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# Explaining skills of prospective teachers – Findings from a simulation study

Stefanie Findeisen[1] · Juergen Seifried[2]

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## Abstract
Providing instructional explanations is a central skill of teachers. Using interactive simulations, we examined the explaining skills of 48 prospective teachers attending a teacher education program for accounting in vocational schools in Germany. We used a performance-based assessment that relies on explanatory quality as an indicator of teacher candidates' explaining skills. Video analysis was used to assess the quality of prepared and impromptu explanations in respect of different quality aspects. We found that the prepared explanations of prospective teachers were of high quality in terms of *student–teacher interaction* and *language*. With respect to the quality of *content* (e.g., accuracy, multiple approaches to explaining) and *representation* (e.g., visualization, examples), prospective teachers performed significantly worse. The quality of teacher candidates' improvised explanations was significantly lower. This was especially true for the quality of *representations*, the *process structure*, and the interaction between student and teacher. For four of the five quality criteria examined, no correlation could be found between the quality of prepared and improvised explanations. For the *language* criterion, however, there was a correlation between the two types of explaining situations. Implications on how to support teacher candidates in developing explaining skills during teacher education are discussed.

Extended author information available on the last page of the article

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## Introduction

Providing explanations is regarded both as a central task in the daily practice of teachers (Ball et al., 2005; Charalambous et al., 2011; Gage et al., 1968; Leinhardt, 2010) and a crucial skill of instructors (Brown, 2006; Brown & Atkins, 1986; Leinhardt, 1987). Although the teacher is not the only one engaged in explaining content in the classroom (for evidence on the importance of self-explanations or of explanations by fellow students see Chi et al., 1989, 1994), teacher explanations play a central role in classroom instruction (Leinhardt, 1997). Typical instructional situations that call for teacher explanations include, for instance, student errors or the demonstration of a process (Hargie, 2011).

Prior research on teaching and instruction highlights the importance of teachers' competencies for students' learning processes (Hattie, 2009; Kunter et al., 2013; for vocational education and training [VET] teachers see the conceptual review by Antera, 2021). The same is true for instructional explanations. Some older studies show that the quality of a teacher's explanation (e.g., clarity) correlates positively with students' learning outcomes (Eisenhart et al., 1993; Hines et al., 1985) and satisfaction (Hines et al., 1985). Consequently, teachers' explaining skills, meaning the skills to generate and present an explanation that is adequate and comprehensible for learners (Findeisen, 2017), are an important aspect of teachers' professional competencies (Shulman, 1987; for commercial teachers see Holtsch et al., 2019). Explaining skills should therefore be specifically promoted in initial and in-service teacher training.

Empirical evidence shows that explaining subject matter is a learnable skill (Borko et al., 1992; Charalambous et al., 2011; Kulgemeyer et al., 2020; Miltz, 1972), and it is expected that the explaining skills of teachers develop during university teacher education. However, previous studies from the field of general education point to pre-service teachers' difficulties when it comes to explaining subject matter (e.g., Borko et al., 1992; Halim & Meerah, 2002; Thanheiser, 2009). For vocational education, research is available from Austria (Schopf, 2018; Schopf & Zwischenbrugger, 2015) and Germany (e.g., Jeschke et al., 2019; Zlatkin-Troitschanskaia et al., 2019). In these studies, a similar finding emerges: prospective teachers at vocational schools have difficulty presenting and explaining lesson content well.

Providing instructional explanations comprises several facets. Besides providing verbal information to students, teachers also design representations (e.g., visualizations, examples, analogies; Brown, 2006; Leinhardt, 2001). Moreover, while explaining, teachers need to have their students in mind so as to adapt their explanations to the prerequisites and characteristics of the learners (Brown, 2006; Leinhardt, 2001; Wittwer & Renkl, 2008). Since the misconceptions and common errors of students as well as suitable representations depend on the specific content being explained, explaining is often regarded as a content-specific skill that is not directly transferable from one content to another (Wagner & Wörn, 2011). However, empirical evidence on the relationship between the quality of teachers' explanations on different topics is still scarce. For teachers in vocational schools, who are the focus of our study, empirical evidence on this question is entirely lacking (for the specific conditions of work as a teacher in vocational education see Andersson & Köpsén, 2018).

In terms of explanatory content, this study focuses on the domain of accounting. The purpose of accounting is to document all business transactions (e.g., income, expenses, liabilities, etc.) in order to provide both the company and external third parties (e.g., tax office, banks, shareholders, investors, etc.) with the necessary information about the financial situation of the company. Accounting education is considered very important for commercial schools to promote economic competencies, as this area is crucial for developing a comprehensive understanding of business contexts among students or trainees (Seifried, 2012). Teachers' explaining skills seem especially important in the field of accounting, as this domain has been shown to be susceptible to student errors (Wuttke & Seifried, 2017), and students at German vocational schools report that lesson content is often not presented in a comprehensible way (Seifried, 2009). A thorough examination of the explaining skills of prospective accounting teachers is a prerequisite for designing tailor-made learning opportunities that support teacher candidates learning processes during teacher education.

Consequently, the present study aimed to examine the explaining skills of 48 prospective accounting teachers (teacher candidates at one German university) who will be teaching in vocational schools in Germany. We used a performance-based assessment to evaluate the quality of instructional explanations provided by the teacher candidates. The explanatory quality measured was used as an indicator of the teacher candidates' explaining skills. Following Blömeke et al. (2015), we assumed that the performance shown in an action situation can be considered a valid indication of individual dispositions. In order to describe the overall quality comprehensibly, we distinguished five aspects of explanatory quality: *content*, *student–teacher interaction*, *process structure*, *representation*, and *language*. We were interested in the following research question: To what extent are prospective accounting teachers able to provide high-quality planned and impromptu explanations with regard to different quality aspects?

This study used a video analysis of the explanatory processes of prospective accounting teachers. Each teacher candidate ($n = 48$) provided both a planned and an impromptu explanation for a common topic in accounting. For each explanation, we evaluated the quality of its different aspects (*content, student–teacher interaction, process structure, representation,* and *language*). We report the strengths and deficits of prospective teachers' explanations, the relations between different quality aspects, and the differences between planned and impromptu explanations.

The present study contributes to existing research in several ways. This study is—to our knowledge—the first to systematically examine different quality dimensions of explanatory quality separately and analyze to what extent different aspects of explaining are interrelated (e.g., quality of content and quality of representation). By comparing planned and impromptu explanations on different accounting topics, we also provide evidence on the still scarcely researched question of whether explaining is a transferable, as opposed to a topic-specific, skill. Regarding the assessment of explaining skills, we used videotaped simulated student–teacher interactions with standardized students. Hence, we introduced a performance-based standardized instrument that accounts for one central characteristic of the explanatory processes that most prior studies on explaining skills have neglected, namely, the interactive nature of an explanation. In general, our study provides results that are of interest for the field of teacher education, both in accounting and other fields. The results can inform teacher educators in providing suitable learning opportunities for teacher candidates.

