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Instructional strategies for using video in teacher education

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HIGHLIGHTS

- Two instructional strategies for using video in teacher education were investigated.
- A rule-example strategy scored higher in factual knowledge and class observation.
- An example-rule group scored higher in identifying challenges in lesson planning.
- The findings show a differential but positive effect of using video.
- Implications call for the informed and specific use of video in teacher education.

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ABSTRACT

Using video in teacher education can increase pre-service teachers' ability to apply knowledge. However, video is not effective in itself. To be useful, it must be embedded in appropriate instructional contexts. We investigated the differential impact of two university modules—one using video as an illustrative example (rule-example) and one using video as an anchor (example-rule)—on pre-service teachers' ($N = 56$) knowledge. The rule-example group scored higher on reproducing factual knowledge and evaluating videotaped classroom situations, whereas the example-rule group scored higher on lesson planning. The findings emphasize the need for their targeted use depending on specific learning goals.
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1. Introduction

University-based teacher education has been criticized for not bridging the gap between theory and practice, resp. helping pre-service teachers in successfully linking pedagogical knowledge to the actual practice of classroom situations (Borko, Liston, & Whitcomb, 2006; Cochran-Smith & Zeichner, 2005). Many pre-service teachers struggle when trying to integrate basic knowledge that is taught in the different courses on content and pedagogy, as well as to apply this knowledge to the actual situation of classroom teaching (Ball, 2000; Blomberg, Stürmer, & Seidel, 2011; Brouwer, 2010; Schoenfeld, 1998). Much emphasis, therefore, has been given to integrate practice into the context of initial teacher education (Darling-Hammond & Bransford, 2005; Grossman et al., 2009; Grossman & McDonald, 2008).

A call was given to support pre-service teachers in acquiring 'integrated' knowledge, meaning well-defined and differentiated knowledge structures that are connected to multiple contexts of application (Borko, 2004; Putnam & Borko, 2000). Contexts for knowledge application, however, do not necessarily have to involve the complex and dynamic setting of real classrooms. Researchers rather argue for "approximations of practice" (Grossman & McDonald, 2008), meaning that application contexts can vary and include diverse aspects in the full cycle of teaching, such as lesson planning (as a form of constructing mental representations of possible classroom settings) or observation of classrooms (as a form of applying knowledge to the observation and reflection of teaching).

So far, a number of researchers have answered to this call, some by describing existing curricula and instructional activities in teacher education programs and providing valuable information with regard to existing structures and practices (e.g. Grossman

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et al., 2009); others have taken a stance to study specific instructional approaches and their impact on the acquisition of applicable teacher knowledge (e.g. Hammerness, Darling-Hammond, & Shulman, 2002; Santagata & Angelici, 2010).

In this second strand, Vermunt and Verloop (1999) have argued that teacher candidates should be taught in the same sophisticated way that educational researchers expect children to be taught at school. To this end, they have called for research examining whether, how, and why teacher education programs work. Current teacher education research should therefore further the understanding of the connections between specific aspects of teacher education (e.g. the instructional strategies implemented) and pre-service teachers' learning to address the lack of knowledge about instructional practices and how they relate to learning outcomes (Kennedy, Ahn, & Choi, 2008). A focus on the design of learning environments—especially at an early stage of their professional education, at which pre-service teachers have not yet gained much practical teaching experience—may thus help to close the gap between the intentions and outcomes of teacher education (Brouwer, 2010).

One tool often seen as an important resource in addressing the acquisition of pedagogical knowledge is classroom video. Indeed, video examples of classroom practice have become a popular resource in teacher education (Brophy, 2004; Goldman, Pea, Barron, & Derry, 2007). It has been shown that observing classroom video can help pre-service teachers to relate their university learning to their later classroom practice. Thus, video can bridge the gap between theory and practice (Abell & Cennamo, 2004). Activities involving video have the potential to meaningfully guide the acquisition, activation, and application of pre-service teachers' knowledge (Seago, 2004). However, research stresses that video should not be regarded as effective in itself (van Es, 2009): Video is a technology for delivering content rather than a body of content in and of itself (Brophy, 2004). It must therefore be employed with clear objectives in mind (van Es, 2009).

