From DevOps to TeachOps: An Agile Approach for Instructional Design

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Abstract: The dependence of companies on the education of their employees has positioned human resource development as a strategic asset and a core competitive factor. Instructional design serves a crucial role in optimizing the quality of training and education for sustainable employee qualification. The fast pace of digital transformation demands a new and more agile approach to instructional design, which requires cross-organizational collaboration and the adoption of new frameworks. In response, we propose the TeachOps model, which builds on the principles of DevOps used in software development. The TeachOps model is a new framework for instructional design that enables efficient and continuous HR development. We contribute to the scientific discourse by proposing a new framework that applies DevOps principles to instructional design. Furthermore, we provide practical guidance on how instructional designers can efficiently and continuously provide HR development.

Keywords: Instructional Design, HR Development, Digital Transformation, DevOps

1 Introduction

Digital transformation has made its way into every industry, offering not only enormous potential but also creating a significant demand for skilled workers. Recent studies confirm an overall shortage of qualified staff, especially in the IT sector [Bi23] [KO23]. Companies have only one viable option: to empower their employees by equipping them for the future [Hü23]. The continuous acquisition of knowledge is a key source of competitive advantage for organizations in the 21st century [Sh08]. Modern companies' reliance on their employees' level of education has elevated sustainable human resources (HR) development to a strategic concern, making it a central competency within organizations. Today's global economic conditions are driving organizations to increase productivity with a quantitatively reduced workforce [Ro10]. Consequently, instructional designers face the challenge of developing higher-quality instructional programs to best develop each employee. Despite the importance of investments in education to maintain competitiveness, the initial cost can be prohibitive [MKL14]. Therefore, research on sustainable and responsible instructional design to optimize its quality is essential. Smith and Ragan [SR04]

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state that "the term instructional design refers to the systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources, and evaluation". However, there is no standardized method for this systematic and reflective process, and the limitations of traditional instructional design have already been debated for decades [Ro10]. Today, instructional designers must continuously search for the most suitable method and the latest learning theories in times of ever-changing technological progress [MKL14]. The fast pace caused by digital transformation makes it necessary to discuss and revise traditional HR management. As technology continues to evolve, it opens doors to game-based tools in HR selection [OMK23] and innovative learning formats in HR development [Dr21], facilitating efficient adaptation to knowledge updates in an increasingly digitized and globalized world. Given the dynamic nature of learning content—especially in rapidly evolving fields like computer science—it is unwise to cling to outdated instructional design practices. This challenge requires a new and more agile approach and a revision of traditional frameworks for instructional design. It demands cross-organizational collaboration that involves much more than the effective arrangement of human activities. Collaborative practices need to be animated and filled with meaning [VKN20]. Instructional designers often fail because instructional design takes too long to implement [Bi05] [GZ00] [Ro93]. Roytek [Ro10] criticizes research on this topic for not focusing enough on instructional design efficacy and Schwier et al. [SCK04] state that prior research had a higher conceptual focus and built less on insights from instructional design practice. Other sectors such as software development have already responded to similar challenges by adopting agile frameworks such as DevOps to manage complexity caused by rapidly changing markets and deliver software efficiently and continuously [Ki21]. In the following, we demonstrate how the principles that emerge from DevOps can also be applied to HR development to address the criticism of traditional, slow-moving instructional design processes that do not invest sustainably in employee qualifications. We propose a framework that builds bottom-up on the practical experience in the field of instructional design and top-down on the successful DevOps model from software development and answers the research question: *How can we design HR development efficiently and continuously?*

Our paper is structured as follows: the next section provides an overview of DevOps and prior research on how DevOps has been used to improve HR development processes. Then, we describe our methodology, which involved analyzing contemporary instructional design practices through ten interviews, with the findings mapped onto DevOps principles. Next, we present our findings in detail by outlining five instructional design steps identified from the interviews and applying them to the DevOps principles to propose the TeachOps model. In this way, we make a theoretical contribution by proposing a novel framework that leverages DevOps principles in instructional design. Moreover, we provide practical guidance on how to sustainably enhance HR development in practice.