## Theoretical foundation and state of research

### Quality of instructional explanations

Instructional explanations are defined as "interactional moves that occur when one partner offers a piece of new information (explanans) referring to an object, event or piece of information of joint attention (explanandum). This information clarifies what was formerly obscure" (Barbieri et al., 1989, p. 131). Three key features characterize instructional explanations (Findeisen, 2017): the person providing the explanation (1) interacts with the audience, (2) has an advanced knowledge of the explanatory content (compared to the audience), and (3) has the intention of clarifying something for the audience.

Since instructional explanations aim at students' understanding, the ultimate quality criterion of an instructional explanation is the addressee's understanding (Brown, 2006; Hargie, 2011). However, there are further quality criteria that can be used to evaluate instructional explanations from an observer's point of view (Leinhardt, 2010). Quality aspects can refer to both the resulting explanation (product; e.g., correctness of information, examples used) and the explanatory process (e.g., actively engaging students, adapting an explanation in response to students' questions). The criteria for the quality of an explanation are generally related to the discussion on the basic dimensions of instructional quality (e.g., Praetorius et al., 2018 or Kulgemeyer, 2021, who relates the quality of instructional explanations to the basic dimensions of instructional quality). There are also several aspects that are specific to the quality of instructional explanations. To identify the most crucial aspects of explanatory quality, in a previous study we systematically screened the literature on quality criteria for explanations (Findeisen, 2017). The literature search revealed a total of 24 articles that contain frameworks or lists of quality criteria for instructional explanations. The 24 sources include both theoretically postulated quality criteria (e.g., Brown, 2006; Hargie, 2011) and empirically derived quality aspects (e.g., Geelan, 2013; Kulgemeyer & Schecker, 2013; Kulgemeyer & Tomczyszyn, 2015; Schopf & Zwischenbrugger, 2015). From all quality aspects, we selected those that were mentioned in at least three independent contributions. Hence, the framework was not supposed to include all possible quality aspects but rather only the most important ones. Moreover, only quality aspects that relate directly to an explaining situation were selected. This means that, for instance, aspects regarding the preparation of an explanation or considerations whether a teacher or a student explanation is more suitable were not included in our framework.

As a result, 23 important elements of high-quality explanations were identified and inductively categorized into the five quality aspects (see Fig. 1; similar approaches are used in studies on the quality of explanatory videos, see e.g., Ring & Brahm, 2022). Since the core of each instructional explanation is a certain teaching content, we first considered quality aspects regarding *content*. Second, there were aspects of *student–teacher interaction,* which is closely related to the discussion on the basic dimensions of teaching quality (e.g., Praetorius et al., 2018) and especially the discussion on cognitive activation. While explaining, it is important to focus the cognitive activities of learners on the learning objectives, especially on the central elements of understanding, to draw connections to student thinking (i.e., prior knowledge from earlier lessons and everyday life), and to stimulate and maintain demanding cognitive processes, such as by creating links between different aspects (e.g., Chi & Wylie, 2014; Hattie, 2009; Kunter et al., 2013). In the third quality aspect, we sorted together aspects of the *process*

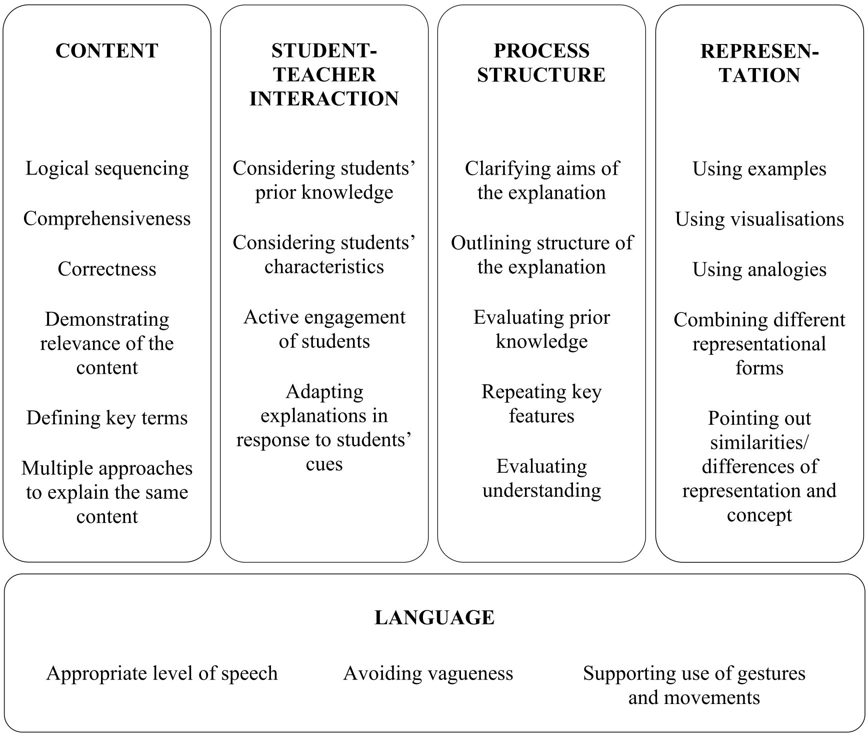


**Fig. 1** Quality aspects of instructional explanations (see also Findeisen, 2017)

*structure* of an explanation. Aspects in this category refer to how teachers can support their students while explaining and are, as such, again closely related to the discussion on teaching quality. Student support entails, among other matters, structuring explanations, assisting with difficulties in understanding through some form of scaffolding process (e.g., van de Pol et al., 2015), and providing effective feedback (e.g., Hattie & Timperley, 2007). Fourth, there were several quality aspect referring to the *representation* of the explanatory content (e.g., examples, visualizations). Fifth, since instructional explanations are often presented verbally, there were certain aspects of *language* that need to be considered when evaluating explanatory processes.

### Prospective teachers' explaining skills

Teachers' explaining skills, meaning the skills to generate and present an explanation that is adequate and comprehensible for learners (Findeisen, 2017), are regarded as a prerequisite for successful action in explanatory situations (Leinhardt, 1989). These explaining skills include the ability to prepare content appropriately and in a way that is suitable for the target group and to present learning content to learners in such a way that they can understand it.

Teachers' explaining skills are generally expected to develop during university teacher education programs, and empirical evidence shows that explaining subject matter is a learnable skill (Borko et al., 1992; Charalambous et al., 2011; Kulgemeyer et al., 2020; Miltz, 1972). However, previous studies demonstrate that preservice teachers often struggle when it comes to providing instructional explanations. Their difficulties occur in (almost) all areas of the quality framework (Fig. 1). Regarding *content*, teacher candidates have difficulties providing correct and coherent explanations (Borko et al., 1992; Guler & Celik, 2016; Halim & Meerah, 2002; Leinhardt, 1989; Thanheiser, 2009). Compared to experienced teachers, teacher candidates also struggle to focus on key features of the explanation (Kocher & Wyss, 2008; Sánchez et al., 1999), structure the content in a suitable way (Leinhardt, 1989), and offer multiple explanatory approaches (Housner & Griffey, 1985). With respect to *student–teacher interaction*, the difficulties of teacher candidates include actively involving students in the explanatory process (Kocher & Wyss, 2008; Spreckels, 2009), tailoring explanations to students' needs (Halim, 1998), reacting flexibly to unexpected events or to students' questions (Borko & Livingston, 1989; Leinhardt, 1989), and accounting for typical difficulties or misconceptions during the explanatory process (Halim & Meerah, 2002; Inoue, 2009). Novice teachers are generally less flexible during the explanatory process. Unlike experienced teachers, teacher candidates usually stick to the explanatory approach they prepared in advance (Spreckels, 2009) and are often not able to react flexibly to additional questions or difficulties (Borko & Livingston, 1989; Housner & Griffey, 1985; Spreckels, 2009). Furthermore, teacher candidates experience difficulties when evaluating and activating prior knowledge (Sánchez et al., 1999) or evaluating understanding (Leinhardt, 1989; Leinhardt & Greeno, 1986) (*process structure*). When it comes to *representations*, teacher candidates show difficulties in designing suitable representations or examples (Ball, 1988; Borko et al., 1992; Inoue, 2009; Wheeldon, 2012); their representations and examples are often incorrect, incomplete, or confusing. They are likewise often unable to provide multiple ways of representing the content (Clermont, Borko, & Krajcik, 1994; Leinhardt, 1989).

