatesh et al. 2003).

Another prominent model is the Will-Skill-Tool-Pedagogy model (WSTP; Knezek and Christensen 2016). It comprises four constructs influencing technology integration in teaching: teachers' attitudes toward technology use in instruction (will), the ability to use technology, self-efficacy and readiness (skill), the availability and accessibility of technology (tool), and teaching style and instructional strategies (pedagogy). At this point, links can also be drawn to the TPACK framework (Technological Pedagogical Content Knowledge Framework, Mishra and Koehler 2006), which describes different knowledge component required for integrating technology into teaching. For example, Cattaneo et al. (2025b) identify conceptual overlaps between the construct *skill* and technological knowledge (TK component of TPACK), as well as between *pedagogy* and technological pedagogical content knowledge (TPCK component of TPACK).

Taken together, the models described above have different focuses, but overall point to the presence of diverse influencing factors for technology use in the classroom. Given the diversity of existing models and empirical findings, the present study deliberately adopts an exploratory perspective. Rather than testing a specific acceptance or integration

model, we structure potential determinants along distinct dimensions. Drawing on the transfer of innovations in the educational context, four dimensions for categorizing influencing factors can be distinguished: the characteristics of the innovation itself, the characteristics of the teachers, conditions at school level, and characteristics of the context and transfer support (Gräsel 2010). The subsequent section presents a selection of considerations and empirical findings on these four dimensions to provide an overview of the range of potential influencing factors, without claiming to be exhaustive.

The characteristics of the innovation refer to its perceived attributes. In this context, the innovations attributes described by Rogers (2003) can be considered (Gräsel 2010): relative advantage compared to previous practices, compatibility with users' attitudes and beliefs, the level of complexity, the possibility to experiment with the innovation (trialability), and the visibility of achieved results (observability) (Rogers 2003). These attributes are inherently perception-based and intertwined with teacher-related factors. In the context of technology integration, teachers' beliefs have been identified as a relevant teacher characteristic. For example, Antonietti et al. (2022) found in a TAM-based study with 2011 vocational education teachers that teachers' digital competence beliefs, beliefs about ease of use and perceived usefulness of technology are associated with their intention to use technology. Furthermore, Cattaneo et al. (2025b) investigated the influence of personal and school-related factors on the quality of technology integration, which was operationalized through four types of learning activities (passive, active, constructive, and interactive). Based on a survey of 1660 teachers, the authors found that personal factors – including teachers' positive beliefs about technology as well as their technological knowledge and technological pedagogical knowledge – were associated with all types of learning activities. Further findings also indicate that a positive attitude towards information and communication technology (ICT) can positively contribute to the extent of technology use in teaching (Drossel et al. 2017; Eickelmann and Vennemann 2017). Furthermore, teaching experience has been considered in relation to technology integration. Findings suggest that prior experience in using technology for instructional purposes constitutes a relevant driver of technology use in the classroom (Drossel et al. 2017). Moreover, teaching experience may also be associated with differences in the quality of technology integration (Backfisch et al. 2020; Cattaneo et al. 2025b).

For school-related factors, infrastructure can be mentioned. A study involving 3339 teachers examined, among other factors, the influence of school infrastructure on the use of ICT (Gil-Flores et al. 2017). The results indicate that infrastructure is a prerequisite for incorporating technology into the classroom, but its presence alone is insufficient to ensure technology integration. Beyond general infrastructure, access to educational software appears to play a relevant role. At the faculty level, collaboration between teachers has also been identified as a factor associated with ICT use (Gil-Flores et al. 2017). Informal collaboration seems to be particularly important for interactive activities (Cattaneo et al. 2025b). In addition, support from school principals, for instance through a transformational leadership approach, has been identified as relevant for technology integration (Schmitz et al. 2023). Principals are also considered to play a role in school readiness for technology integration, which in turn affects teacher readiness (Petko et al. 2018).

Within the contextual dimension, professional development for teachers can be mentioned (Gräsel 2010). Teachers who perceive high training needs in this context tend to

use technology less frequently (Gil-Flores et al. 2017), and a lack of training can act as a barrier to teachers' use of digital technologies (Mercader and Gairín 2020). This underscores the pivotal role of teacher training, providing an opportunity to prepare (future) teachers for the effective utilization of technology (Tondeur et al. 2019). Another contextual characteristic relates to time resources. Perceived high workloads and lack of time can be barriers for teachers to engage more extensively with technology in their instructional practices (Watty et al. 2016; Mercader and Gairín 2020). For example, in the context of integrating 3D printing, a shortage of time for detailed planning of technology use and insufficient time to provide instruction to students on how to use it effectively are identified as challenging (Cheng et al. 2024).

