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Developing scripted video cases for teacher education: Creating evidence-based practice representations using mock ups

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Video cases are commonly used in teacher education to support evidence-based professional knowledge acquisition. Novice teachers, however, often struggle when learning with video, since they lack professional knowledge schemata that facilitate noticing and reasoning about relevant events. Scripted video case development provides an approach to make relevant events more salient and visible. In alignment with previously reported approaches, we applied relevant design steps and quality criteria within the presented project to promote use in further research. Thereby, we introduce the novel approach of using mock-up settings as a way to identify naturalistic behavior as a basis for script development. User experience (UX) evaluations based on defined quality criteria of realistic experiences (i.e., authenticity), personal relevance (i.e., utility value), engagement (i.e., situational interest), and challenge (i.e., cognitive load) were carried out in a set of four studies including N =423 teacher students. Findings support the conclusion that our design approach resulted in the development of high-quality scripted video cases for further use in initial teacher education.

KEYWORDS

scripted video cases, educational design, teacher education, practice representation, mock-up, user experience evaluation

Introduction

Using video cases has become a commonly implemented and effective approach for evidence-based teacher education, in which research and practice in teaching are closely aligned (Bauer and Prenzel, 2012; Diery et al., 2020). Video cases have shown to incorporate several advantages: they can be viewed multiple times, from various perspectives, and based on varying observational tasks, with the consequence that prospective teachers learn to adaptively apply professional knowledge such as pedagogical (PK) and pedagogical-content knowledge (PCK) to practical teaching situations (*cf.* Gaudin and Chaliès, 2015; Santagata

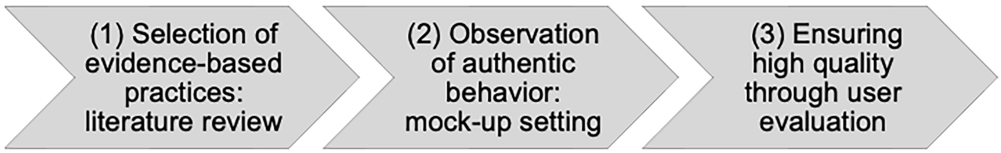

FIGURE 1
Three-step design approach for evidence-based video case development.

et al., 2021). However, research has also identified specific pitfalls to consider, particularly when promoting the learning of teachers who have not yet acquired profound professional knowledge or revised their intuitive theories (Suomala and Kauttonen, 2022). Since professional knowledge guides visual processing, the knowledge limits of teachers often prevent them from noticing relevant events due to the transient flow of information represented in a video case (Chandler, 2004). Particularly, novice teachers need additional instructional support, either from learning scaffolds (such as prompts) or through representational scaffolds (such as salience in video cases), that guide visual processing and professional vision (Fischer et al., 2022). Thereto, theories of multi-media learning in cognitive psychology are of relevance for designing effective instructional support (Derry et al., 2014). In this paper, we focus on the development of scripted video cases as an approach to representational scaffolding.

As instructional time for learning with video cases is often limited in teacher education, video events have to be carefully selected and should represent the most relevant situations, such as core practices of teaching (Grossman et al., 2018; Grossman, 2020). However, specific teaching-learning behavior as well as vivid representations of core teaching situations are often difficult to observe in natural classroom settings. For this reason, some researchers focus on the development of scripted video cases that are carefully designed as representational scaffolds (e.g., Piwowar et al., 2018; Codreanu et al., 2020). Typically, developing evidence-based video cases emphasizes empirically determined situations and events that are particularly relevant for teaching and learning (Dieker et al., 2009; Piwowar et al., 2018). However, by strictly focusing on evidence, video case production might lack authenticity. In order to further optimize evidence-based video case development, additional observations of naturalistic teaching-learning situations might be helpful to create a balance between research-based selection of events and incorporation of authentic teaching and learning behavior (Codreanu et al., 2020).

In this article, we introduce such an approach by implementing a mock-up setting to identify authentic teaching and learning behavior as a basis for video script development. In our example, we apply this approach to the teaching of the human circulatory system in biology education and focus on two evidence-based core teaching practices: eliciting and addressing student (mis) conceptions (Kloser, 2014) and productively managing a small group situation (Ball and Forzani, 2011).Thereby, we chose tutoring as a small group instructional context, since tutoring can demonstrate evidence-based teaching practices from a general as well as subject-specific perspective (Farrell et al., 2022).

As the use of video in teacher education is continuously growing, it becomes more and more important to explicate design steps and principles in order to develop commonly shared standards. In our case, it was particularly beneficial to follow and build upon the systematic knowledge of design steps and principles from Dieker et al. (2009) and Piwowar et al. (2018).

In our project, we applied the following three-step design approach (Figure 1): (1) reviewing literature on elements of core teaching practices and selecting relevant situations; (2) designing naturalistic mock-up settings in order to observe authentic behavior and transfer this authentic behavior into scripts and video cases; (3) ensuring video quality through evaluation of user experiences (UX). With this approach, we aim to contribute to an emerging field in teacher education regarding the use of evidence-based video cases and the development of video production standards. Following the design approach, we explicate the way in which previously determined steps in video case development (Dieker et al., 2009; Piwowar et al., 2018) have been implemented in our project, which aspects have been added, and how the use of a mock-up setting was integrated as an additional component in the design process (see Table 1).