2 DevOps to Revise Instructional Design

Despite the popularity of DevOps, there is still no common definition [GP22]. Humble and Farley [HF10] state that DevOps is based on two main principles. First, it focuses on the collaboration of development and operations, and second, it emphasizes the use of agile principles and automation tools for the continuous delivery of software. According

to Thomas et al. [Th17], the foundations of DevOps reside in the agile movement. Kim et al. [Ki21] detail DevOps guiding principles as three ways, which resemble flow (the first way), feedback (the second way), and continual learning and experimentation (the third way). As a first and fundamental principle of DevOps the flow, grounded on the idea of the value stream, is characterized by many tools supporting digital change. For instance, the utilization of Kanban, a management methodology for lean production [Li04], serves this purpose in multiple directions as it makes work visible, encourages a reduced batch size, improving the flowrate, and limits the number of parallel tasks for each person by the pull principle and a work in progress limit. It also visualizes where bottlenecks are, which directly enables the reduction of these, to achieve a permanent improvement in terms of speed and quantity, and therefore the improvement of the value stream. Other approaches in the pursuit of an improved flow are the reduction of handoffs, as they are always time-consuming and inhibit knowledge loss, and the early prevention of defects to ensure high quality. The second way is a seamless continuation focusing on the principle of feedback. It directly helps to prevent these defects from congesting the value stream by enabling a fail fast-methodology. The many ways of feedback are characterized by the different sources which result in different cycles. The sources are developers with immediate response and extend to the continuous integration, explorative testing, acceptance tests, stakeholder feedback, and up to the longest cycle: the user feedback. The third way focuses on continual learning and exploration, targeting an organizational change as a cultural change guided by organizational leaders. Their tasks would be the establishment of trust through information sharing and responsible distribution along the value stream. Failure should be seen as an incentive for reflection and further research.

The development of the DevOps principles is a response to an increasingly complex business world from a software development perspective. We apply the DevOps lens to address current challenges in HR development. The fast pace caused by e.g., digitalization makes it necessary to revise traditional procedural models in instructional design. This will enable instructional designers to respond to the ever-changing knowledge in a digitized and globalized world. Thereby, it is necessary to not only shift to digital learning formats but to achieve a holistic didactic transformation. In the same way that IT and business resources need to be well aligned [WBW14], HR development and business resources also need to be well aligned. For this purpose, tools and principles from other domains can be applied. Rowland [Ro93] already pointed out the need to systematically study the process of instructional design, similar to the design fields of architecture and engineering. For example, Jones and Richey [JR00] already applied the rapid prototyping methodology, which originated in computer software program design and manufacturing, to the instructional design practice to reduce cycle time. The application of this software development technique in education was successful and they were able to provide HR development more efficiently. Taking elaborated Action Design Research [MH19] into account, which shares numerous attributes with the DevOps methodology, this cyclic methodology has even been proven successful in a multiyear project targeting instructional design [DMA22]. In previous research, the DevOps framework, in particular, has rarely been applied to the education domain. One example is Simpson et al. [SEB19], who used DevOps tools to create, deploy, and share cybersecurity labs based on learning theories to improve student learning. Particularly for cybersecurity topics, it is necessary to access new learning content quickly, as content can rapidly become outdated, making DevOps

an appropriate framework to apply. In the next chapters, we will use the DevOps framework to quickly provide HR development on any topic.

3 Method

Our approach aimed to develop a new sustainable instructional design framework that fits into a rapidly changing and technologically advancing business world. On the one hand, we examined current instructional design practices from ten interviews, and on the other hand, we drew inspiration from the DevOps success story in software development. Our approach follows an inductive and deductive qualitative research approach. Essential steps in the instructional design process emerged from an inductive bottom-up analysis of interview data. These steps were then deductively applied top-down to the DevOps framework.

Interviewee	Duration	Industry Sector
#1	31:08	Public Transport
#2	44:16	Aviation
#3	38:20	Print Media
#4	52:28	Research
#5	29:05	Consulting
#6	39:15	Software Development
#7	40:35	HR Development Freelance
#8	35:10	Customer Experience Management
#9	31:23	Consulting
#10	31:03	Publishing