This study seeks to address the lack of systematic knowledge on the integration of video into initial teacher education (Santagata, Zannoni, & Stigler, 2007). Some previous studies have examined pre-service teachers' learning by means of video-based approaches (Koc, 2011; Llinares & Valls, 2009; Masingila & Doerr, 2002; Rosaen, Lundeberg, Cooper, Fritzen, & Marjorie, 2008; Santagata & Angelici, 2010; Schrader et al., 2003; Wong, Yung, Cheng, Lam, & Hodson, 2006). However, they have not systematically analyzed the specific impact of distinct video-based instructional approaches on pre-service teachers' knowledge application. Studying the impact of distinct ways of integrating video into teacher education courses on pre-service teachers' ability to apply the knowledge acquired, can facilitate informed decisions on the effective use of video in teacher education. Against this background, in the following we (1) identify indicators of pre-service teachers' knowledge application, (2) link different ways of integrating video examples to those indicators, and (3) draw conclusions on how video examples should be implemented in order to systematically foster those indicators.

1.1. Identifying indicators of pre-service teachers' knowledge application

According to Putnam and Borko (2000), teachers' knowledge application—and hence the development of teacher expertise—depends on the quality of knowledge structures. Cognitive science research has demonstrated that the development of knowledge toward greater expertise tends to be characterized by connections among elements of knowledge, understanding of important concepts, and the ability to apply knowledge flexibly and effectively in a wide variety of situations (e.g. Bereiter & Scardamalia, 1985; Chi, Glaser, & Rees, 1982). Furthermore, according to theories of complex cognition, the amount and structure of declarative knowledge determine the ability to apply knowledge (Anderson, 1996). Research on teacher expertise has shown that experts have a broader and better organized knowledge of facts than novices do (Leinhardt & Greeno, 1986). Accordingly, experts in teaching excel in contexts that require the reproduction of declarative knowledge on pedagogical contents such as specific facts or terms (Shulman, 1987). Because applying knowledge means being able to successfully use this declarative knowledge in various situations, future teachers need to develop concepts or schemas of standard classroom situations and to be able to use them to interpret classroom interactions (Sabers, Cushing, & Berliner, 1991). Experts have a well developed knowledge of concepts in their domain that allows them, in the teaching context, to interpret typical classroom situations and to make sense of student thinking (Borko, 2004). It is also important that future teachers are able to anticipate novel situations and to mentally simulate future instructional actions (Borko, 2004) by generating mental representations of new and future classroom interactions. Sternberg (1996, p. 179) has pointed out that differences between expert and novice teachers are particularly apparent in the formulation of lesson plans, "which show better, more complex, and more effective planning for teaching by experts than by novices." Experts' planning is further characterized by their flexibility to adapt to the situational demands of certain subjects (Borko & Livingston, 1989). Gruber (2001) attributed these findings to experts' metacognitive skills, including the ability to generate mental images of future actions, which serve to guide their decisions. Despite the fact that teacher experts are better in generating mental images as shown for example in their lesson planning but it can not be concluded that better lesson planning would directly translate into better teaching action. This may be true for expert teachers but cannot be generalized to other groups of teachers, especially to novice teachers. However, lesson planning represents one form of an approximation of practice (Grossman & McDonald, 2008), indicating to what extent persons use knowledge in order to mentally simulate future actions (Borko, 2004).

1.2. Using video examples to foster pre-service teachers' knowledge application

There is consensus that creating effective learning environments that link theoretical knowledge to practical experience can help to bridge the theory–practice gap in teacher education (Brouwer & Korthagen, 2005; Korthagen & Kessels, 1999; Rovegno, 1993). The provision of practical experience is a particular challenge in initial, university-based teacher education, and video has assumed a prominent role in this context. In considering how to link theory to practice in initial education, Korthagen and Kessels (1999) emphasized the role of *examples* such as those provided by classroom video. They further argued for the need to provide pre-service teachers with certain *rules* respectively "principles". These kinds of principles refer, for example, to basic knowledge about effective principles of teaching and learning such as clear goal setting and orientation, activation of student thinking and learning activities, support and guidance in regulating learning, and evaluating learning processes and outcomes (Seidel & Shavelson, 2007). The principle for goal setting and orientation, for example, includes knowledge about the relationship between teaching and learning goals, the importance to specific and explicitly addressing learning goals to students and to align instruction according to those learning goals. The activation of student thinking refers to knowledge about the relevance of higher-order questions and tasks that stimulate deep student thinking about content matter. Next to

knowing about these principles pre-service teachers most importantly should be encouraged to encode and interconnect both abstract rules/principles and concrete examples in which it is shown how this knowledge is applied (Renkl, 2011).