Selection of evidence-based practices

Given the multitude of complex and dynamic teaching and learning processes in a classroom, one main characteristic of professionalism in teaching is acquiring professional vision to notice relevant events for further knowledge-based reasoning (Sherin and van Es, 2009; Seidel and Stürmer, 2014; Van Es and Sherin, 2021). Professional vision is strongly guided by acquired professional knowledge, which is taught in early phases of teacher professional development and makes professional vision highly relevant to consider in initial teacher education (Santagata et al., 2021).

In teacher education, instructional time with student teachers is limited (Bauer and Prenzel, 2012). Hence, identifying the most relevant teaching and learning events as core practices is highly advantageous (Grossman et al., 2018; Fischer et al., 2022). Educational research has identified a number of core practices that

TABLE 1 Design process of scripted video case development in this study based on previous realizations.

Phase / Step	Realization in Dieker et al. (2009)	Realization in Piwowar et al. (2018)	Realization in this study, as well as newly added to the field (A)
Selection of evidence-based teaching practices			
Research review	Selecting evidence-based strategies based on literature review; identifying essential characteristics of strategies.	Focus on typical dysfunctional teacher behaviors.	Review on evidence-based teaching practices for decomposition of practice: tutoring of small groups **(A)**. Review to select evidence-based practices for combinations of PCK and PK **(A)**. Review to select more and less facilitative PCK and PK tutoring practices **(A)**. Decisions: Content: PCK circulatory system, PK classroom management; Setting: 1:4 small-group tutoring; learning phases: elicitation and learning **(A)**
Introductory outline	Outlining key elements of instructional strategy and effective implementation; consulting other researchers.	Select indicators or behaviors derived from real lesson examples.	Development of short introductory texts based on research review **(A)**. PCK: description of four facilitative and four less facilitative PCK tutoring strategies; PK text: description of four more facilitative and four less facilitative PK tutoring strategies; Professional Vision: description of systematic observation elements.
Observation of authentic behavior for video script development			
Design of micro-teaching situation			Design of a micro-teaching situation that represents selected evidence-based practices **(A)** Teaching setting: 4 simulated students, 1 teacher acting as tutor for small-group setting
Training simulated learners			Training of 4 simulated learners who saliently show empirically described student (mis) conceptions regarding the circulatory system **(A)**.
Mock-up study			Carrying out mock-up study with six student teachers and four practicing teachers as participants **(A)**. Task: 30 min tutoring students in understanding the circulatory system, instructional material is provided. 25 min preparation time before going into tutoring task **(A)**. Analysis: Video- and audiotaping of mock-up situation; systematic video analysis of tutoring and student behavior, transcription of selected verbal statements for further video case script development **(A)**.
First draft	Developing scripts of 'best practices' using different types of scripts.	Development of functional and corresponding dysfunctional scripts. Pilot first draft, check with expert mathematics education.	Brainstorming for main scenes to be depicted in each video, based on mock-up observations; further selection of specific tutoring moves as relevant decompositions of practices; orchestrating video scenes in a way that allow for further segmenting and signaling of video clips; writing basic storyline for each video, followed by minute-by minute storyline; selection of usable dialog in mock-up videos that match with scripted tasks and tutoring moves. Revision of dialogues to fit the storyline, adding transitions between scenes. Development of two elicitation and two learning teaching phases scripts, including various elements of more or less facilitative PCK and PK tutoring strategies **(A)** Script dialogues between tutor and tutees are based on observed interactions in mock-up study **(A)**
Script revision	One expert review regarding comprehensiveness, appropriateness, flexibility. One teacher review regarding plausibility.	Several types of reviewers with specific criteria	Ongoing revisions within research group
Storyboard development	Mapping out scenes of lesson (incl. Camera position, teacher, students).	Predefined seating and panel chart, simplified story board; organization of film set.	Scene setting, actor placement and seating.
Internal review	Regular team meetings during each project stage.		

(Continued)

TABLE 1 (Continued)

Phase / Step	Realization in Dieker et al. (2009)	Realization in Piwowar et al. (2018)	Realization in this study, as well as newly added to the field (A)
Video case production			
Video shoot preparations	Equipment needs, technology, teacher, students, and instructional materials. Detailed planning and organization of video shoot.		Training selected student actors, training selected university teacher educators as tutor actors, camera position fixed, film set pre-organized. Shootings with actors in different University locations.
Video shoot fidelity	Recording following predetermined script and storyboard, allowing natural interactions Ensuring that each strategy component is captured		High fidelity due to the fact that tutor actors were trained biology teacher educators. Allowed for natural interactions that slightly vary from script. Marking particularly important lines in the script so that acting tutors and students were able to act naturally but still stick to important lines. Shooting multiple takes for each video segment of the script.
During-shoot procedures	Logging of critical events indicate which were essential or should be cut.		
Editing process	Editing the videos in several stages	Introduction by a preface, closing information	Editing best takes of each video segment together to create the completed video, adding introduction.
Review of video products	Review of final products (external experts, team).		Review of final products (external experts, team).
Streaming	Streaming video models, compressing and buffering files.		Integration of video files into online platform to conduct surveys and experimental studies **(A)**.

leverage the quality of teaching and learning processes in classrooms and positively affect learning outcomes. Joint professional consortia have described several core elements of teaching practice, such as introducing new topics, eliciting student thinking, guiding student learning, managing group work, designing learning tasks, and making assessments (McDonald et al., 2013). These practices have also been specified with regard to subject-specific considerations, such as domain-specific eliciting and challenging student (mis)conceptions (e.g., through cognitive conflicts) and guiding student thinking towards more scientific conceptions in a subject domain (Kloser, 2014).