Tab. 1: Overview of the interviewees

To gain insight into instructional design practices, we conducted ten interviews with individuals working in HR development in German organizations across various industries (Tab. 1). The interviews lasted 29 to 52 minutes, were carried out between 02/12/2021 and 05/01/2022, and followed the guidelines of Myers and Newman [MN07]. To give the interviewees a feeling of comfort and minimize social dissonance, the group of people participating was limited to two researchers. One researcher primarily conducted the interview and the second took the observer role to increase the reliability of the findings. We conducted the semi-structured interviews using an interview guideline that included open-ended questions and aimed to identify the steps of the instructional design process. The semi-structured interview guideline allowed us to flexibly adapt to the interviewees' positions and the industries to which their companies belong. The first questions aimed to introduce the interviewees and describe their positions and roles in their organization. Then, the focus was on discussing the process of how they typically plan an intervention to identify the steps of instructional design. Interviewees imagined a specific situation in which they had recently planned an intervention. They used this specific situation to discuss each step in detail. Finally, we asked if there were any situations in which the planning process was done differently to uncover variations in the instructional design process. We recorded, transcribed, and abductively coded the interviews in MaxQDA[6]. The main concern of the abductive approach is theory development through the discovery of new

[6] We used MAXQDA 2020 (VERBI Software, 2021) for data analysis.

variables and relationships [DG14]. In our case, we examined when each step in the process of instructional design occurs and how they are interrelated. In the first round of coding, two researchers looked at the interview data and conducted open coding related to the theoretical themes presented as process steps [Sa16], [Ku14]. In a second round of coding, we discussed the assignment of themes, selected representative quotes, and translated them into English.

4 The Steps of Instructional Design

Analyze. The first step in instructional design is the initial analysis. While prior research often focuses on what is being analyzed [Co06], [WS05], [WS01] the interviewees did not specifically address what aspects they were analyzing. Most of the interviewees stated that they do not work with a structured checklist, but rather conduct their analyses spontaneously and based on their gut feeling: “It's also a gut feeling. What do people like? What do they respond to? If you've been with the company for a while, you already know a little bit about the reservations they may have expressed at previous training sessions.” (Interviewee 8). The only checklist-like aspect is the initial analysis of costs in a very rough form. Furthermore, the interviewees mentioned specific methods of how the analysis is conducted: "In a large company, if the client doesn't know the topic yet, I usually use a survey for the participants first, then an interview, and then from time to time we do a workshop together on the relevant topic." (Interviewee 2). In addition, interviewees made a clear distinction between analyses conducted by speaking with the principal and those conducted by addressing the target audience of the intervention.

Design. The second step of the instructional design process involves the design of the intervention. Factors influencing the decisions made in this step include the goal, the target group, availability of time, and the trainer of the intervention. According to the interviewees, each trainer should consider his or her personal strengths and weaknesses in the design step: “It's also an important point to think about what feels natural to me. For example, if I hold back, give people speaking time and so on. Then I feel out of place.” (Interviewee 4). Furthermore, organizational characteristics such as company size, shape, and learning culture influence the design of an intervention. One of the most important actions in the design step is deciding on a learning format. The interviewees distinguish between analog, digital, or hybrid formats and between individual and group-level formats.

Develop. Interviewees name three sub-steps in developing an intervention: finding content, selecting content, organizing materials necessary for the intervention (e.g., room, beamer, and internet connection), and revision of materials. To find content, interviewees mentioned various channels they currently use. These include internet research, e.g., via Google search, exchanging ideas with colleagues, going through content provided by training agencies, and their personal materials from past interventions. Thereby, this search for learning content is presented by the interviewees as not very structured: “I research on the internet. Well, not on any specific websites. But just in... search engines (laughs).” (Interviewee 5). To revise their selected materials, interviewees mentioned various formative evaluation methods. They use formal methods in the form of test runs with one or more test candidates and informal methods by mentally going through their intervention or asking a colleague for informal feedback. The principal of the intervention is

also often involved in feedback loops to revise materials.

Evaluate. A major gap between research and practice exists when it comes to the summative evaluation of an intervention. One of the best-known frameworks for summative evaluation calls for measurement at four levels: trainee reactions, trainee learning, change or improvement in trainee's subsequent job behavior, and improvement in organizational-level results [Ki75]. In our ten interviews, however, only the level of trainee reaction was addressed: "What I have also noticed in the work context is that there is a strong focus on evaluating participants' satisfaction. How satisfied were they with the course and maybe with the trainers? How competent was the trainer? And so on. [...] That's nice, but the bottom line is that the training is supposed to have an impact. It's actually more important to evaluate the success of the training and the transfer, and not whether they are satisfied with this half day. And in my opinion, companies don't do that very often." (Interviewee 9).