How rules and video examples are best combined depends on the specific learning objective: video examples may be used (1) to illustrate *rules* and set them in the context of schools and classrooms or (2) to demonstrate the complexity of classroom action, from which they then derive *rules* (Korthagen & Kessels, 1999). Two strategies can thus be differentiated: *rule-example* vs. *example-rule* (also known as rule-eg vs. eg-rule). Likewise, Santagata et al. (2007) have distinguished two ways of using video examples in teacher education in terms of the guidance required. Using video examples to illustrate rules requires direct guidance and the content illustrated to be taught in advance; using video examples to derive rules requires more indirect guidance in terms of support for group thinking processes. Decisions on how to implement video examples into teacher training should therefore be based on the learning goals at hand (Korthagen & Kessels, 1999). Rule-example strategies have generally been shown to foster the acquisition of facts (declarative knowledge) and concepts (Tomlinson & Hunt, 1971), whereas example-rule strategy seem to be more favorable to action-related learning (e.g. Champagne, Klopfer, & Gunstone, 1982).

Inspection of the video-based modules in teacher education programs reveals that they tend to be aligned with the example-rule strategy and corresponding learning goals (Llinares & Valls, 2009; Rosaen et al., 2008; Santagata et al., 2007; Schrader et al., 2003; Wong et al., 2006). Likewise, video cases are sometimes used as an anchor to support pre-service teachers' informed decision-making (e.g. what to teach, when to teach it, and how best to do so; Schrader et al., 2003). Furthermore, video may be used as a starting point in situated learning for pre-service teachers' investigation of practice (Llinares & Valls, 2009), discussions, and reflections (Masingila & Doerr, 2002). Observation of video examples is often followed by group discussion or theoretical input (Llinares & Valls, 2009).

Research with students using the rule-example strategy demonstrated a positive impact on the acquisition of factual and conceptual knowledge. Since beginning pre-service teachers are in their initial phase of acquiring basic pedagogical knowledge the general results stemming from psychology should also be studied carefully in this context of teacher education.

In this study, we therefore analyze the specific impact of the two instructional strategies on pre-service teachers' learning. In so doing, we investigate whether experimental findings on the differential impact of the two instructional strategies on specific learning outcomes (rule-example: facts and concepts; example-rule: heuristic/procedural knowledge and motivational aspects) can be transferred to video-based learning environments in the complex setting of initial teacher training.

1.3. Hypotheses

We designed the present study to test the impact of two instructional strategies for using classroom video in the context of university-based teacher education on pre-service teacher learning. To this end, we developed two video-based modules, one using video to illustrate rules, the other using video to elicit pre-service teachers' knowledge, from which they then derived rules. The following three indicators of pre-service teacher learning—derived from teacher research—were used as dependent variables and assessed at the end of the three-month term: (1) reproducing factual knowledge about principles of teaching and learning, (2) observing and evaluating video-taped classroom situations, and (3) mentally simulating instructional action by lesson planning.

Given the different learning goals behind the two strategies, we expected that the two learning environments would be differentially effective. We expected learning environments based on the rule-example strategy to foster the acquisition of factual knowledge and conceptual understanding. Therefore, we hypothesized that the group taught according to the rule-example strategy would be better at reproducing factual knowledge (Hypothesis 1) and applying that knowledge to observe and evaluate video-taped classroom situations (Hypothesis 2). In contrast, learning environments based on the example-rule strategy aim to foster problem-oriented learning which helps to mentally simulate novel classroom situations. Therefore, we expected the group taught according to the example-rule strategy to be better at generating mental images of their future classroom action (Hypothesis 3).

2. Method

2.1. Participants

Participants were 54 pre-service teachers (28 females, 28 males) in their second year of teacher education at a university in central Germany. Their mean age was 21.0 years (SD = 1.8), and their final high school examination score ("Abitur") was good (M = 2.3, SD = .40). All participants were enrolled both in the mandatory lecture "principles of teaching and learning" and in the course designed for this study. Participants, thus, could be compared with the full cohort of the mandatory lecture regarding important prerequisites (pre-knowledge, interest). Descriptive analyses showed that the participants of this study scored in the midrange on the prior knowledge test of the lecture (M = 45.8%, SD = 11.1%) and were also interested in teaching and learning (M = 3.60, SD = .52, Likert-scale ranging from 0 = low to 5 = high). Prior knowledge was assessed by a 16-item multiple-choice test. The test items assessed participants' knowledge of basic principles of teaching and learning and were developed on the basis of a frequently used German textbook. Interest in teaching and learning was assessed by a questionnaire of Drechsel (2001). Comparisons showed no significant differences between participants (N = 54) and the full cohort (N = 632) in age, high school examination score, prior knowledge, and interest, all t-values of t-tests (df = 684) were smaller than 1, with $p > 0.05$. Prior to enrollment to the study all participants were exposed to the same instruction as represented in the teacher education program in which various pedagogical strategies are represented and no single pedagogical strategies are specifically favored. Courses vary from lectures to problem-oriented seminars and small-group courses. Thus, it can be assumed that participants have not been specifically familiarized with a certain type of instruction that might favor one of the two instructional strategies under investigation.