Building on the preceding discussion, the present study draws on different dimensions to explore facilitating and hindering factors influencing teachers' intention to use an office simulation in commercial teaching practice (see Fig. 1). These include characteristics of the office simulation, teacher-related characteristics, school-related characteristics, and contextual characteristics. In addition, perceived learner characteristics are considered as a further dimension. Although perceived characteristics of the office simulation may implicitly involve learner-related considerations, a distinct category allows for explicitly capturing learner-related aspects from the teachers' perspective.

Method

Context of the study

This study aimed to explore vocational trainee and in-service teachers' intentions within the business domain to implement the digital office simulation LUCA into their classroom practices, along with identifying relevant determinants. The LUCA office simulation (see Rausch et al. 2021; Gentner et al. 2024[1]) is a computer-based environment and open educational resource developed for business education. It exemplifies scenario-based learning by integrating principles from the 4C/ID model, self-regulation and self-organization of learning processes (Zimmerman 1990; Zimmerman and Schunk 2011; for an overview, see Sitzmann and Ely 2011; Panadero 2017), as well as simulation-based learning (Cook 2014; Chernikova et al. 2020) and scenario-based learning (Errington 2010, 2011), rooted in situated learning and cognition theory (Brown et al. 1989; Cobb and Bowers 1999). The office simulation supports authentic learning scenarios where

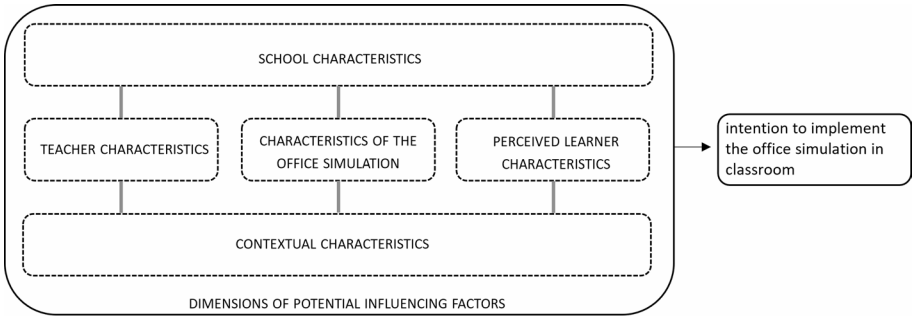

Fig. 1 Conceptual framework outlining the dimensions of potential influencing factors for the implementation of the office simulation

[1] First findings from ten initial interviews, part of the broader study discussed here, were published in Gentner et al. 2024a. This study expands on this by utilizing a larger sample, investigating additional research questions, and conducting more detailed analyses.

learners work on tasks (work scenarios) that replicate real-world challenges. The work tasks are embedded in a simulated model company, enabling learners to adopt the perspective of employees and thereby enhancing the relevance of the scenarios. Interactions with simulated colleagues via email further contribute to an authentic workplace experience (Braunstein et al. 2022). Each scenario begins with an email from a fictional supervisor assigning a task and concludes with learners submitting their solutions via email. Learners identify and process relevant information from multiple data sources using tools commonly used in professional settings, such as ERP systems, spreadsheet software, calculators and email clients. Based on processed information, learners make and justify decisions and communicate these decisions adequately. A typical example of a business task that can be represented within such a scenario is the selection of a supplier. Learning processes are closely monitored through real-time log data analysis, enabling the system to automatically trigger prompts if learners encounter challenges or fail to complete certain steps on time. These prompts, delivered as predefined emails, provide tailored hints or additional information to support learners (Ludwig et al. 2024). Teachers are equipped with a dashboard that offers a real-time overview of learners' workflows, enabling them to monitor progress and provide individualized support as needed. Teachers can create their own scenarios or modify scenarios from a shared pool to meet specific learning objectives, allowing for flexibility and customization.

A crucial prerequisite for exploring trainee and in-service teachers' intentions and the determinants of implementing the office simulation was ensuring that they were familiarised with the office simulation and had the opportunity to explore its functionalities. This was accomplished through workshops offered to both trainee and in-service teachers.

On the one hand, these workshops occurred in a digital setting, utilizing virtual video conferencing, and interested teachers could register for the free introduction to the simulation-based environment. On the other hand, for a cohort of trainee teachers, an in-person workshop was offered as part of their formal teacher training. The decision to offer two formats was based on organisational and accessibility considerations. The online format was effective for reaching in-service teachers due to its scheduling flexibility and voluntary participation. The in-person workshop aligned well with the training context of trainee teachers, where access to participants was most feasible.