Video cases have become a relevant instructional tool in teacher professional development to provide authentic examples of teaching practices and promote professional vision (Gaudin and Chaliès, 2015; Santagata et al., 2021). However, video case design is challenging, as complex teaching concepts need to be decomposed in order to achieve manageable learning units (Grossman and McDonald, 2008; Grossman et al., 2009b; McDonald et al., 2013). At the same time, these units with manageable complexity should still provide authentic practice representations and possibilities for re-composition on subsequent higher-order levels of the represented teaching concepts (Codreanu et al., 2020).

As an example, when teaching the human circulatory system in biology education, research has identified a number of typically occurring student (mis)conceptions which can promote or hinder a deep understanding (Van Lehn et al., 2003; Graesser et al., 2011; Dorfner et al., 2019; Scharfenberg and Bogner, 2019; Kramer et al., 2020). This evidence can be used for video case design by presenting students who saliently model these conceptions in their verbal interactions with a teacher (Codreanu et al., 2022). In addition, science education research has identified a number of teaching situations in which these kinds of conceptions can become particularly salient, for example, when teachers elicit and guide student thinking in small group situations (Park and Chen, 2012; Kloser, 2014). Furthermore, facilitative teaching practices in these small group situations have been identified. For example, tutoring strategies from a general perspective can include eliciting students' prior experiences and uncovering possible comprehension problems (Chi, 1996), reacting to student responses with specified questions and feedback (Van Lehn et al., 2003), as well as assessing understanding by encouraging students to further explain their thinking (Graesser et al., 2011). In addition, keeping students engaged by balancing attention between individual students and the group (Kaufman and Holmes, 1996). From a biology education perspective (Dorfner et al., 2019), tutoring situations can cover student-centered content-specific teaching practices. This could include eliciting students' biology-related preconceptions in relation to subject-specific ideas and norms (Chi et al., 2001). For example, in 8th grade

biology education with regard to the human circulatory system, students tend to share the conception that the blood flows back and forth from heart to body. Thus, tutors should recognize these naïve conceptions from a biology education perspective and react appropriately by offering scientific models as alternatives (Kloser, 2014). Moreover, the strategy of evoking a cognitive conflict can help students evaluate their existing beliefs and conceptions (Van Lehn et al., 2003), and checking whether students have made relevant modifications to their thinking and understanding assesses whether learning has taken place or further instruction is needed (Scharfenberg and Bogner, 2019). These described teaching practices represent elements in which teachers need to draw on both pedagogical-content knowledge (PCK) and pedagogical professional knowledge (PK), which are ideally applied to video case stimuli wherein both knowledge components are (simultaneously) integrated (Shulman, 1986).

Selecting teaching practices for scripted video case development also involves decisions with regard to the quality of practices to be represented (Table 1, section 1). Piwowar et al. (2018), for example, focused on the topic of classroom management and selected both functional as well as dysfunctional teaching behaviors for their scripted video case development, with the argument that selecting contrasting cases can help to make subtle teaching behaviors more salient for novice learners. This approach was adapted to our study context by also reviewing and selecting more and less facilitative tutoring practices according to the state-of-the-art as described above. These included the following four PK related tutoring practices:

- generic elicitation of students' conceptions and comprehension problems (more facilitative: eliciting understanding through questions or tasks; less facilitative: not revealed due to a lecture-style instruction);
- generic reactions to incorrect student responses (more facilitative: asking targeted questions and/or providing feedback on student's response; less facilitative: ignoring or overlooking the response);
- assessing student understanding (more facilitative: tutor assessing individually and takes action; less facilitative: students assessing their own understanding from tutor's closed comprehension gauging questions, e.g., "did everyone understand?");
- group focus (more facilitative: keeping all students active and engaged with balanced individual attention, less facilitative: focusing too much time on an individual student while ignoring the rest of the group).

With regard to PCK related tutoring practices, the following four aspects were covered:

- eliciting and addressing students' common misconceptions about the circulatory system (more facilitative: explicitly looking for and addressing three specific misconceptions, less facilitative: ignoring content-specific misconceptions to maintain lecture-style instruction);
- evoking cognitive conflict (more facilitative: trying to evoke a cognitive conflict; less facilitative: no attempt at stimulating a cognitive conflict);
- providing convincing scientific alternatives regarding the circulatory system to students' misconceptions (more facilitative: robust scientific alternatives are explicitly offered; less facilitative: alternatives are not offered);
- checking for modification of students' misconceptions (more facilitative: explicitly assessing for potential modifications; less facilitative: not examining modifications in student thinking, assuming learning took place).

Since these eight tutoring practices often occur either in phases of elicitation at the beginning or in phases of learning in the middle /end of a tutoring situation, these two phases were additionally targeted for contextualizing our video cases.

As an introductory outline we additionally developed short theoretical pre-training texts (Martin et al., 2020), including short summaries of the selected more and less facilitative PK and PCK tutoring strategies. All the texts were comparable in length, structure, and difficulty. The introductory outlines were used as introductory material that can be used as additional theoretically-based information when working with the scripted video cases in teacher education.

As shown in this example, the process of selecting evidence-based practices for scripted video cases is highly complex. Basing it on evidence is a helpful and important way for a clear structuring of the overarching core teaching practice to be represented in a video case, decomposing it into underlying events and units, deciding on variations of selected practices (e.g., more and less facilitative), as well as providing introductory material. In this way, video cases are purposefully and intentionally designed to optimize teacher learning.