Manage. In this step, the people involved in the process clarify initial organizational tasks. This includes agreeing on terms, such as where the intervention will take place, how many people will participate, and how much time is needed. Another aspect that needs to be negotiated in this step is the cost of the intervention. Interviewees stated that this aspect is of great importance: "Of course, agreeing on the terms of the contract is one of the most important things that need to be clarified from the very beginning so that there are no misunderstandings later on." (Interviewee 7). In addition, responsibilities must be defined. The principal, the departments of the organization, and the service providers agree on who is responsible, for example, for the rough and fine conception of the content and who is responsible for organizational tasks such as sending out invitations. Interviewee 1 vividly described his responsibilities in instructional design using the metaphor of planning a music concert: "*In human resource development, we are the ones who organize the concert. That means we are not the musicians performing, and we are not the audience sitting in front of the stage. But we provide the stage, we make sure the equipment is there, we do the advertising, and we get all the people together beforehand to put this whole thing together. We sent out the reminders. Well, we coordinate everything else to make sure it all works out. But we're usually not the ones creating the learning content.*"

5 From DevOps to TeachOps

In this chapter, we propose the TeachOps framework developed for instructional design. Equally as for DevOps, originating from software development, the concept of "development" also has a central meaning for instructional design, addressing questions such as: "What are the topics that they are concerned with? What are topics that they need in their further development, where they still see potential in themselves?" (Interviewee 1). The core meaning of the concept implies improvement and progression. Therefore, it is never reached by a singular activity, it must be sustainably embedded in a continuum of activities. As the interviewees state, there are always some previous events and some future events as well: "So most of the training we do is actually recurring" (Interviewee 8). To address this continuum, we need to acknowledge the paradigm shift that has already taken place in the software industry with the introduction of DevOps [SC18]. TeachOps proposes to link specific HR interventions to their corresponding organizational consequences

and vice versa, to reduce the discrepancy between the common expectations of training results and the real implications of job performance [ON11]. For a more efficient procedure, analogous to DevOps [AL19], the continuous integration of education into the day-to-day operation plays an essential role in TeachOps. In addition, learning from past mistakes and continuous improvement of the overall instructional design promote the successful integration of TeachOps.

The DevOps lifecycle repeats distinct steps which are attributed to the development and operations departments [AL19]. We took this DevOps lifecycle as a blueprint for the construction of a TeachOps lifecycle. Although it seems to be only a transfer from the software domain there are certain challenges. DevOps had naturally some years to mature towards an accepted framework guiding organizational transformations. Moreover, DevOps targets software and affects highly technical affine people who are even able to create the appropriate tools for themselves. In a direct comparison, this could limit the potential for a fully automated TeachOps. It will take more time to establish such a sophisticated level of automation which is incorporated into DevOps. Nevertheless, there is great potential for the successful implementation of a didactic transformation. From an overall perspective, TeachOps, comparable to DevOps, features two alternating main phases, named “Teach” and “Ops”. Where in DevOps two formally distinct departments development and operations get fused, we merge the instructional design given by didactic experts with HR (Fig. 1). Both phases are closely tied to distinct roles that represents the main actors during the whole process. The "Teach" phase is led by the instructional designer, who plays a central role in orchestrating the educational aspects. On the other hand, the "Ops" phase is primarily overseen by the HR staff, responsible for managing all interventions. This association aligns with their roles as HR professionals are instrumental in overseeing the operational aspects of the process. This iterative framework promotes a holistic perspective in which interventions are no longer seen in isolation. Instead, they occur within specific contextual conditions and influence future interventions.

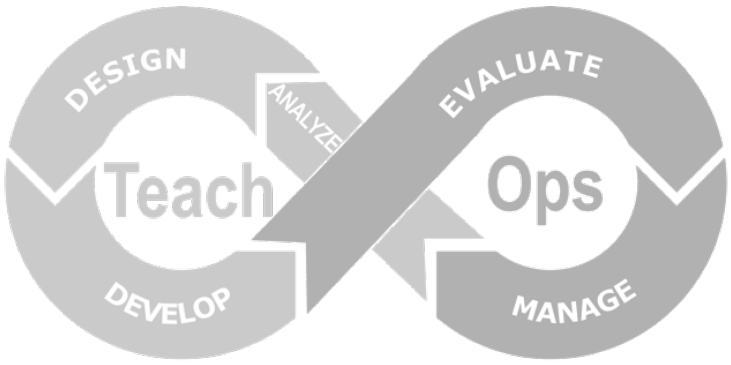

Fig. 1: Conceptual lifecycle of TeachOps

We outline the appropriate tools for implementing TeachOps for each step (Tab. 2) and begin our examination of TeachOps at the step **analyze**, which aims to gather a holistic picture of the current situation and give a forecast regarding changing requirements. This step can be supported by technological implementations such as analytical dashboards and