In both the digital and the in-person workshop, participants were initially given the opportunity to acquaint themselves with the office simulation as perceived by VET students. This involved working through an exemplary work scenario. Subsequently, they received additional information on didactical possibilities and software functionalities. Following this, participants were guided through the process of creating work scenarios and had the chance to independently experiment with various functions. Participants also had access to supplementary multimedia information material that provided additional guidance on using the office simulation. In the in-person setting, trainee teachers additionally worked in groups to develop a scenario, as this activity was integrated into the design of the on-site workshop. In alignment with the study's objective, the workshop participants – having gained insights into the office simulation through their hands-on experience – constitute the study's target group.

Sampling

The study took place in Germany, where teacher education generally consists of earning a university degree followed by a preparatory teacher traineeship. This traineeship is a practical training program combining in-school experience with reflection processes at a teacher training academy, emphasizing teaching competence and typically lasting 18–24 months, depending on the state (Deissinger et al. 2018). Individuals undergoing this phase are referred to as trainee teachers, while those who have completed it are described as in-service teachers.

To obtain the sample, participants in the workshops introducing the office simulation were briefly informed about the project. Subsequently, they were invited to take part in the interview study. A total of 28 individuals agreed to participate, yielding a participation rate of 19% among in-service teachers and 58% among trainee teachers. The final sample comprises 14 in-service teachers and 14 trainee teachers from vocational schools, all of whom teach business studies/commercial subjects. The sample size was deemed adequate because recurring themes indicated saturation and comparable group sizes allowed meaningful contrasts. The participants include 15 females and 13 males, with the in-service teachers group consisting of 6 females and 8 males, and the trainee teachers group comprising 9 females and 5 males. The average age of the in-service teachers was 45 years, with the oldest participant being 62 and the youngest 31. For the trainee teachers, the average age was 29.3 years, with the oldest participant being 36 and the youngest 26. The in-service teachers had professional experience ranging from 2 to 34 years. Eight participants had between 2 and 13 years of experience, while 6 participants had more than 19 years of experience. The trainee teachers were all still in the first year of their teacher training.

At the time of the interviews, some participants had already used the office simulation in their teaching, whereas others had only participated in the introductory workshop. This aspect was considered during the analysis. No systematic thematic differences emerged between these groups; therefore, the data were analysed jointly. Nevertheless, prior usage experience may have influenced the depth and concreteness of the reported perceptions.

Data collection

To explore individuals' experiences within their real-world contexts, gaining a deeper understanding of their perspectives (Patton 2014), conducting interviews seemed beneficial concerning our interest in capturing teachers' individual perceptions of the office simulation and identifying the factors that influence their intention to implement it in their teaching. Consequently, semi-structured interviews were conducted, providing the flexibility to adapt to the responses of the interviewees (Adams 2015) and thereby facilitating the acquisition of in-depth insights. Participants were asked about perceived facilitating and hindering factors influencing the use of the office simulation, with predefined thematic categories serving as flexible interviewer guidance for possible follow-up questions (see supplementary material for the interview guide). Due to time constraints and varying scheduling processes, the interviews took place at different intervals following the attended workshop sessions, ranging from one to eight weeks after the workshop date. The interviews were conducted online via a video conferencing platform or via telephone. All interviews were recorded and transcribed, with the language slightly

smoothed for better readability (Mayring 2014). On average, the interviews lasted 24 min, with durations ranging from 14 to 46 min.

Data analysis

The transcribed interviews were analysed using the software MAXQDA and applying the qualitative content analysis (Mayring 2014). The overarching categories of influencing factors are based on the previously mentioned five dimensions of determinants (see Sect. 2.2), with additional subcategories emerging inductively from the dataset. The analysis involved distinguishing whether the discussed aspects were perceived as facilitating or hindering to the implementation process. In this manner, a coding manual was developed (see Table 1 for a excerpt from the coding manual and refer to the supplementary material for the full version). The Cohen's Kappa coefficient, calculated from the coding of 50% of the data by two raters, exceeded 0.78, indicating an acceptable level of inter-coder reliability. In addition, to uncover potential differences between trainee