Observation of authentic behavior for video script development and production

Next, to an evidence-based determination and selection, scenes in video cases also need to represent authentic teaching practices (Grossman et al., 2009a). In this context, video-based classroom research has provided valuable insights into typical teaching and learning behavior in various school subjects that can serve as a basis for selecting authentic scenes (Janik and Seidel, 2009). However, when looking for specific or particularly leveraged practices, other approaches come into play as these scenes are often difficult to observe in natural classroom situations. One approach is the design of micro-teaching situations for which novice or experienced teachers are asked to perform in a predefined setting with specifically required teaching tasks (Arsal, 2014; Seidel et al., 2015). By designing a comparable teaching setting, the observed variations in teaching and learning behavior can be related and compared in more systematic ways.

In other professional fields, simulations of relevant professional situations are used for case-based learning (e.g., emergency medicine; airplane piloting). Within these simulations,

TABLE 2 User experience of authenticity as indicator for realistic practice representation.

		1 disagree	2	3	4 agree	Mean	SD
Authenticity	E					2.96	0.59
	L					3.04	0.63
Overall, the video model (VM) was credible	E	9.4%	18.8%	50.6%	21.2%	2.84	0.87
	L	7.1%	12.9%	51.8%	28.2%	3.00	0.84
The VM was realistic.	E	10.6%	24.7%	45.9%	18.8%	2.73	0.89
	L	7.1%	20.0%	45.9%	27.0%	2.92	0.87
The VM showed typical behaviors of students.	E	0%	16.5%	44.7%	38.8%	3.22	0.71
	L	0%	14.1%	44.7%	41.2%	3.26	0.70
I could identify with the teacher/tutor.	E	13.0%	28.2%	38.8%	20.0%	2.66	0.95
	L	8.2%	27.1%	41.2%	23.5%	2.79	0.90
The actor/actress performed his/her role as a	E	5.9%	12.9%	49.4%	31.8%	3.07	0.83
teacher/tutor convincingly.	L	2.4%	10.6%	51.8%	35.2%	3.19	0.72
The actors and actresses performed their roles as	E	0%	11.8%	49.4%	38.8%	3.27	0.66
students convincingly.	L	5.9%	16.5%	42.4%	35.2%	3.06	0.87

N = 85, Study 1 Data, Video material: Elicitation (E) and Learning (L) teaching phase.

settings are developed to mimic real-world affordances (e.g., emergency rooms or pilot cabins) (Peavey et al., 2012). Thus, the creation of these simulations requires educational designers to plan and produce an environment which depicts authentic settings and scenarios that fit to the learning aims of the simulation. The use of mock-up settings can offer a frame for the elicitation of these authentic elements to be used in further development of the simulation. The design and use of micro-teaching situations can be viewed in light of such simulation development. A micro-teaching mock-up can provide a simulated setting wherein underlying core teaching concepts can be realized as decomposed yet still authentic scenarios (Codreanu et al., 2022).

In the context of our project (Table 2, section 2), a mock-up setting was used by designing a micro-teaching task which required participants to act as a tutor in a small-group situation. The setting was arranged how students are typically seated in small groups (Farrell et al., 2022; Martin et al., 2022). The task was to support four students in understanding basic concepts of the human circulatory system within a fixed instructional time frame (30 min). The students were simulated learners who followed a coarse script that specified their content-related (mis)conceptions regarding the learning topic; we did not choose a detailed script to allow for "natural" behavior of the students. Each simulated learner represented a different student profile according to research on specific (mis)conceptions of the human circulatory system. For example, student 1 showed a conception assuming that the blood flows back and forth from the heart to the extremities of the body, student 2 had a conception that the circulatory system consisted of one big cycle around the body, student 3 had a conception that there is an upper and lower blood circle, and student 4 had a scientifically robust understanding of the human circulatory system. The students were trained in advance and acted according to the constraints of their assigned role. However, their specific utterances or behaviors were not scripted, and they were free to naturally adapt depending on the tutoring strategies of the participating tutors.

The participating tutors were instructed on their teaching task before entering the mock-up setting. They had a fixed yet sufficient preparation time (25 min) and instructional materials available (e.g., diagrams, texts, writing materials) to plan their tutoring lesson. They were instructed to perform a 30 min. Introductory lesson on the circulatory system, with the goal of an initial overview of the structure and function of the circulatory system. They could use any of the materials we provided or not, and they were free to arrange the lesson as they wanted to, with the only requirement to incorporate at least one interactive group activity and/or discussion. When performing in the mock-up, they were videotaped so their behavior and interactions with students could be systematically observed. Afterwards they received a debriefing and feedback. The mock-up study was carried out with a total of six student teachers and four experienced teachers as participating tutors to ensure a range of more and less facilitative tutoring practices. Based on this sample of 10 participating tutors we started the coding process. If this sample would not have been sufficient to observe appropriate behavior, we would have initiated another round of data collection for the mock-up study.

The verbal interactions and observed actions were used as authentic content for video case script development. Thereto, video and audio recordings were analyzed and suitable verbal interactions between tutors and students were transcribed. Based on the introductory texts we applied an open coding session with the research team looking at a range of potential tutoring strategies based on the literature search. The four most frequent and salient PK and PCK practices were chosen so that a balance of four represented PK and four PCK strategies was reached. Based on the selected more and less facilitative PK and PCK tutoring practices we identified relevant events in the mock-up material. Thereto, the mock-up video material was coded by the research group with regard to their occurrences and classifications of PK /

PCK and more / less facilitative practices. The coding was further validated within the research team. Based on these codes, tutor and simulated learner utterances were identified in verbal transcripts which represented the selected tutoring practices well. Thereby, we could assure that the scripted video cases included authentic behavior and verbal interactions as observed in the mock-up.