## Transferability of explaining skills: Domain specificity and preparation

Explaining skills are assumed to be domain-specific; that is, generating an explanation in one domain is believed to be very different from the ability to generate an explanation in a different domain (Keil & Wilson, 2000). The fact that teachers especially face problems when explaining content that is not related to their area of expertise (Sanders et al., 1993; Schempp et al., 1998) speaks in favor of this assumption. Wagner and Wörn (2011) even argue that explaining is a content-specific skill that is not directly transferable from one content to another. For instance, they claim that students' misconceptions, common errors, and suitable representations depend on the specific content being explained. The question of the extent to which the explanatory skills of teachers are situation- or topic-specific, or whether they can be transferred to different topics, has not yet been sufficiently investigated. First, it is generally assumed that explanatory skills are topic-specific or at least domain-specific (Keil & Wilson, 2000), so it cannot be expected that explaining skills are simply transferable from one topic to another. Second, it is to be expected that the chance to prepare an explanatory approach contributes to the quality of the explanation. Planning teaching–learning sequences (pre- and post-active thoughts on teaching, see Clark & Peterson, 1986) is generally assumed to determines teachers' teaching actions and to increase teaching quality. This is especially true when teachers have not yet developed routines (Koeppen, 1998). Hence, it is reasonable to assume that qualitative differences exist between the decisions made at the actual moment of teaching and the teacher's reflections on the teaching activities before action (and after the lesson).

Although classroom interaction requires both planned and impromptu explanations by teachers, evidence on how explanatory quality is related to the possibility of preparing an explanatory approach is still lacking. It seems plausible to assume that some aspects of explaining (e.g., developing *representations*) are more difficult to perform spontaneously than others (e.g., *language*). Our study aimed to provide evidence on this question.

## Assessment of explaining skills

Prior studies on the explaining skills of prospective teachers have certain limitations when it comes to the methodology used. Several studies are set in real classroom scenarios, where conditions are not standardized for all participants and analysis is often based on individual cases (e.g., Borko et al., 1992). Another set of studies uses laboratory settings and relies on written explanations (Guler &

Celik, 2016; Kinach, 2002a, 2002b; Leite et al., 2007) or oral explanations conducted as a presentation during an interview (Halim & Meerah, 2002; Thanheiser, 2009; Wheeldon, 2012) or during a university course (Inoue, 2009; Kinach, 2002a, 2002b). While such test formats offer certain advantages, especially concerning standardization or the effective use of research resources, those approaches fail to account for one central characteristic of explanatory processes, that is, the interactive nature of an explanation. The present study aimed to overcome these limitations. Drawing on videotaped simulated explanations, we implemented a realistic yet standardized assessment of teacher candidates' performance in interactive explaining situations (see "Study design"; a similar approach is also used in Kulgemeyer, 2021; Kulgemeyer & Riese, 2018).

## The present study

This study aimed to analyze the quality of teacher candidates' explanations in an interactive setting with respect to five quality aspects (*content*, *student–teacher interaction*, *process structure*, *representation*, and *language*). The findings of prior studies outlined above show that pre-service teachers across disciplines generally struggle when asked to explain subject matter to students. Hence, we also expected prospective accounting teachers to experience difficulties when explaining. However, it seemed plausible to expect differences between different quality aspects, which is why we divided explanatory quality into the five aspects, which are examined separately in this study. This approach will allow teacher educators to pay specific attention to those aspects of providing explanations that are most difficult for prospective teachers.

(1) To what extent are prospective accounting teachers able to provide high-quality explanations regarding *content*, *student–teacher interaction*, *process structure*, *representation*, and *language*?

Moreover, we analyzed differences between planned and impromptu explanatory processes. In the interactive simulation outlined above, each teacher candidate provides two explanations, one prepared and one impromptu. The explanations cover different topics of the accounting domain. It is plausible to assume that there are qualitative differences between the decisions made spontaneously during an impromptu explanation and those made during the planning process of a planned explanation, especially for teacher candidates who have not yet developed routines. Hence, differences in the quality of prepared and impromptu explanations are expected. However, although teacher candidates' explaining skills have been examined for decades now (see the studies reported in "Prospective teachers' explaining skills"), so far the differences between different explaining situations have not been analyzed. It is also yet to be examined which aspects of explanatory quality benefit most by the opportunity to prepare the explanation or—the other way around—which quality aspects are particularly difficult for teacher candidates when providing impromptu explanations. Ultimately, we aimed to examine whether teacher candidates providing high-quality planned explanations also performed well when they were asked to explain a concept spontaneously. This analysis also provides insights into the question of to what extent explaining skills are content-specific versus transferable between different topics within one domain.

(2) How do prepared and impromptu explanations differ in respect of different quality criteria?

## Methodology

### Study design

We implemented an interactive simulation to assess the explaining skills of teacher candidates (see Findeisen, 2017; Findeisen et al., 2021). Interactive simulations have been a central element of medical education in the US for about six decades (Barrows & Abrahamson, 1964). Subsequently, they have been implemented in teacher education as well (see Dotger et al., 2008, 2010; Dotger, 2011, 2013). The main idea of these simulations is to create an authentic situation for the respective profession where university students can develop their professional skills by interacting with a standardized individual (trained actor). While the actor plays a given role, the participants are free to act according to their skills or personality (Dotger, 2013).

In the present study, interactive simulations were used as an assessment tool. Each teacher candidate was teamed up with a standardized student (an actor trained in the role of an accounting student; "standardized individual", see Dotger et al., 2008) to whom they provided an explanation from the field of accounting in a simulated explaining situation. Participants were given a preparation time of 20 min. They received written instructions containing basic information about the student (e.g., age, type of school, prior knowledge in accounting) and were asked to prepare an explanation for an interactive setting; hence, they could assume that the student would ask questions. However, they were not informed that they would be asked for an additional impromptu explanation. During preparation, we provided printed information material on the explanatory topic to avoid the possibility of individual candidates being unable to design an explanation owing to a lack of content knowledge. The material was strictly based on relevant facts and included neither visualizations nor examples nor any information on how to teach the topic. We also made sure that all participants received the same information, and so an individual search for information (e.g., using internet resources) was not allowed.