Table 1 Excerpt from the coding manual

(Sub-)Category	Coding rule	Examples
Facilitating factors: Characteristics of the office simulation		
Instructional possibilities	Coded when specific characteristics, functions or benefits of the office simulation are discussed as facilitating. This includes technical or pedagogical features. Exception: If the main focus of the statement pertains to the specific characteristics of the following categories, it is coded accordingly in that category	Aspects such as enabling "holistic learning", "the processing of complex tasks", "variety for the students", "self-organised learning", and "reduces workload for teachers during lessons".
Authenticity	Coded when the authenticity (closeness to reality) of the office simulation is discussed as facilitating. Both general statements about authenticity and statements about the authenticity of specific tools or work scenarios/processes are coded	"I like these prompts. The ability to interrupt the process is in line with actual practice."
Sharing community	Coded when the possibility of using existing materials, providing own content or collaborative creation of content is discussed as facilitating	"And overall, the idea that it is open source, that one shares teaching ideas, that one can also see what other colleagues have done in these areas."
Ease of use	Coded when user-friendliness is discussed as facilitating. This includes, for example, aspects such as the simple handling of functions or an intuitive user interface, both for teachers and learners	"There is really very little you can do wrong. The advantage is that this software is relatively intuitive and user-friendly."
Differentiation and support options	Coded when the opportunities for differentiation and support within the office simulation are discussed as facilitating. This encompasses the consideration of the individual needs of the students (such as provision of different materials, adaptation of difficulty levels, feedback options)	"In particular from a didactic perspective, the simulation appealed to me because it offers these possibilities for differentiation that are otherwise only possible with significant interruptions in traditional lessons."
Context of development	Coded when the development of the office simulation as part of a university research project is discussed as facilitating	"Basically, that is of course always a good source for software where you can actually assume that it is compliant with data protection regulations, that it is well thought out, that it is scientifically proven, what is there."
Other	Coded when there is another statement referring to facilitating characteristics of the office simulation that cannot be categorised in the previous categories.	

and in-service teachers, the number of coded determinants was evaluated and compared across both groups.

Findings regarding the implementation of an office simulation in teaching practice

In the analysis, teachers' references to technological features, didactic potentials, and contextual conditions are treated as interrelated aspects of their implementation reasoning. From the teachers' perspective, these dimensions may not be clearly separable, as perceptions of the software are closely linked to assumptions about its pedagogical use and feasibility within existing school infrastructures. Against this analytical background, most participants expressed a generally positive disposition towards implementing the office simulation; 27 out of 28 participants indicated that they could principally imagine using it in their future teaching. However, both facilitating and hindering factors were identified, and the distribution of codings across the different categories is shown in Fig. 2. In total, 278 codings were generated for the in-service teachers (per interview: M = 18.86; SD = 5.35; min = 9; max = 31) and 342 codings for the trainee teachers (per interview: M = 24.43; SD = 8.17; min = 16; max = 48). The following sections describe teachers' perceived determinants, beginning with the findings across both groups (RQ 1) and then highlighting differences between trainee and in-service teachers (RQ 2).

Facilitating and hindering factors (RQ 1)

In total, 408 codings were obtained regarding facilitating factors to the implementation of the office simulation in teaching practice. More than half of these codings (232) fall into the category of the characteristics of the office simulation. Given the occasion of the interview was the office simulation and its novelty, this does not seem surprising. This category encompasses both perceived technological features and anticipated didactic potentials. From the teachers' perspective, these aspects are closely intertwined and jointly inform their implementation decisions. Predominantly the instructional possibilities are appreciated. The teachers particularly rate it as varied, as it is "a different approach for the students, to engage with the course content in a different way" (IST6, l. 42)[2]. This variety is also seen as a motivational incentive for learners:

> *"I actually believe that it's more varied and exciting for the students when they can click around and receive the emails themselves, rather than simply just being presented with material" (TRT4, l. 12).*

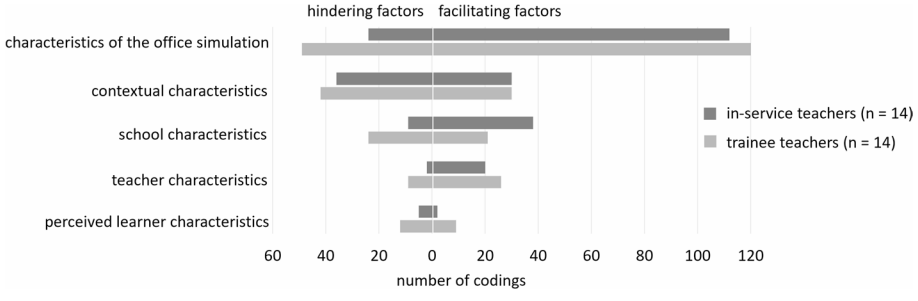

Fig. 2 Number of codings for facilitating and hindering factors within different categories

[2] IST denotes an in-service teacher; TRT signifies a trainee teacher. The subsequent numbers indicate the interview number and the specific line within this interview.

While such statements may appear superficial at first glance, they reflect teachers' broader expectations regarding learner engagement, self-directed activity, and the departure from predominantly teacher-centred instructional formats.

In addition, the possibility of independent and self-organized processing of complex scenarios by learners is emphasized, which can promote these skills and reduce the workload of teachers in the classroom. The opportunity to acquire digital skills in a simulated environment, which are also of central importance for the requirements of future workplaces, such as communicating by email, is also seen as beneficial:

> *"This email writing is superb because they really need it as a skill" (IST13, l. 34).*

Furthermore, the trainee and in-service teachers appreciate the level of authenticity of the office simulation. In particular, the e-mail communication and the procedure of work scenarios, beginning with an e-mail and interruptions in the course of the work process, are mentioned as close to reality. From the teachers' perspective, this enables the creation of practical relevance in classroom, offering insights into the world of work and effectively preparing apprentices in the dual system for real-world scenarios:

> *"In the field of office management clerks, this is a realistic situation that is depicted here, where we can create parallels with the reality of the in-company part of the apprenticeship" (IST3, l. 20).*

These insights into business processes in the simulated environment was also described as an opportunity for vocational orientation for students who are still in the process of choosing an apprenticeship.