In a next step, scripts were developed for the context of elicitation and learning teaching phases. For each phase, we used relevant events and behaviors representing more and less facilitative PK and PCK practices. After writing first drafts for the video case scripts, the research team revised them and included feedback of external reviewers. Storyboards for the production setting were developed and finally several rounds of internal reviews were run. A total of four final scripts were developed, two for an elicitation phase and two for a learning phase. With regard to script development and video case production we followed design processes and steps as implemented in previous approaches (Dieker et al., 2009; Piwowar et al., 2018).

Finally, eight scripted video cases were produced (Table 1, Section 3), including video shoot preparation, ensuring video shoot fidelity, procedures to ensure quality during video shoots, editing process, review of video products, and finally the streaming of the produced scripted video cases. For each of our four scripts, two video cases with varying tutor and student actors were produced (e.g., for having parallel pretest and posttest materials), resulting in a total of eight scripted video cases. Again, for our project, we oriented our production phase along the guidelines of previous approaches (Dieker et al., 2009; Piwowar et al., 2018).

Ensuring video quality through evaluation of user experiences

As outlined in the introduction, scripted video cases can serve as authentic practice representations to be used in various teacher training formats. Particularly in initial teacher education, scripted video cases can serve as learning material to adaptively apply acquired professional knowledge toward practical professional situations. Scripted video cases can be effective for this kind of teacher learning if they meet a set of quality criteria, as they have emerged through UX evaluations and investigations of their relevance for teacher education (Piwowar et al., 2018; Codreanu et al., 2020; Thiel et al., 2020; Farrell et al., 2022; Martin et al., 2022; Nickl et al., 2022). According to Kim et al. (2006) they should comply with four criteria: first, video cases need to be experienced as *realistic* representations of practice, mainly including aspects of experienced authenticity (Codreanu et al., 2020). Second, video cases should be experienced as *relevant* for learning, and thereby matching individual expectations and values as motivational drivers (Nickl et al., 2022). Third, video cases should be *engaging* by triggering and maintaining situational interest through the represented learning content (Nickl et al., 2022). Fourth, video cases should be cognitively *challenging*, meeting the demands of maximizing learning-related cognitive load, while simultaneously minimizing extraneous load, which can occur due to low instructional quality or overwhelming intrinsic demands from rich video information processing (Sweller et al., 2019; Martin et al., 2022).

Research questions

With regard to our target group of pre-service teachers, a set of four research questions guided our inquiry regarding their user experiences (UX):

1. Are the scripted video cases perceived by a majority of pre-service teachers as authentic, and therefore meeting the demand of a realistic practice representation?
2. Does a majority of preservice-teachers experience high utility value as an indicator for personal relevance when learning with our scripted video cases?
3. Do the scripted video cases fulfill the criterion of stimulating interest for a majority of users as an indicator for engagement support?
4. Are the scripted video cases experienced by a majority of users as cognitively challenging, indicated by maximizing learning-related cognitive load and minimizing extraneous load?

Materials and methods

Sample

User experiences were assessed in the project for a total of four samples, overall including data from 423 pre-service teachers enrolled in initial, university-based teacher education programs in Germany. Study 1 sample included $N = 85$ biology teacher education students from the University of Education Ludwigsburg and Technical University of Munich (female: 81%; age: $M = 23.5$ years). Study 2 sample included $N = 89$ biology teacher education students from University of Education Ludwigsburg and University of Education Karlsruhe (female: 90%; age: $M = 23.5$ years). Study 3 sample comprised $N = 129$ biology teacher education students from University of Education Freiburg and Münster (female: 74%; age; $M = 23.3$ years). Study 4 sample included $N = 138$ biology teacher education students from University of Cologne, University of Education Freiburg and University of Education Ludwigsburg (female: 80%; age; $M = 22.1$ years). On average, students were enrolled between semester three to six, thus, in about the middle of their respective study programs. Students participated only once in our studies.

Procedure

Data collection was administered *via* secure online software. In study 1 and 2, data collection was integrated into a teaching

TABLE 3 User experience of utility value as indicator for relevant practice representation.

	1/2 disagree	3/4	5/6	7/8 totally agree	Mean	SD
Perceived utility					5.99	1.26
I can apply what I learned in this study to the real world.	1.8%	9.7%	38.2%	50.3%	6.26	1.41
The study material is relevant to my future career plans.	5.0%	16.0%	41.9%	37.2%	5.75	1.71
The study material is personally relevant to me.	3.7%	13.9%	41.1%	41.4%	5.91	1.59
I see how the learning content of this study is important to my future.	0.8%	11.0%	37.7%	50.5%	6.29	1.43
The study material is useful in my everyday life as a teacher.	1.8%	7.1%	33.0%	58.1%	6.45	1.44
Participating in this study will help me achieve my future goals.	7.3%	23.8%	42.7%	26.2%	5.30	1.71

N = 382, Studies 2–4.

TABLE 4 User experience of triggered and maintained situational interest as engagement indicator.