job profiles linked with corresponding competency models. Going beyond the current situation even a skill demand forecast is possible. A prerequisite involves the creation of learner profiles, characterized by dimensions like skills and experience. A data warehouse enables data aggregation and further reporting, both features are necessary to support this step from the technological perspective. The step **design** deals with the generic construction of a learning course. It needs a lot of educational experience to consider the appropriate didactic formats. A knowledge management system inside the company helps formalizing and keeping specific knowledge. Additional opportunities for this step arise from the use of AI tools, for example by suggesting format choices or serving as idea generators or creative tools [SB23]. Every input from the didactic expert should get digitized and fed into the knowledge base. The **development** step means the final arrangement of specific teaching materials, culminating in a learning course, stored in a learning management system. Here, a content base with links to content providers is of great value as content production is expensive and more structured guidance has a practical impact. Generative AI for content creation is of equal use. Enabling feedback mechanisms across the previous steps enhances overall refinement, particularly in cases where responsibilities are shared between HR and didactic experts. The actual execution of the intervention may be either guided by an instructor or carried out as digital learning elements for self-guided education. The **evaluation** of an intervention ensures high quality and should be grounded in rigorous scientific methods. Ideally, multifaceted evaluations with an automatic connection to the skill model of each learner are possible. The corresponding measures and indicators must be defined appropriately. Software supporting this step would enable on one hand the data collection, for instance by providing online surveys, and on the other hand the data visualization, for instance through key performance indicators served by an analytical dashboard already introduced in the first step. All running interventions should get measured and provide meaningful insights from their execution. Typically, this will be best delivered by software products enabling learning analytics, which measure learning success in an automated way. This step is not limited to these metrics, as from another standpoint it is essential to monitor the skill demand of the organization for a timely reaction when changes in these demands happen. As well it is fruitful to get insights into the efficiency of the instructors to fuel a process of continuous improvement. The **manage** step enables the connection between certain interventions from the past and the future. Interventions are in the context of the organizational schedules and their interrelation plays a huge role, concerning the feasibility of their planning. During the execution of the intervention, all people must be there and all digital and non-digital tools and materials for presenting, and teaching must be in place and accessible. Moreover, an orchestration of an entire program of instructions is possible. Many parallel interventions lead to huge demands in resource management. From an organizational point of view, classic project management tools could help in this step, especially in the aspect of resource management. However, as pointed out above, collaboration is key for project management. Thus, it is necessary to integrate modern collaboration tools for instance [Sp21] if they are not already available. Curriculum management should be supported by software but is most likely not covered by all mentioned tools. For that reason, it may be necessary to employ a specialized solution with a close connection to the knowledge-management from the design step for that topic, therefore we suggest a learning management system.

Applying TeachOps can be thought of as the construction of digital learning courses comparable to software artefacts getting constructed in the DevOps world. This results in

Step	Tools
analyze	• data warehouse and analytical dashboard • learner profiles and skill metrics • demand forecast • ticket system or Kanban board
design	• wiki for didactic knowledge management • AI recommender
develop	• content database and content-creating software • generative AI • learning management system
evaluate	• data warehouse and analytical dashboard • learning analytics and monitoring tools • survey tools
manage	• resource planning and project management • scheduling and communication tools • learning management system • ticket system or Kanban board

Tab. 2: Suggested tools for each step of TeachOps

several implications. First, as a real entity, a learning course needs a global unique identifier. Moreover, it should be accessible through a URL, representing a responsive visualization. Responsiveness itself originates from modern web development ensuring the optimal display and behavior on every device. In the TeachOps context, responsiveness takes on an additional didactic dimension, where the learning element is tailored to be user-centric. According to didactic principles regarding diverse learning personalities, it it's the content should with each user's distinct learning style.