After the preparation time, teacher candidates entered a simulated classroom (Fig. 2 shows the setup of the simulation). While explaining, they could use a whiteboard and paper to visualize content. During the simulation, the standardized student acted according to a script and requested changes in the explanations of the teacher candidates at specific points in time (e.g., graphical visualization, a different explanatory approach). The explaining situations, where teacher candidates presented the planned explanation, lasted about 10–12 min. After this, the standardized student requested an additional explanation on a different topic. The participants were not prepared for this situation, so this necessitated them giving

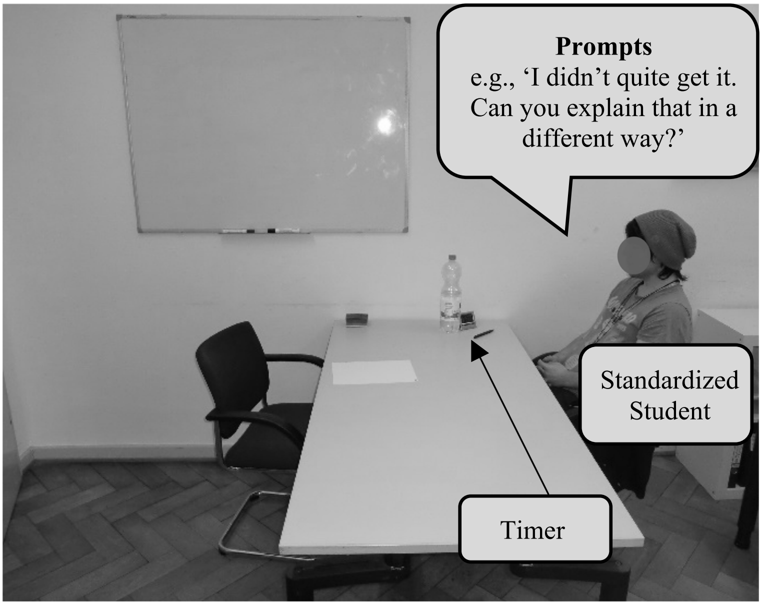


**Fig. 2** The simulated student–teacher interaction setting

a short impromptu explanation. The whole explaining sequence was videotaped. The standardized student role was played by one of four students with the same characteristics (male, age 17) from a vocational school. Each student received an intensive four-hour training based on a written script and took several test runs.

By using a simulation, we were able to create a standardized setting with comparable conditions for every teacher candidate. Simultaneously, we made sure that, compared to the relative uncertainty of real classroom interactions, teacher explanations actually occurred during the time in which the teacher was being observed. Altogether, the simulation created an authentic close-to-reality teaching situation that allowed for a performance-based assessment of prospective teachers' explaining skills. One-on-one interaction creates a high-intensity situation where teachers are expected to account for the needs and prior knowledge of students. We also assumed that the performances of teacher candidates in simulated situations allow for predictions concerning their performance in real classroom settings. In particular, those who are not able to explain content adequately to one student will probably also struggle to explain it to a whole class of students.

## Sample

The sample consisted of 48 prospective teachers from a German university (teacher candidates in a Master's program of Business and Economics Education). Thirty-six participants were female. The mean age of the sample was 25.2 ($SD = 1.9$). The teacher candidates were training to be teachers at commercial vocational schools in Germany, where they will be teaching accounting both to full-time students and commercial trainees in VET (part-time students who are completing a dual VET program in the commercial sector). Accounting is considered a very important field for commercial VET programs to promote economic competencies, as this area is crucial for a comprehensive understanding of business contexts (Seifried, 2012). All participants had already completed a Bachelor program that includes introductory courses in accounting. As part of their Master's program, all teacher candidates participated in theoretical courses on didactical topics, and all had gained some teaching experience during mandatory school internships ($M = 7.1$ weeks; $SD = 2.0$). About half of the sample ($n = 23$) had designed lessons in accounting during their internships ($M = 3.7$ lessons; $SD = 2.5$). However, the participants did not receive any specific training on how to design successful explanations, and they were not familiarized with the 23 quality aspects used to assess their explanations.

## Selection of the instructional explanation content

The content chosen for the explaining situation was identical for all participants. In the first part (planned explanation), teacher candidates were asked to explain the reason the value-added tax (VAT) does not affect the net profit of a company. The main motive for choosing this topic was that it allows for multiple explanatory approaches. The ways of explaining can be distinguished into an *economic approach* and a *bookkeeping approach*. An economic approach focuses on the economic background of the VAT. One could explain that companies only collect VAT for government authorities and that the tax is designed to not affect the company itself. Similarly, the neutrality of the VAT on the net profit of a company can be explained by showing that the amount of VAT paid (input tax) is deducted from the amount received and the differential amount is forwarded to the tax authorities.

An explanation following the bookkeeping approach refers to bookkeeping principles. To show that both paid and collected VAT do not affect a company's profit, one could show that VAT is entered in the balance sheet of a company and does not affect the profit and loss account. A combination of both approaches is also possible. Apart from the different explanatory approaches, VAT is a topic for which a visualization—either of transaction processes (goods and VAT amounts) or of the bookkeeping accounts of a company—seems to be crucial for understanding. A possible visualization of the transactions during a production process is given in Fig. 3. Hence, the chosen explanatory content allowed for a thorough examination of prospective teachers' explaining skills, as it accounts for the different requirements of teachers attempting to explain (e.g., flexible adaptation of the explanatory approach, visualization).

In the impromptu explanatory situation, teacher candidates were asked to explain the reasons companies depreciate assets (e.g., account for declines in value). Typical examples used for an explanation on this topic include different tangible assets (e.g., machines, vehicle fleet). One could also draw on different methods of depreciation (linear vs. degressive).

| | | Step 1 | | Step 2 | | Step 3 |
|---|---|---|---|---|---|---|
| | | A supplier sells automotive parts to a car manufacturer. | | A car manufacturer sells a car to a car dealer. | | A car dealer sells a car to a consumer. |
| | | Net price: **1,000 €** | | Net price: **10,000 €** | | Net price **13,000 €** |
| Sale price with VAT | | 1,190 € | | 11,900 € | | 15,470 € |
| VAT collected by seller | | 190 € | | 1,900 € | | 2,470 € |
| Credit for VAT paid in previous stage (deductible input tax) | | - | | - 190 € | | - 1,900 € |
| Net VAT collected | | 190 € | | 1,710 € | | 570 € |
| Total VAT collected by tax authorities: | **2,470 €** | 190 € | + | 1,710 € | + | 570 € |