Furthermore, perceived ease of use plays a role. Participants emphasized the intuitive and understandable handling of the environment. For example, it is described as "easy to get used to" for teachers (IST6, l.12), and its use is also considered to be "absolutely simple and intuitive" for students (TRT12, l.22). Barrier-free access is also seen as a benefit, since no software download and no mandatory learner registration are required.

In addition, the collaborative nature of the platform is valued, as existing scenarios shared by other users can be reused or adapted. Both teachers and trainee teachers described this as facilitating their work. One trainee teacher describes the benefit of this procedure as follows:

> *"I publish my work, I may have put my heart and soul into it, but conversely, I can also draw on the good work of someone else, perhaps someone who already had more experience with the topic and would teach a topic differently than I would, and you can see that well in the platform. How he has structured a task, how he utilized certain things, how he generally approached the subject. I think that's a huge enrichment" (TRT14, l.20).*

Facilitating sharing materials can therefore serve to reduce the own workload and to get inspiration by others. Moreover, the possibilities for supporting learners are mentioned as beneficial, as, for example, automated assistance can be used, making differentiation easier than in traditional lessons.

Participants were explicitly asked whether the development background of the office simulation played a role for them. While some participants perceived its development as part of a research project at a university as a facilitating factor, for example by describing

it as "reputable source" (IST8, l.23), others stated that it made no difference to them as long as it is practically applicable.

Within the contextual category, participants reported that attending the workshop enabled them to familiarise themselves with the software, reduced their inhibitions about trying it out and thus encouraged them in their intention to implement it into their teaching practice. Besides, existing information materials on the office simulation, such as a manual or video tutorials, are perceived as helpful resources for reference when needed. However, some consider the barrier to independent familiarisation to be too high, which is why, for example, a vocational teacher who has already used the office simulation in the classroom describes the workshop as a prerequisite for actual implementation:

> *"I probably wouldn't have tried it without the workshop because I would have found it too much of a hurdle navigating through the entire manual on my own, and I wouldn't have even expected to be able to do it all by myself" (IST8, l. 31).*

On the part of the trainee teachers, the workshop's integration into their teacher training program is also valued as beneficial:

> *"What I like is that we learnt about it during our training, because I didn't know exactly what it was beforehand and I probably wouldn't have explored it otherwise" (TRT4, l. 28).*

Regarding the school characteristics, it can be stated that the faculty plays an important role for the implementation intention. The exchange of ideas and mutual support among colleagues, along with collaborative efforts such as jointly creating scenarios in the office simulation, are seen as facilitating. One teacher emphasizes the significant time commitment involved and therefore highlights the importance of viewing its implementation as a team task for long-term success:

> *"This is a crucial prerequisite for sustainable implementation within the faculty; it's essential that is supported by everyone else, not just by me" (IST3, l.26).*

Additionally, receiving interest and positive feedback from colleagues regarding one's work with the office simulation is also appreciated, highlighting the value of peer support. For trainee teachers, the support of the subject mentor during traineeship, who points out the office simulation and expresses interest in it, proves to be advantageous. Besides the faculty, having the required infrastructure and adequate technical equipment plays a role.

Teacher motivation contributes to teachers' intention to implement the office simulation. The enthusiasm for using new tools and a readiness to experiment with them in the classroom seem essential elements in this process. As one interviewee said:

"Overall, I'm always open to exploring new programs or things like that. So, I would definitely give it a try" (TRT6, l. 10).

Furthermore, positive instructional experiences with other digital tools also appear to be facilitating. For example, one participant confirmed that his previous experiences influenced his intention to implement the office simulation, stating "Definitely, I would say so" (IST10, l. 30).