Taking a deeper look into the particular activities of HR and didactic experts a processual overview emerges (cf. Fig. 2). There are many drivers for initializing the TeachOps process, usually demand from other departments of the company marks this starting point. This demand could get persisted in a ticket system as a new ticket that serves as a twin for a potential digital learning course. Another more lightweight solution for tracking is a Kanban board. The first part of the analyzing step has a pure organizational character and is performed by HR staff. It is important to setup the framework for the need properly to ensure it can be met. Typically, not all information is known at the very beginning and HR staff has a lot to do gathering the missing information. As soon as the basic questions are cleared and a first idea to satisfy the educational demand exists, there is a handover to the didactic experts who look through their didactic lens in order to complement the analyzing step. In most cases these experts are not available inside the company, they must be contracted. Feedback loops follow each step by default, which ensures full agility through the whole process. As soon as the analytical step is done by both parties, the next design step and as well the development step are both fully in the hands of the didactic experts. Although the result is already a promising digital learning entity, the process itself is still running. Even if instructors are already at work, the evaluation through the didactic experts and HR staff takes place. The final step management helps, setting the singular learning entity into a holistic context.

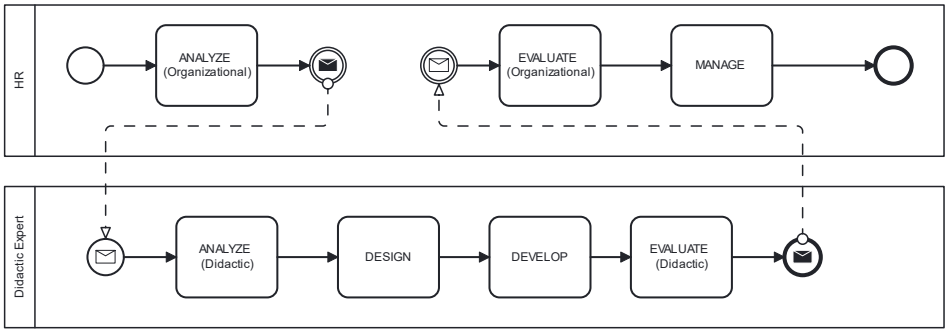

Fig. 2: TeachOps as a process between HR and didactic experts

6 Discussion and Conclusion

The shortage of skilled workers, particularly in the IT sector, has become a concern for organizations. To counter this, companies need to invest in their employees by making them "future-ready" through continuous and sustainable training. Traditional instructional design approaches follow outdated patterns and are not suitable for rapidly changing content and teaching methods, thereby falling short of sustainable HR development. As an effective solution to this problem, we introduce the TeachOps model. Our TeachOps model applies DevOps principles from software development to HR development, presenting a new framework grounded in practical experience in the field of instructional design. It serves as a practical guide that can be used by instructional designers in HR development, following Schwier et al.'s [SCK04] call for research to focus more on insights from instructional design practice. In our study, we investigated state-of-the-art instructional design practices to design HR development efficiently and continuously for sustainable employee qualification. Due to the ever-changing knowledge in today's global economy, optimizing instructional design is becoming increasingly important for organizations to remain competitive [Ro10] [Sh08]. We deductively applied the DevOps framework to make HR development processes more flexible and consequently increase their efficiency. In doing so, we responded to Roytek's [Ro10] request for more research on instructional design efficacy. With the innovation creation driving process enabled by our proposed TeachOps framework, we aim to strengthen the economic sustainability of companies. By investing in the qualification of their employees, companies support initiatives that ensure the long-term sustainability of their business instead of only maximizing short-term profits.

Our proposed TeachOps framework offers a response to our research question on how to design efficient and continuous HR development. On the one hand, we contribute to the project management body of knowledge by proposing a novel framework that adapts DevOps principles to instructional design. By transferring DevOps from its origins in software development to the educational domain, we were able to demonstrate a higher degree of universal applicability to DevOps principles. On the other hand, our results yield practical implications, providing instructional designers with blueprint guidelines for a more efficient and continuous process. In Section 5, we offer practical recommendations for

each instructional design step, including information on the use of appropriate technological tools for support. As in all research endeavors, there are some limitations to our study. With a total of ten interviews conducted, our sample is relatively small. However, while conducting the interviews, we already noticed a theoretical saturation. In addition, the TeachOps framework is still only a theoretical model that needs further validation. Future research should focus on evaluating the practical use of the model. For this purpose, its practical use could be evaluated by calculating the return on investment of implemented interventions. Furthermore, future research should focus on identifying challenges that may arise when using TeachOps in practice. This way, the framework can undergo further improvement. Moreover, future research should investigate what types of organizations specifically benefit from TeachOps. Possibly, the use of agile frameworks in instructional design is dependent on, for example, staffing or time dimensions. Looking ahead, the transferability of DevOps to other sectors should be explored to further test its universal applicability. In a digitalized and rapidly evolving business environment, a measure of agility is required in every domain.

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