**Fig. 3** Visualization of a transaction process including VAT (simplified example; German VAT rate: 19%)

## Video analysis

Using the software Interact (Mangold International GmbH), we analyzed the videotaped interactive explaining situations with a focus on the quality of teacher candidates' explanations (quality aspects in Fig. 1). A coding system was developed by the researchers (Findeisen, 2017). In line with standards commonly used for video studies (e.g., Bell, 2020; Seidel, 2005), the coding system included both low-inference codes and high-inference rating systems. This approach allowed us to account for complex, holistic aspects of the explanatory process and specific individual features (i.e., well-observable aspects) (Rosenshine, 1970). To code low-inference features (e.g., speaker turns, errors, use of representations, evaluation of prior knowledge), we used a combination of event and time sampling approaches (30 seconds). In addition, we used rating scales to evaluate high-inference characteristics (e.g., overall assessment of the main quality aspects: *content*, *student–teacher interaction*, *process structure*, *representation*, and *language* on a four-point Likert scale from 0 [*candidate does not comply with the quality requirements*] to 3 [*candidate fully complies with the quality requirements*]). After independent coders were trained and the coding system pretested, the coding system was applied to the video data. The amount of material subject to double coding was chosen rather conservatively (30% of the material regarding low-inference criteria; 100% of the high-inference criteria); due to the high-inference nature of the ratings, we chose to double code 100% of the material regarding the rating scales. For low-inference ratings, a lesser amount of double coding is usually sufficient (e.g., 10%; Charalambous, 2008). To assess interrater reliability, we relied on Cohen's Kappa for the nominal scaled low-inference codes and on intraclass correlation coefficients (ICC) for the high-inference ratings (following Döring & Bortz, 2016, p. 346). Measures of interrater reliability showed substantial agreement on each category (low-inference aspects: $0.62 < \kappa < 1.00$ [see Landis & Koch, 1977]; high-inference aspects: $0.87 < ICC < 0.93$ [see Koo & Li, 2016]). We used the mean of two independent coders' ratings as a measure of the high-inference quality aspects. The results reported in the "Findings" section focus primarily on the high-inference ratings for the five quality aspects of explanations described above. Details on specific quality indicators (e.g., based on low-inference events or additional specific ratings) are reported selectively when suitable to explain the different quality aspects in greater detail.

## Data analysis

To examine the quality of teacher candidates' explanations with respect to different quality aspects (Research Question 1), we drew on both qualitative and quantitative analysis. For the latter, we used a Friedman test (non-parametric equivalent of the one-way related ANOVA) because the independent variables were not normally distributed. As post hoc tests, we applied Wilcoxon signed-rank tests and used Bonferroni correction to avoid the accumulation of alpha errors. As we examined 10 individual comparisons in applying the Wilcoxon tests, we report all effects at the 0.005 level of significance. We also analyzed relationships between different quality criteria by applying correlation analyses (Bonferroni correction: $p < 0.005$). For the comparison of planned and impromptu explanations (Research Question 2), the Wilcoxon test (non-parametric equivalent of the t-test; Bonferroni correction: $p < 0.01$) and correlation analyses (Bonferroni correction: $p < 0.01$) were used.

## Findings

### Quality of teacher candidates' prepared explanations

We were initially interested in the quality of prospective teachers' explanations (Research Question 1). An analysis of the overall quality of teacher candidates' explanations yielded mixed results. Each of the five quality aspects could be rated on a four-point Likert scale, ranging from 0 to 3 points. Teacher candidates reached an overall quality measure of $M = 8.74$ out of 15 possible points ($SD = 2.29$), with the minimum score of 4.00 and the maximum of 13.50. Hence, there seems to be great variance regarding the overall quality of the explanations. A total 20 of the 48 teacher candidates received a favorable rating (scores 2 and 3) for at least three of the quality criteria (7 of them managed to score highly on all five quality aspects). By contrast, 12 teacher candidates failed to achieve (more than) one favorable rating (5 of them scored poorly [scores 0 and 1] on all quality aspects). For the remaining 16 teacher candidates, the scores for different quality aspects varied between favorable and less favorable ratings.

Furthermore, there were significant differences between the ratings of the five quality aspects ($\chi^2(4) = 33.88$, $p < 0.001$). The explanations of teacher candidates reached the lowest ratings for *content* ($M = 1.52$, $SD = 0.75$) and *representation* ($M = 1.50$, $SD = 0.73$). Drafting a correct and coherent explanation and designing suitable representations seemed to be the most difficult tasks for teacher candidates. Only half of the participants reached a favorable score (2 or 3 points) on the quality aspects *content* and *representation*. For instance, 31 of the 48 explanations contained at least one error (quality aspect *content*), with a mean of 1.5 errors ($SD = 1.9$) and a maximum of 11 errors in one explanation. Twenty-four of those 31 explanations contained errors that were not directly linked to understanding the main aim of the explanation (the fact that the VAT does not affect net income). Hence, it can be assumed that the success of the explanation was not directly compromised by these errors. However, these errors still demonstrated crucial flaws in the teacher candidates' content knowledge (e.g., incorrect use of bookkeeping principles, confusing net and gross amounts). Seven explanations contained errors that directly contradicted the main explanatory goal (e.g., entering the VAT in the profit and loss account) and, therefore, severely affected the explanation's quality. Moreover, only two teacher candidates provided multiple explanatory approaches to the topic of VAT (economic approach and bookkeeping approach). Even after being prompted by the student, only four other teacher candidates were able to offer comprehensive explanations using both explanatory approaches.

Turning to the *representation*, the rather low quality can, for instance, be explained by limitations in the use of examples. Although the majority of teacher candidates ($n=41$) referred to an example to illustrate the content, the chosen examples were not always adequate. As there is a reduced VAT rate on groceries in Germany, the examples concerning this industry ($n=10$) were unnecessarily complex. They were especially problematic if the differences between the tax rates were not made explicit, or if the regular tax rate was incorrectly applied to groceries also ($n=3$). Similar results were found for the visualizations of prospective teachers. About half of all visualizations displayed significant faults. Eight visualizations contained errors (e.g., wrong tax amounts, arrows depicting the wrong connections), and another 14 representations were fragmentary.

The explanations of teacher candidates were evaluated only slightly better in relation to *process structure* ($M=1.57$, $SD=0.82$). This rather low result is due to the fact that, for instance, only half of the participants ($n=23$) evaluated the student's prior knowledge of the subject by using either open-ended questions (e.g., *What do you already know about the value-added tax system?*) or closed-ended questions (e.g., *Which VAT rate is applicable in Germany?*). Furthermore, although 32 participants evaluated the student's understanding, most teacher candidates used closed-ended questions (e.g., *Did you understand that? Do you have any questions?*). Only three participants prompted the student to explain the key elements back to them to make sure they had reached an understanding of the topic (e.g., *Can you explain, in your own words, why the value-added tax does not affect profits?*).

The second-best quality criterion was *student–teacher interaction* ($M=1.84$, $SD=0.86$). A common approach to including students actively in an explanatory process is to ask questions while explaining the topic. Thirty-four of the 48 teacher candidates asked at least one question concerning the explanatory content (e.g., *What is the share of VAT in this example? Can you assign the suitable account?*). There was a mean of 4.9 content-related questions per explanation ($SD=5.2$). Moreover, on average, teacher candidates dominated 88.2% ($SD=6.4$) of the conversation. One teacher candidate even talked the entire time, giving the student no chance for active participation. The lowest ratio of teacher activity was 74.4%. However, almost half of the teacher candidates ($n=21$) used more than 90% of the interaction time for their teacher-centered explanation. In 41 of 48 explanations, the standardized student prompted the teacher candidate to modify the explanation (see "Study design"). The quality of such adaptations was rated on a four-point Likert scale from 0 (*candidate does not comply with the quality requirements*) to 3 (*candidate fully complies with the quality requirements*), which resulted in a mean of 1.8 ($SD=0.90$) over 41 explanations. Fifteen teacher candidates reached (rather) low ratings because they did not respond to the student's prompt and did not alter their approach to the explanation or because their response was not sufficient or was incorrect.