	1 not at all	2	3	4 very much	Mean	SD
Triggered situational interest					3.02	0.55
The video task sparked my curiosity.	2.6%	17.5%	50.8%	29.1%	3.07	0.75
The video task captured my attention.	4.4%	29.3%	46.9%	19.4%	2.82	0.79
I was concentrated on the video task.	1.0%	5.8%	41.9%	51.3%	3.44	0.64
The video task was entertaining for me.	5.5%	27.2%	49.2%	18.1%	2.80	0.79
The video task was fun for me.	1.5%	22.0%	53.7%	22.8%	2.98	0.71
The video task was exciting for me.	2.6%	22.0%	50.8%	24.6%	2.98	0.75
Maintained situational interest					2.89	0.60
I would like to talk about the video task with others.	5.8%	33.5%	41.1%	19.6%	2.75	0.84
I would like to know more about the topics I came across.	3.1%	28.3%	44.0%	24.6%	2.90	0.80
I would like to learn more about the video task.	3.9%	31.2%	44.5%	20.4%	3.13	0.73
Working on the video task was useful to me.	1.3%	17.0%	49.5%	32.2%	2.91	0.74
I found the video task to be personally meaningful.	1.8%	26.2%	50.2%	21.2%	2.85	0.75
Involvement with the video task was important for me.	3.4%	27.0%	51.3%	18.3%	2.89	0.60

N = 382, Studies 2–4.

course onsite, studies 3 and 4 were administered online due to the Corona pandemic but also served as an additional part of a teaching course. Onsite, students were provided with laptops and headphones, online they were asked to use their own devices. All participants were provided with anonymized login codes. After voluntary informed consent, all participants (onsite and online) began to work with the scripted video cases, self-paced through the platform. The procedure included three parts: (1) participant demographics and a pre-test in week 1; (2) contextual information, video observation and analysis tasks in week 2; (3) UX evaluation in week 3. Procedures varied slightly for study 2 in which part 2 and 3 were combined in one session (week 2). Upon completion, participants received a written debriefing and compensation (15 Euro in study 1, 25 Euro in Studies 2–4).

Measures

Authenticiy

For measuring adequate authenticity of the scripted video cases, we used a scale consisting of six items (Table 2), adapted from Piwowar et al. (2018). Video cases were rated by participants only in study 1 on a four-point scale, each for the elicitation and learning phases video cases (disagree 1, to agree 4), with a reliability estimate of $\omega = 0.73$.

Utility value of learning

In order to assess to what extent participants experienced the scripted video cases as relevant practice representations, we used the motivational indicator of perceived utility value of learning (adapted from Hulleman et al., 2017). Six rating items were judged by participants in studies 2–4 on an 8-point Likert-scale (reliability estimate of $\omega = 0.90$). Single items are presented in Table 3.

Situational interest

As an instrument to capture situational interest, two questionnaire sub-scales regarding triggered and maintained situational interest were used (adapted from Knogler et al., 2015). Participants from studies 2–4 rated their agreement with these items with a 4-point Likert-scale, ranging from not at all (1) to very much (4) (reliability estimates of $\omega = 0.85$ for triggered interest, $\omega = 0.86$ for maintained interest). Single items are presented in Table 4.

TABLE 5 User experience of cognitive load as challenge indicator.

	1 absolutely wrong	2	3	4	5	6	7 absolutely right	M	SD
Germane Cognitive Load (GCL)									
I made an effort, not only to understand several details, but to understand the overall context.	1.8%	2.6%	4.5%	6.3%	17.5%	41.6%	25.7%	5.64	1.33
My point while dealing with the task was to understand everything correctly.	2.9%	8.9%	14.9%	15.4%	25.1%	23.8%	9.0%	4.59	1.55
Intrinsic Cognitive Load (ICL)									
For this task, many things needed to be kept in mind simultaneously.	3.4%	13.1%	13.1%	14.9%	23.8%	24.1%	7.6%	4.46	1.62
This task was very complex.	10.7%	22.0%	20.4%	21.2%	16.8%	7.6%	1.3%	3.40	1.51
Extraneous Cognitive Load (ECL)									
During this task, it was exhausting to find the important information.	5.7%	23.8%	22.8%	16.5%	17.3%	9.9%	3.9%	3.62	1.57
The design of this task was very inconvenient for learning.	14.1%	32.5%	20.7%	17.8%	8.9%	5.5%	0.5%	2.94	1.41
During this task, it was difficult to recognize and link the crucial information.	7.4%	25.9%	23.0%	16.5%	17.8%	8.4%	1.0%	3.41	1.48

$N = 382$, Studies 2–4.

Cognitive load

For evaluating participants' perceived challenge, we used a cognitive load questionnaire instrument comprising three subscales, which separately measure the different facets of cognitive load: germane, intrinsic, and extraneous load (Klepsch et al., 2017). Seven rating items (Table 5) were judged in studies 2–4 on a 7-point Likert-scale (from 1 = completely wrong to 7 absolutely right; reliability estimate for cognitive load scale without differentiating between three sub-scales: $\omega = 0.66$).

Results

Realistic practice representations

When learning with our scripted video cases, participants of our first study were asked about the extent to which they experienced the video cases as authentic. These judgments served as an indicator for meeting the criterion of a realistic practice representation (Table 2). Overall, participants rated the eight scripted video cases as highly authentic. The means are shown for both elicitation and learning phases as represented in our video cases. More specifically, participants judged the video cases as convincing, realistic, and depicting actors that demonstrated typical tutor and student behavior. Participants also judged the portrayal of the simulated tutor and students convincing, with the learning phase video cases rated somewhat lower than the elicitation phase cases on this specific aspect. Concluding, we consider the development and production of the scripted video cases as successful with regard to providing realistic user experiences.

Relevant practice representations

Participants experienced utility value of learning with our scripted video cases as very high. Looking into the single items, particularly high agreement was given for learning that is applicable to the real world, personal relevance of the learning material, and relevance for a future teaching career.