In terms of learner-related aspects – which here reflect teachers' perceptions and interpretations of their students rather than empirically assessed learner characteristics – the implementation of the office simulation may be influenced by whether teachers perceive that students possess sufficient prior digital knowledge and are open to engaging with the office simulation. One trainee teacher, for instance, articulated this viewpoint in favour of using the office simulation in lessons:

> *"Students are always open to new things, especially when it involves computers, tablets, or anything like that – then they are always happy. That's been my observation thus far" (TRT5, l. 65).*

As far as hindering factors are concerned, a total of 212 codes were generated. The most mentioned obstacle to implementing the office simulation in teaching practice relates to contextual characteristics, particularly to time resources: According to a trainee teacher "the time is already very limited during the traineeship, and that's where the challenge lies" (TRT11, l.46), but it is also a task which "of course comes on top" (IST2, l.30) for in-service teachers. Both in-service teachers and trainee teachers acknowledge the high amount of time required for becoming acquainted with the office simulation and for preparing lessons. The teachers stress the importance of familiarisation with the office simulation, noting that it is a "big tool" (IST4, l. 43) and underscoring the need "to be able to handle such a powerful instrument" (IST7, l.24). It is also emphasized that while the tool is complex, one can extract significant value from it with proficient usage: compared to other tools "you can do a lot more things and you can go into much more depth" (IST4, l.43) and "you can get a lot out of it if you use it well" (TRT9, l. 45). The temporal structures within teaching practice, including the perceived level of the curriculum load and the prioritisation of other topics, restrict the time available for familiarising with and effectively implementing the office simulation.

In addition, there are also hindering factors for the implementation that relate to specific features of the office simulation. These include limited functionalities, such as criticism regarding integrated replications of established office software rather than offering original products, or its lack of tablet compatibility. Additionally, documenting results with students is perceived as challenging. The lack of an integrated documentation feature is criticized (IST3, l.28), as it adds extra effort for teachers: "One would have to come up with additional ideas and material for documentation purposes" (TRT8, l.14). The limited functionalities of the office simulation contribute to the overall picture of the instructional possibilities.

The ease of use is also perceived as demanding, which is mentioned more often by trainee teachers who describe the office simulation or certain features as not being self-explanatory. For example, it is noted that "some terms within the system are not intuitive at first glance" (TRT1, l. 44). Concerns about the collaborative nature are also mentioned, as some materials cannot be used in the environment due to copyright issues or it leads to discomfort if self-developed content is also visible to all other users. It is also noted that the simulated office setting may be redundant for some groups of learners, as they already encounter typical office tasks in their training company.

Other obstacles lie, for example, in the school's infrastructure, with the insufficient technical equipment being criticised and the extra work involved in switching to a computer room. Regarding the teacher characteristics, a lack of teaching experience emerges

as hindering, merely mentioned by two trainee teachers. Due to the lack of experience, the focus initially lies on "coping with everyday school life" (TRT13, l. 40), and it is difficult to "assess the tool's value" (TRT14, l. 12). In terms of perceived learner characteristics, insufficient prior knowledge of students, which impede working within the office simulation, as well as difficulties with self-organised learning was identified as hindering. This indicates that the office simulation may not be suitable for all learners or classes.

Comparison of trainee teachers' and in-service teachers' perspectives (RQ 2)

As shown above, the qualitative analysis of the statements reveals a high degree of thematic alignment between in-service teachers and trainee teachers regarding both facilitating and hindering factors. However, compared to the in-service teachers, the support of their subject mentor during traineeship was identified as an additional facilitating factor for the trainee teachers and the lack of teaching experience as an additional hindering factor (see Sect. 4.1). Beyond this group-specific factors, differences were primarily observed in the number of codings rather than in the substantive content of the statements.

To be more specific: Although the various possibilities and the authentic character of the office simulation are among the top five facilitating factors in both groups, participation in the workshop might be more relevant for the in-service teachers, while for the trainee teachers, their own motivation to explore new digital tools and the opportunity to share instructional materials seem to be more relevant (Table 2). Overall, there were nearly equal numbers of codings for facilitating factors identified in both groups (202 vs. 206 codings) and a Mann-Whitney U-test suggested no statistically significant difference in the frequency of codings between in-service teachers and trainee teachers ($U = 94.0$, $p = .85$; effect size $r = .04$).

For the hindering factors, the group of trainee teachers has an overall higher number of codings (136 codings in total; median codings per interview = 8) than the group of in-service teachers (76 codings in total; median codings per interview = 5). A Mann-Whitney U-test suggested a statistically significant difference in the frequency of codings for hindering factors between in-service teachers and trainee teachers ($U = 47.500$, $p = .019$; effect size $r = .44$). This might indicate that trainee teachers perceive a greater extent of obstacles compared to the in-service teachers. Nevertheless, there is agreement regarding the most prevalent coding for hindering factors, which pertains in both groups to time resources (see Table 3).