The explanations of teacher candidates reached the highest ratings with regard to *language* (see Table 1). A mean value of 2.30 ($SD=0.62$) out of 3 possible points demonstrated a rather high quality of *language* for the majority of teacher candidates. The Wilcoxon tests actually revealed that the quality aspect *language* was rated significantly higher than all other quality aspects ($Z_C=-4.91$, $p=0.000$,

**Table 1** Mean quality ratings of prepared explanations ($n = 48$)

| Quality criteria | *M* | *SD* | *Min* | *Max* |
|---|---|---|---|---|
| Content | 1.52 | .75 | 0 | 3 |
| Student–teacher interaction | 1.84 | .86 | 0 | 3 |
| Process structure | 1.57 | .82 | 0 | 3 |
| Representation | 1.50 | .73 | 0 | 3 |
| Language | 2.30 | .62 | 1 | 3 |

Quality aspects are rated on a four-point Likert scale from 0 (*candidate does not comply with the quality requirements*) to 3 (*candidate fully complies with the quality requirements*)

$r = -0.50$; $Z_{STI} = -3.00$, $p = 0.001$, $r = -0.31$; $Z_{PS} = -3.98$, $p = 0.000$, $r = -0.41$; $Z_R = -5.08$, $p = 0.000$, $r = -0.52$). Concerning the *language* of the explanations, teacher candidates performed well on each of the aspects belonging to this quality dimension (see Fig. 1); for example, they did a good job in choosing the appropriate level of speech for their students.

We likewise analyzed the relationship between different quality aspects (see Table 2). For the prepared explanations, we found a significant rank correlation between the aspects *content* and *representation* ($r = 0.56$; $p = 0.000$). Moreover, ratings on *student–teacher interaction* correlated positively with the *process structure* aspect ($r = 0.47$; $p = 0.001$). However, there were weaker correlations between *student–teacher interaction* and *representation* ($r = 0.30$; $p = 0.036$) as well as between *language* and *representation* ($r = 0.39$; $p = 0.006$) that were not significant at the 0.005 level.

**Table 2** Rank correlations between different aspects of instructional explanations' quality for prepared and impromptu explanations

| | | | | | |
|---|---|---|---|---|---|
| **Prepared explanations ($n = 48$)** | | | | | |
| | 1 | 2 | 3 | 4 | 5 |
| (1) Content | – | | | | |
| (2) Student–teacher interaction | .10 | – | | | |
| (3) Process structure | .13 | .47*** | – | | |
| (4) Representation | .56*** | .30* | -.13 | – | |
| (5) Language | .28 | .17 | -.07 | .39** | – |
| **Impromptu explanations ($n = 45$)** | | | | | |
| | 1 | 2 | 3 | 4 | 5 |
| (1) Content | – | | | | |
| (2) Student–teacher interaction | -.01 | – | | | |
| (3) Process structure | -.06 | .51*** | – | | |
| (4) Representation | .10 | .33* | .13 | – | |
| (5) Language | .27 | .25 | .14 | .12 | – |

On the basis of the Bonferroni correction, we only interpret correlations with a value of $p < .005$

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .005$

For teacher candidates' impromptu explanations, which will be described in detail in the following section, we also found a significant correlation between *student–teacher interaction* and *process structure* ($r = 0.51$; $p = 0.000$; see Table 2). The positive correlation between *content* and *representation* could, however, not be replicated for impromptu explanations.

### Quality of teacher candidates' impromptu explanations

As described in "Study design", participants were prompted to provide a spontaneous explanation in the simulated setting (topic: depreciation of assets). Forty-five of 48 participants acted on that prompt and designed an explanation; the remaining three reacted evasively (e.g., *We'll talk about that in the next session.*). Hence, 45 impromptu explanations could be (1) analyzed regarding quality aspects (Research Question 1) and (2) compared to prepared explanations (Research Question 2; see the following section for results).

Overall, the impromptu explanations of teacher candidates achieved low to medium quality ratings, with a mean of $M = 6.82$ out of 15 possible points ($SD = 1.76$, $Min = 4$, $Max = 11$; see Table 3). Again, there were significant differences regarding the five quality aspects ($\chi^2(4) = 126.03$, $p < 0.001$). While the qualities of *language* and *content* were evaluated rather highly, the quality of *representation* was rated at a medium level and the qualities of the explanations' *process structure* and *student–teacher interaction* were low.

Accordingly, the impromptu explanations, for instance, contained significantly fewer errors (quality aspect *content*) than did the planned explanations described above. There were only two impromptu explanations that contained errors; one of these was only a minor error (wrong use of a technical term that was not directly related to the explanatory content).

The low score regarding *student–teacher interaction* can be explained by a rather low student involvement in the impromptu explanations of teacher candidates. The learner's share of the conversation ranged between 10 and 43% ($M = 26$, $SD = 8$). However, this rate included the learners clarifying their question in the spontaneous explanation context. Eighteen teacher candidates asked at least one question during the impromptu explanation process. However, only seven of them used

**Table 3** Mean quality ratings of impromptu explanations ($n = 45$)

| Quality criteria | *M* | *SD* | *Min* | *Max* |
|---|---|---|---|---|
| Content | 1.97 | .83 | 0.5 | 3 |
| Student–teacher interaction | .83 | .83 | 0 | 3 |
| Process structure | .32 | .53 | 0 | 2 |
| Representation | 1.17 | .50 | 0 | 3 |
| Language | 2.53 | .42 | 2 | 3 |

Quality aspects were rated on a four-point Likert scale from 0 (*candidate does not comply with the quality requirements*) to 3 (*candidate fully complies with the quality requirements*) content-related questions. Others only inquired whether they had understood the student's question correctly.

The *process structure* of the impromptu explanations was of poor quality. Only four teacher candidates evaluated the prior knowledge of the student, and nine teacher candidates evaluated their understanding. None of the participants summarized the explanatory content at the end of the process.

The quality of *representations* was rated at medium level. Here, for instance, the fact that all teacher candidates used an example to illustrate the purpose of the depreciation of assets had a positive impact. However, only 10 of the 45 participants visualized the explanatory content on the whiteboard or paper provided.

The high quality regarding *language* can be explained by the continuously high performance of teacher candidates regarding different aspects of *language* during the impromptu explanation, that is, by using an appropriate level of speech, avoiding vagueness, and supporting the explanation through the use of gestures and movements.

## Differences between prepared and impromptu explanations

Table 4 illustrates the differences between the quality ratings of prepared and impromptu explanations (Wilcoxon test, $n=45$). First of all, the results show that the overall quality (derived as the mean of all five quality aspects) is significantly lower for impromptu explanations than for prepared explanations ($M_I=1.36$; $M_P=1.73$; $Z=-4.38$; $p=0.001$; $r=-0.47$). Interestingly, there were significant differences between the two types of explanations for each quality criterion. The biggest difference concerned the *process structure* (e.g., evaluating prior knowledge and understanding, summarizing content), which was strongly affected by the possibility of preparing an explanation. There was an equally strong effect for *student–teacher interaction*, which was rated significantly higher for prepared explanation processes. The same result applies to the quality of *representations*.