Situational interest

Overall, ratings for triggered situational interest were very positive. Participants reported that their curiosity was sparked by the video task, that they were highly concentrated, and that they experienced the video cases as entertaining, exciting, and fun. Thus, the video cases seemed to have positively triggered situational interest, which can be regarded as an indicator for high engagement with the video material. After the initial triggering of interest, maintaining interest throughout the learning activity and beyond was also of importance. Again, overall ratings for maintained situational interest were positive. Most participants were interested in talking with other students about the video cases, wanted to learn more about the topics and the video tasks, and experienced working with the video cases as personally meaningful, useful, and important.

Challenge

As a fourth criterion, we evaluated participants' perceived challenge when learning with the video cases. According to

Cognitive Load Theory (Sweller et al., 2019), high germane load is most strongly linked to carrying out learning-related cognitive activities, indicated by the experience of keeping an overview and staying on track with the learning tasks. Intrinsic load is related to the complexity of the learning material, which can be dependent on a learner's prior knowledge. Video material in general is often discussed as being high in intrinsic load, particularly for novice learners (Derry et al., 2014). Extraneous load refers to processing which is unproductive for the learning task that can stem from aspects of the learning materials or the quality of instructional design, such as information within the visualization of video material unnecessary for the task.

Items for cognitive load were rated by our participants on a 7-point Likert scale (Table 5). Overall, the highest ratings were given for germane load, indicating that participants were able to apply learning-related cognitive activities ($M = 5.11$, $SD = 1.12$). At the same time, participants rated intrinsic ($M = 3.91$, $SD = 1.35$) and extraneous load ($M = 3.32$, $SD = 1.21$) lower, indicating that the complexity of video material did not overwhelm the learners and that there was not too much distraction by the video task design. However, we found a larger diversity in participants' user experiences of cognitive load in comparison to the other UX quality criteria.

Discussion

We applied a three-step design approach toward the development of scripted video cases for teacher education. Compared to previous approaches, we introduced an additional design component by using a mock-up setting to identify authentic behavior as a basis for script development. This approach was applied to the context of small-group tutoring of basic concepts about the human circulatory system. Thereby, an integration of core teaching practices regarding the application of PCK (eliciting and addressing domain-specific student conceptions) and PK (managing a small group) was targeted.

As a first design step in scripted video case development, decisions regarding the selection of events to be represented in video cases had to be made. In line with previous approaches (Dieker et al., 2009; Piwowar et al., 2018), we based our decisions on a literature review regarding facilitative tutoring that have been shown to be highly relevant for student learning. In our case, we specifically aimed for teaching practices in which both pedagogical content knowledge as well as pedagogical knowledge is necessary for achieving high teaching quality (Grossman et al., 2009a,b). Furthermore, an additional emphasis was given to theoretical foundations with regard to core teaching practices (; Grossman et al., 2018), as well as acquisition of evidence-based teacher knowledge, including selecting relevant practice representations, decomposing of these practices, and creating approximations for knowledge application (Grossman and McDonald, 2008; Grossman et al., 2009a,b). By applying these principles, we made decisions regarding the focus and selection of events to be represented in the scripted video cases. We decided to focus on the context of teaching basic concepts regarding the human circulatory system, for which specific student (mis) conceptions as well as more and less facilitative practices have been empirically described and determined (Kloser, 2014; Dorfner et al., 2019). In addition, we focused on tutoring instruction for a small group of four students, a situation that represents student-centered instructional techniques that are also transferable to small-group or whole-class instruction in biology education. In addition, the situation is suitable for novice learners since student conceptions and tutoring practices can become particularly salient.

In order to base script development on authentic behavior to be represented in the video cases, we introduced a mock-up setting in which authentic behavior regarding our targeted teaching situation could be observed (Peavey et al., 2012; Seidel et al., 2015). The mock-up represented a biology education classroom setting. Four students were trained as simulated learners and represented typical student (mis)conceptions of our targeted learning content. As tutors we decided to include both student teachers as well as practicing teachers in order to be able to observe a broader range of more and less facilitative tutoring practices. We had decided to start with a first round of 10 participants as tutors in the mock-up setting. Depending on our observations, we would have run another round of data collection. However, given this first sample, we were already able to observe a range of behavior consistent with the more and less facilitative practices as identified in our research review. However, this was a bottom-up approach and more research might be helpful to identify optimal sampling procedures for these kind of mock-up studies.

By applying the mock-up setting, naturalistic verbal interactions between tutors and learners as well as typical behavior in this situation were identified. These observations served as a valuable basis for further script development since we were able to both identify relevant events with regard to eliciting and learning phases, as well as with regard to authentically occurring verbal tutor-student interactions. To our knowledge, this approach has not yet been used for scripted video case development in teacher education. In previous approaches, researchers have mainly used research reviews for script development (Dieker et al., 2009; Piwowar et al., 2018). In addition, several rounds of internal reviews are typically applied for further optimization. These design sub-steps have also been applied in in our project, however, the mock-up setting to us seemed to be particularly helpful. By drawing on naturalistically occurring verbal interactions and utterances between tutors and students, we could efficiently create lines for scripts as a basis for video production. After script development, video cases were produced according to design steps as previously described. As a further extension to existing research, trained biology teacher educators served as tutor actors in video case production. The fact that our tutor actors were particularly trained might have added to the positive assessment of authenticity of the video cases and should be explored in more detail in future studies. Video case production is often carried out

based on tacit and intuitive decision making and – as far as possible – on existing technical reports (Janik and Seidel, 2009). In order to move design approaches forward, however, publications regarding an explication of design steps and applied quality criteria are important. We hope that, through the explanation of our design process and applied quality criteria, we can contribute to the ongoing improvement of video case production and the establishment of research-based standards in the field of teacher education.