Table 2 The five most frequent codes for facilitating factors

In-service teachers			Trainee teachers		
Code	**Codings (*N*)**	**Participants (*N*)**	**Code**	**Codings (*N*)**	**Participants (*N*)**
1. instructional possibilities	36	13	1. instructional possibilities	39	13
2. workshop participation	20	14	2. authenticity of the office simulation	29	14
3. ease of use of the office simulation	20	12	3. motivation for exploring digital tools	20	11
4. authenticity of the office simulation	18	11	4. sharing community of the office simulation	18	9
5. peer support	17	11	5. ease of use of the office simulation	17	9

Table 3 The five most frequent codes for hindering factors

In-service teachers			Trainee teachers		
Code	**Codings (*N*)**	**Participants (*N*)**	**Code**	**Codings (*N*)**	**Participants (*N*)**
1. time resources	32	12	1. time resources	37	11
2. limited functionalities of the office simulation	11	8	2. ease of use of the office simulation	19	8
3. infrastructure	5	4	3. infrastructure	18	11
4. lack of peer support	4	4	4. limited functionalities of the office simulation	15	10
5. ease of use of the office simulation/ perceived learners' skills	4	3	5. perceived learners' skills	8	4

Discussion

Research on technology integration consistently highlights the interplay of individual, institutional, and contextual factors shaping teachers' implementation decisions (e.g., Drossel et al. 2017; Gräsel et al. 2020; Niederhauser and Lindstrom 2018). In line with this body of research, the present study examined teachers perceived determinants of implementing a simulation-based environment in vocational education. In the following, the findings are discussed with reference to existing research on technology integration, teacher beliefs, and implementation processes. It is important to note that the reported determinants reflect teachers' anticipatory perceptions and interpretations rather than empirically validated effects on learning outcomes. These perceptions nevertheless play a crucial role in shaping implementation decisions and therefore constitute a relevant object of analysis in their own right.

We identified several aspects across different dimensions – characteristics of the office simulation, teacher characteristics, perceived learner characteristics, school characteristics, and contextual characteristics – that influence the implementation intentions. Regarding the similarities and differences in the perceptions of trainee teachers and in-service teachers, we found a substantial overlap in terms of content, despite minor differences in the perception of different aspects. For instance, both groups appreciate the diverse instructional possibilities as well as the authentic character of the simulation-based environment and cite time constraints as main barrier to implementation. However, the quantitative results indicate that the trainees might perceive a higher level of barriers. A possible explanation could be that trainee teachers, as digital natives, have higher expectations regarding ease of use and infrastructure, which might explain why these factors were mentioned more frequently by them as hindering factors, while the in-service teachers might have a more pragmatic perspective. The difference could also be attributed to the limited teaching experience of the trainees, as well as other challenges they face during their traineeship, such as being assessed and observed, which may lead to a reluctance to take risks with using a new educational technology. Moreover, the observed difference could potentially be attributed to variations in the groups' overall motivational levels. The in-service teachers participated voluntarily, suggesting higher intrinsic motivation, whereas trainee teachers attended the workshop as part of their teacher training curriculum, which may reflect extrinsic motivation. Despite this limitation, this approach seemed reasonable for reaching trainee teachers.

In line with other findings on technology use in classroom, our results highlight the relevance of various factors, such as teachers' motivational conditions (Backfisch et al. 2020), experience with the integration of technology (Drossel et al. 2017), infrastructure (Gil-Flores et al. 2017) or lack of time as an obstacle (Watty et al. 2016; Mercader and Gairín 2020). This alignment with other findings on factors influencing technology use is unsurprising, considering that the office simulation investigated is itself a computer-based environment.

At the same time, the results of this study are based on a specific office simulation and therefore reflect perceptions related to this educational technology. Accordingly, the findings should not be considered directly generalisable to other simulation-based environments or educational technologies. Nevertheless, the study highlights implementation-related aspects that may be relevant for integrating other innovative educational technologies. Against this background, the following practical implications can be derived:

Firstly, it should be ensured that the educational technologies provided are appreciated and considered beneficial. When it comes to office simulations, particular emphasis should be placed on ensuring an authentic character.

Secondly, integrating a variety of instructional possibilities can be beneficial in this regard. Besides the characteristics of the educational technology, factors at the teacher and contextual level should also be considered. Strengthening teachers' attitudes and their early experiences with educational technologies may require targeted field experiences during their studies. According to Nelson and Hawk (2020), field experiences during the studies of prospective teachers can play a role in forming their beliefs: Observing experienced teachers who effectively and frequently use technology can positively influence their beliefs and intentions regarding technology integration, emphasizing the importance of early exposure to effective technology use in teacher education (Nelson and Hawk 2020). In line with this, Çebi et al. (2022) emphasize how pre-service teachers' digital competence develops throughout training, highlighting the value of structured and ongoing support to enhance their skills in integrating technology. In later developmental stages, perceived opportunities for participation during training may shape trainee teachers' emotional engagement (Bottling et al. 2024). Building on this, trainee and in-service teachers should receive a comprehensive introduction to new educational technologies and appropriate support. Sufficient time should be allocated for familiarization and implementation, peer support should be encouraged, and an adequate infrastructure ensured.