There was a significant difference in the quality of *content* as well. Surprisingly, however, *content* was rated significantly higher in the impromptu explanations. The

**Table 4** Prepared vs. impromptu explanations ($n=45$)

| | Prepared explanation | Impromptu explanation | *Z* | *p* | *r* |
|---|---|---|---|---|---|
| Overall Quality: *M* (*SD*) | 1.73 (.42) | 1.36 (.35) | -4.38 | .001 | -.47 |
| Content: *M* (*SD*) | 1.50 (.74) | 1.97 (.72) | -2.97 | .002 | -.32 |
| Student–teacher interaction: *M* (*SD*) | 1.82 (.86) | .83 (.83) | -4.90 | .000 | -.53 |
| Process structure: *M* (*SD*) | 1.53 (.81) | .32 (.53) | -5.17 | .000 | -.56 |
| Representation: *M* (*SD*) | 1.49 (.74) | 1.17 (.50) | -2.59 | .008 | -.28 |
| Language: *M* (*SD*) | 2.32 (.60) | 2.53 (.42) | -2.69 | .006 | -.29 |

Quality aspects were rated on a four-point Likert scale from 0 (*candidate does not comply with the quality requirements*) to 3 (*candidate fully complies with the quality requirements*). Overall quality is calculated as the mean over all five quality criteria same is true for *language*. Finally, except for the ratings for *language* ($r = 0.53$, $p = 0.000$), there were no significant correlations between the prepared and impromptu explanations of the teacher candidates (Table 5).

When interpreting the results, one has to take into account that there was a significant difference concerning the length of the two types of explanations. Prepared explanations on average took up almost six times as much time as did impromptu explanations ($M_P = 528$ s, $SD_P = 141$; $M_I = 91$, $SD_I = 38$).

## Discussion

### General discussion

In this paper, we report findings on the explaining skills of teacher candidates in the field of accounting. First, we were interested in the extent to which prospective accounting teachers were able to provide high-quality explanations (Research Question 1). The results show that the quality of instructional explanations varied considerably across our sample of teacher candidates. Overall, participants received a medium quality rating. Looking at the different aspects of explanatory quality, we found that teacher candidates experienced the greatest difficulties with respect to the aspects of *content* and *representation*. Major weaknesses in the explanations of teacher candidates were found, for instance, in relation to correctness or the use of multiple explanatory approaches. Hence, we were able to confirm previous findings on deficiencies in prospective teachers' explanations (for correctness see e.g., Borko et al., 1992; Thanheiser, 2009; for a lack of multiple explanatory approaches see Housner & Griffey, 1985; for representations see e.g., Borko et al., 1992; Inoue, 2009; Wheeldon, 2012). There were also certain deficiencies regarding the *process structure* of an explanation. Only half of the participants evaluated the student's prior knowledge, and although the majority thought of evaluating the student's understanding, they did so by asking closed-ended questions. This finding is, again, in line with evidence from prior studies on activating prior knowledge (Sánchez et al., 1999) and evaluating understanding in explanatory processes (Leinhardt, 1989; Leinhardt & Greeno, 1986).

**Table 5** Rank correlations between quality ratings of prepared and impromptu explanations ($n = 45$)

| | Impromptu explanation | | | | |
|---|---|---|---|---|---|
| Prepared explanation | 1 | 2 | 3 | 4 | 5 |
| (1) Content | .14 | - | - | - | - |
| (2) Student–teacher interaction | - | .19 | - | - | - |
| (3) Process structure | - | - | -.16 | - | - |
| (4) Representation | - | - | - | -.06 | - |
| (5) Language | - | - | - | - | .53** |

$^{**}p < .01$

However, we also identified several strengths of teacher candidates' instructional explanations. Specifically, the explanations achieved good quality ratings on *student–teacher interaction* and especially on *language*. In their explanations, teacher candidates demonstrated strengths in choosing an appropriate level of speech or ensuring the student's active engagement. The latter contradicts previous findings (Kocher & Wyss, 2008; Spreckels, 2009). One deficit regarding *student–teacher interaction* that also emerged in our findings is the difficulty of teacher candidates to react flexibly to students' cues. Out of 41 teacher candidates who were prompted to change their explanatory approach, 15 did not respond to the student's prompt and did not alter their approach to the explanation or provided an insufficient or incorrect response. Again, this outcome is in line with prior evidence (Borko & Livingston, 1989; Leinhardt, 1989). Adapting an explanation flexibly seems to be particularly difficult for teacher candidates, who—unlike experienced teachers—usually stick to the explanatory approach they prepared in advance (see also Spreckels, 2009).

Moreover, we identified correlations between selected quality aspects. When interpreting these correlations, one has to keep in mind that some part of the correlations might be explained by a potential overlap between certain categories or raters' difficulty to strictly distinguish between certain quality aspects. However, the identified correlations are also not unexpected from a conceptual point of view. First, the positive correlation between the *content* and *representation* aspects of prepared explanations is not exactly surprising, as it seems plausible that one needs a sound knowledge base regarding the explanatory content to design suitable representations. Hence, the fact that the explanations of accounting teacher candidates reached especially low quality ratings regarding *content* and *representation* could be due to deficits in content knowledge. This seems especially plausible since the majority of teacher candidates' explanations were error-prone, demonstrating their lack of sound knowledge regarding basic accounting principles. The results of certain deficits in the content knowledge of teacher candidates are in line with the findings of prior studies on the professional knowledge of prospective accounting teachers (Fritsch et al., 2015). The fact that the correlation between *content* and *representation* was not replicated for impromptu explanations also underlines the differences between prepared and impromptu explanatory processes or differences between different explanatory topics respectively (see below). Another possible explanation would be the rather broad assessment approach used in this study, since Ring and Brahm (2022) report significant correlations between selected aspects of *content* and *representations* only (completeness and use of examples).

We also found a significant correlation between *student–teacher interaction* and *process structure* for both prepared and impromptu explanations. Similarly, as both quality aspects comprehend pedagogical and didactical considerations, this relationship was not unexpected. It only seems logical that after evaluating prior knowledge, one would consider the knowledge and characteristics of students when designing the explanation.

Second, we examined how prepared and impromptu explanations differed in respect of different quality criteria (Research Question 2). The results revealed significant differences between the overall quality in favor of prepared explanations. The difference between prepared and impromptu explanations even reached a medium effect size ($r = -0.47$). Accordingly, except for *language*, none of the quality aspects showed significant correlations between prepared and impromptu explanations. While this result is not very surprising, it still demonstrates that teacher candidates benefit from the possibility of preparing explanatory processes and are ill-prepared to spontaneously design high-quality explanations. When looking at different quality aspects, it becomes evident that prepared explanations reached significantly higher scores, especially with regard to *process structure* and *student–teacher interaction* as well as *representation*. The lower quality of *content* for prepared explanations is surprising but might be explained by differences in the complexity of the explanatory topic. A slight improvement in the quality of *language* could be due to training effects, as the impromptu explanation was presented after the prepared explanation. As different quality aspects for prepared and impromptu explanations did not correlate, except for the aspect of *language*, our findings support the assumption that explaining is a content-specific skill (e.g., Keil & Wilson, 2000; Wagner & Wörn, 2011). Consequently, our findings provide additional insights into this question, which has so far not been sufficiently examined, as we show that the ability to generate high-quality explanations with respect to *content*, *student–teacher interaction*, *process structure*, and *representation* does not seem to be transferable to different explanatory situations. While it is plausible that aspects of *language* are rather stable across different teaching situations, our results suggest that each explanatory content needs to be evaluated, for instance, with respect to relevant aspects that need to be included in the explanation or suitable representations and examples. The findings also show that prospective teachers are more able to tailor their explanations to students if they have prepared an explanatory approach. Actively involving students has been one of the problems identified in the explanations of prospective teachers in prior studies (Kocher & Wyss, 2008; Spreckels, 2009). Our findings show that preparation can help prospective teachers overcome this issue. This could be due to the fact that during preparation they actually planned how to engage students or that they were more flexible in actively engaging students spontaneously because the basic course of the explanation (structure, representations, etc.) was already planned in advance.