In order to ensure the quality of developed video cases for teacher education, user experience evaluation criteria were applied in four empirical studies. Thereby, we investigated quality criteria according to Kim et al. (2006) regarding realistic representation, relevance, interest and engagement, and challenge. Similar to previously reported UX evaluations (Piwowar et al., 2018), the scripted video cases of our project were rated quite positively overall. The video cases for the selected elicitation and learning phases were rated as highly realistic and authentic. In addition, working with the video material was experienced as very personally relevant and of high utility for a future career as a teacher. Furthermore, users experienced the video cases as highly interesting, as expressed through positive ratings of triggered and maintained situational interest. Regarding the last criterion of challenge, germane cognitive load seemed to have been achieved, as indicated by users' ability to focus their cognitive activities on learning with the video material without much distraction from the complexity of the task or irrelevant information. However, with regard to cognitive load, overall, we found quite high variability in user ratings. This finding indicates that perhaps personal adaptations of scripted video cases with regard to the prior knowledge of learners might further optimize their use in teacher education (Paas et al., 2010).

Limitations of scripted video case development are associated with their effortful production, which requires specialists from both teacher education and educational technology design (Derry et al., 2014). Even with both specialists, a project such as the one presented in this paper will only result in a limited number of high-quality scripted video cases produced. Thereto, it is highly important to have a joint integration of products available across teacher education programs in the form of open educational resources (Holodynski et al., 2022). However, in order to fully take advantage of these products, instructional information regarding learning goals and alignment with course methods and assessments is required (Blomberg et al., 2013). Moreover, the development of joint standards in teacher education and the definition of core teaching practices provide a basis for relating different video cases and digital tools for teacher education purposes (Seidel et al., 2021).

Another limitation relates to the specific constructs to be measured in UX evaluations. We focused these evaluations on the criteria from Kim et al. (2006) along with additional criteria as used in other video case evaluations (Piwowar et al., 2018). While a joint conceptual framework is shared, standards are limited with regard to the choice of validated instruments. In our project, we measured quality criteria according to pedagogical-psychological constructs such as users' experience of authenticity, utility value of learning with the video cases, situational interest, and cognitive load. In Piwowar et al. (2018), quality criteria were measured with partly different instruments, focusing on specific features targeted in their project. In order to move research forward, more coherence across projects would be helpful. Thereto, the scales and items used in this project are presented in detail to provide transparency.

Finally, two aspects associated with user experience measurements should be considered. For our UX measures from studies 2 to 4, the items did not address the videos specifically, but rather the videos in context (the video analysis task or the video-based training as a whole). While the videos were stimulus material used within the training and video analysis tasks, it is likely that the UX reported in these measures is not directed solely to the experience of the videos themselves, but rather also the use of the videos in our study context. The elaboration of the study material and video analysis tasks were beyond the scope of the current study, but can be found in further publications on individual studies from the project (Farrell et al., 2022; Martin et al., 2022). Videos themselves as learning material are not necessarily effective for instruction, but rather their efficacy also depends on how they are used as a learning tool embedded in the instructional context toward specific instructional goals (Blomberg et al., 2013; Derry et al., 2014). Thus, we argue that evaluating videos within the instructional context they are intended for is a more accurate evaluation of the relevance, engagement and challenge to the user that these videos in context elicit.

Moreover, measurements using self-report questionnaires also come with their own limitations in terms of potential cognitive biases that can be elicited. User experience outcomes can be limited when measures do not take into account the specific contextual knowledge and beliefs that users have, based on their real-world experiences with similar stimuli. If these experiences are limited, or if the context of their experience is too far from the current product being evaluated, the user must adapt their knowledge and beliefs, make inductive inferences, and potentially make decisions which include cognitive biases (Suomala, 2020). To mitigate these limitations, we also examined qualitative feedback responses on what participants liked or what could be improved about the study in general, which included many comments that supported quantitative findings (for an example, see Martin et al., 2022).

Conclusion

This article presents a three-step design process in scripted video case development for teacher education purposes. Thereby, previously reported design approaches served as a basis for our specific project focus. As an additional design component, we introduced the use of a mock-up setting to identify authentic teaching and learning

behavior for script development. By building on the state-of-art with the enrichment of this additional design component, we contribute to solidifying relevant design principles in scripted video case development. In order to evaluate our approach, extensive user evaluations across a set of four empirical studies were carried out. The results clearly point towards very positive user experiences regarding quality criteria such as realistic practice representations, personal relevance for future teaching careers, high engagement, and challenging learning activities. With this approach, we aim to contribute to an emerging field of evidence-based development of video cases for teacher education.

Data availability statement

The datasets presented in this article are not readily available, the data will be made available to other interested researchers upon request after completion of the project in 2023. Requests to access the datasets should be directed to TS, tina.seidel@tum.de.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Commission of the German Psychological Society (DGPs) and the Data Protection Office at the Technical University of Munich. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors equally contributed to the conceptualization of study ideas in terms of formulation and evolution of overarching research goals and aims. TS, AR, and WR were involved with study funding acquisition and project administration. MF and MM contributed to the realization of the design steps/process and production of video material resources, conducted data collection for user experiences, as well as database curation and management activities for study data. TS performed the formal analysis in the application of statistical, and other formal analysis/synthesis techniques of study data. TS wrote the initial manuscript draft, involving preparation, creation, and presentation of original work. MF, MM, WR, and AR participated in reviewing and editing the written manuscript, specifically in terms of offering critical content review and commentary. All authors contributed to manuscript revision, reading, and approval of the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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