One limitation of our study concerns the sample and a potential selection bias. Overall, almost all participants expressed an intention to use the office simulation in the future, and there were considerably more statements referring to facilitating factors than to hindering ones. It is therefore plausible that individuals who had already decided not to implement the office simulation during the workshop were less likely to participate in the interview study, which may have biased the findings.

Furthermore, perceptions of the office simulation may have been influenced by differing levels of prior usage experience. While no systematic differences in the types of determinants mentioned were identified, it is possible that teachers with hands-on experience articulated more concrete concerns. Future studies could explicitly differentiate

between prospective users and experienced users in order to further examine how usage experience shapes implementation-related perceptions.

It is also important to note that learner-related aspects identified in this study are based exclusively on teachers' perceptions and should therefore be interpreted with caution. They reflect subjective assumptions rather than objective learner characteristics and may be influenced by teachers' prior experiences, beliefs, and instructional preferences. While such second-hand perceptions cannot provide valid insights into learners' actual dispositions or competencies, they are nevertheless relevant from an implementation perspective. Teachers' assumptions about learners' motivation, digital skills, or capacity for self-regulated learning may shape their willingness to adopt and use new educational technologies, regardless of whether these assumptions accurately reflect learners' experiences.

The varying time intervals between workshop participation and the interviews may also have shaped the nature and form of the participants' reports. Additionally, the workshops differed slightly in format (digital versus in-person) and structure, although the target technology remained consistent throughout and the trainer (who also served as interviewer) was the same in both settings. The in-person interaction may have fostered a greater sense of familiarity, which may have encouraged trainee teachers to be more talkative in the interviews. Furthermore, the trainer's dual role as interviewer constitutes a potential source of bias, particularly in terms of socially desirable responding. Potential differences between the two workshop formats were not analysed, and both were considered to provide a comparable introduction to the office simulation.

Furthermore, the perceived influencing factors within the category 'characteristics of the office simulation' encompass both perceived technological aspects and didactic potentials, which are closely interrelated. However, insights into the exact subject-specific use and curricular alignment of the office simulation are limited, as this was not a focus of the interviews.

Additionally, it should be noted that our study focused on behavioural intentions regarding implementation, and we can therefore provide only limited or no insights about actual behaviours. A valuable area of investigation would be the sustainable use of the office simulation in the classroom and its incorporation into teacher's educational technology repertoire. Future research could investigate the implementation of other innovative educational technologies, further exploring the differences between trainee teachers and in-service teachers. Apart from the frequency of use, it would also be of interest to explore how teachers utilize the office simulation for teaching purposes and to examine the instructional quality. For evaluating the quality of the (planned) implementation, analysing detailed lesson plans drawn up by trainee teachers and in-service teachers could be valuable (for a study that investigated lesson plans of novices and advanced teachers in the context of technology-enhanced mathematics teaching, see Backfisch et al. 2020).

Conclusion

This study examined vocational teachers' perceived facilitating and hindering factors related to the implementation of a computer-based office simulation, with a particular focus on perceived differences between trainee and in-service teachers. By adopting a qualitative, perception-based approach, the study provides insights into how teachers

make sense of a specific simulation-based environment within their instructional and institutional contexts.

The findings highlight that implementation intentions are shaped by an interplay of perceived technological characteristics, didactic potentials, individual dispositions, school-related conditions, and contextual constraints. While trainee and in-service teachers largely referred to similar determinants (e.g., perceived instructional possibilities as facilitating factors and time constraints as hindering factors), trainee teachers tended to articulate a higher number of perceived barriers, particularly with regard to ease-of-use-related aspects.

Rather than evaluating the effectiveness of the simulation itself, this study contributes to implementation research in vocational education by illustrating how teachers' perceptions, expectations, and contextual considerations inform their willingness to adopt complex educational technologies. Addressing perceived barriers and supporting teachers' sense-making processes therefore appears crucial for fostering sustainable implementation. Although the findings are grounded in a specific simulation-based environment, they highlight implementation-related considerations that are likely relevant for other complex educational technologies in vocational education, particularly those aiming to bridge classroom learning and professional practice.

Supplementary Information

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Supplementary Material 1

Author contributions

CRediT authorship contribution statement: S.G.: Writing – review & editing, Writing – original draft, Visualization, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.J.S.: Writing – review & editing, Resources, Methodology, Project administration, Supervision, Funding acquisition, Conceptualization.A.R.: Writing – review & editing, Project administration, Supervision, Funding acquisition, Conceptualization.V.D.: Writing – review & editing, Project administration, Supervision, Funding acquisition, Conceptualization.

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Data availability

The data will not be shared publicly for data protection reasons.

Declarations

Informed consent

Informed consent was obtained from all participants included in the study.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT and DeepL in order to improve language and readability. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Competing interests

The authors declare no competing interests.

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