## Limitations

In interpreting the results, certain limitations need to be taken into account. The interactive simulation seems to be a valuable tool to implement (1) a performance-based assessment that (2) allows for controlled conditions and (3) includes an interactive element, something that has often been neglected in previous studies on explaining. However, we simulated a simplified explanatory situation. In real classroom settings, a teacher has to explain a subject matter to a whole group of students, presumably with individual characteristics, different prior knowledge, different preferences and needs. It has yet to be established if someone who performs well in the simulation will also show high-level explaining skills in a real classroom situation. For instance, the rather positive results concerning *student–teacher interaction* might be partly explained by the one-on-one setting. However, teacher candidates' awareness of the importance of actively engaging students in instructional explanations might also result from the increasing discussion about providing active learning formats for students (for the field of accounting see e.g., Adler & Milne, 1997; Opdecam & Everaert, 2019). Moreover, the preparation of the explanatory approach was not realistic in the sense that teachers would normally use a wide range of self-chosen resources (especially online resources) when preparing to explain a complex content to students. This was not allowed in the setting of our study in order to ensure comparability between participants regarding study conditions.

We also need to take into account that there are limitations regarding the comparability of prepared and impromptu explaining situations. The topics covered in the two explanations (VAT, depreciation of assets) are both central topics in accounting education and part of the curriculum in German vocational schools. However, an explanation of the VAT system is more complex and needs to cover a higher number of individual aspects compared to an explanation of the depreciation of assets. This discrepancy was also reflected in the amount of time that prospective teachers needed to explain these two topics (prepared explanations on VAT were about six times as long as impromptu explanations on the depreciation of assets). In addition, since we varied both the possibility of preparing an explanation and the explanatory topic, we could not distinguish whether the effects found were due to the transfer to a new topic or to the new conditions. The differences might also be due to different levels of content knowledge of teacher candidates. Since content knowledge was not assessed in this study, we could unfortunately not control for differences in this regard. Finally, we also need to consider that lower quality ratings of impromptu explanations might partly be explained by fatigue effects, since impromptu explanation prompts were administered as an add-on after the prepared explanatory processes. Future research should implement randomized study designs that additionally allow for distinguishing between different types of transfers to new explanatory situations.

The most important limitation is probably the reliance on third-party evaluations of explanatory quality. Since we used standardized trained students, we were not able to analyze the decisive quality aspect of an explanation: students' understanding. An idea for future studies might be to include students with equal prior knowledge and characteristics in the assessment of the explanations or to test students' understanding after playing them the video of teacher candidates' simulated explanation.

## Implications

Despite such limitations, there are practical implications resulting from our study. The results demonstrate a need for greater attention to be paid to the design of concrete learning opportunities with regard to essential teaching skills (e.g., explaining) during teacher education. In this context, it is important that the development of professional competencies of (prospective) teachers is viewed from a longer-term perspective and includes all phases of teacher education (Alles et al., 2019). Interactive simulations are a valuable tool for constructing a realistic but controllable setting in which to practice such skills. This instrument is useful both as a performance-based measurement tool for research and as a training setting for teacher education providing, for instance, an opportunity for the introduction of microteaching episodes. In our opinion, this tool will serve as a valuable approach to foster the professional development of teacher candidates (see also Findeisen et al., 2021). Since explaining is a core teaching practice (e.g., Ball & Forzani, 2011) and teacher candidates—as our results show—experience difficulties while explaining, teacher education programs should provide additional learning opportunities for designing explanations. Fostering a deep understanding of crucial topics during teacher education programs is also an important prerequisite for typical teaching activities, like designing instructional explanations. Moreover, it seems important to discuss content- or domain-specific requirements regarding the design of suitable examples or visualizations during teacher education. Finally, teacher candidates do not seem to be aware of the importance of activating the prior knowledge of students and assessing their understanding comprehensibly during explanatory processes. When learning to explain, this gap seems to be an issue that should be addressed in teacher education.

Our findings also show that investing time in the preparation of explanatory approaches leads to instructional explanations with higher overall quality. This is not only true for crucial elements of the explanation, like representations, but a preparation also allows teacher candidates to interact with students in a more flexible way. Hence, we expect that teacher candidates would benefit from being prompted during teacher education to not only prepare a general lesson plan but also to think through single elements of a lesson (e.g., instructional explanations). A detailed preparation of instructional explanations might become less important the more experience a teacher has with explaining in the classroom. Nonetheless, teacher candidates will still benefit from putting time and effort into preparation. Since the comparability of the explanatory content for prepared and impromptu explanations was limited in our study (see "Limitations") and the quality of *content* was actually higher for impromptu explanations, future research should re-examine this aspect for two explanatory contents of similar complexity. Moreover, as teacher candidates still demonstrated difficulties when providing prepared explanations, it would be of interest to examine their preparation process in order to gain information on how they can be better supported during this step.

Our study contributes to existing research in several ways. By distinguishing explanatory quality into different aspects, it allows teacher educators to gain information about different aspects of explaining, the strengths and difficulties of prospective teachers, and how these are interrelated. By comparing planned and impromptu explanations on different accounting topics, we also provide evidence on the still scarcely-researched question of whether explaining is a transferable skill. Finally, the design and implementation of interactive simulations are, from our point of view, a valuable approach for further research on (prospective) teachers' explaining skills, since this approach accounts for the interactive nature of explaining situations that prior studies have often failed to account for.

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## Declarations

**Competing interests** The authors declare that they have no conflict of interest.



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**Stefanie Findeisen** is an assistant professor for Business and Economic Education at the University of Konstanz (Germany). Her research interests focus on the acquisition of teaching skills, modelling and measuring professional competencies, and learning processes in vocational education.

**Juergen Seifried** is a professor of Economic and Business Education at the University of Mannheim (Germany). His research focuses on teaching-learning processes (analysis of the effects of teaching and learning in the context of vocational schools, workplace learning, higher education) and on professional development (analysis of the development of professionalism and expertise in non-institutionalized contexts, workplace learning).

## Authors and Affiliations

**Stefanie Findeisen**[1] · **Juergen Seifried**[2]

✉ Stefanie Findeisen
stefanie.findeisen@uni-konstanz.de

1 Department of Economics, University of Konstanz, Universitaetsstrasse 10, Konstanz 78464, Germany

2 Business School, Area of Economic and Business Education, University of Mannheim, L4,1, 68161 Mannheim, Germany