Participants were randomly assigned to one of the two instructional strategies. They were informed that the module was part of an empirical study, but they were not told about the kind of experimental variation or the research questions. Written consent was obtained from all participants. Participants were able to withdraw from the study at any time. None of the participants, however, withdrew. The two treatment groups did not differ statistically significantly in terms of age, gender, high school examination score, prior knowledge and interest (all t-tests: $p > 0.05$).

2.2. Instructional strategies

Two video-based courses representing the two instructional strategies under investigation were developed. The courses were

designed for pre-service teachers in the second year of their bachelor degree program in which students initially acquire general pedagogical knowledge. German pre-service teachers have no systematic practical teaching experience at this stage of their education due to the fact that a two-year practical internship follows university teacher education (Bauer & Prenzel, 2012). It is therefore of particular importance for educational courses at universities to integrate theory with examples and applications in order to avoid acquisition of inert knowledge.

2.2.1. Shared elements in both courses/instructional strategies

2.2.1.1. Time. Both courses had the same amount of lesson time and comprised eight sessions lasting 90 min. The courses took place every second week during the winter semester 2008/2009.

2.2.1.2. Teacher. To ensure consistency of implementation, both modules were taught by the same professor, who had 10 years of teaching experience in teacher education. Based on previous observations, evaluation reports, and informal discussions with the instructor, we did not expect the instructor's typical teaching style to be more strongly aligned with either of the two instructional strategies, which would have constituted an advantage for one of the approaches.

2.2.1.3. Content. The curriculum referred to a basic teaching and learning model as presented in a recent meta-analysis (Seidel & Shavelson, 2007). Based on this model three teaching and learning components were selected: (a) goal setting and orientation of learning towards goals, (b) activation of student thinking through challenging tasks and support through constructive feedback, and (c) providing a supportive learning climate by taking students' needs seriously. For the three components empirical findings with regard to the effects of a positive practice on student learning (cognitively, motivationally) served as a basis for deriving "rules" respectively principles for teaching and learning (Seidel & Shavelson, 2007). The content was identical in each session of the two courses/instructional strategies.

2.2.1.4. Video clips. The three teaching and learning components have also been investigated in the context of video surveys in German speaking classrooms (Seidel, Prenzel, & Kobarg, 2005). In this context video coding instruments were developed and video clips representing the three components were identified and selected for training purposes (Seidel, Blomberg, & Stürmer, 2010b). Video clips were identical in each course and session. All clips illustrated good teaching (not necessarily best practice); practice that pre-service teachers could potentially see as reflecting their own future teaching. In each session, about two to three video clips were used and participants additionally received contextual information (age, grade, content and course of previous sessions).

As an example, video clips representing goal clarity were focused on the beginning of a lesson. Pre-service teachers could observe how the teacher addresses the goals of the lesson and orients students towards those goals. Another example with regard to scaffolding student learning referred to student group work and the way a teacher is scaffolding the learning processes by posing questions and giving feedback. Finally, video clips representing aspects of learning climate would tackle situations in which teachers have to find a balance between taking the needs of students seriously and still challenging them cognitively by, for example, not giving them direct and easy solutions.

2.2.1.5. Course structure. In both courses, the first session (1) focused on an introduction to teaching in German schools and the presentation of the basic teaching and learning model. In both courses the first session also dealt with an introduction to important factors in classroom teaching such as teacher competencies, student characteristics, student processing of information, and important contextual classroom factors. In the following six sessions, the components of goal clarity and orientation (2, 3), teacher support (4, 5), and learning climate (6, 7) were covered, each in form of two sessions. Both courses ended with a last session (8) reviewing the learning progress and summarizing most important learning results.

2.2.2. Unique elements in the rule-example strategy

The six sessions focusing on the teaching and learning components followed specific instructional strategies that were systematically varied in the two courses. In the rule-example course the instructor started each session with presenting knowledge about the specific component. Thereby, the instructor explained the concepts, provided definitions and referred to empirical findings of practice descriptions and effects on student learning. Regarding goal clarity and orientation, for example, the instructor presented a definition/explanation of the concept (e.g. goal clarity and orientation means that learning goals are explicitly addressed and clarified and that learning activities are aligned to the goal). Following this explanation the instructor gave supportive information with regard to general skills in observing video clips. These skills, for example, referred to the importance to describe observed situations without prior judgment or to explicitly use educational knowledge for explaining and predicting observed situations. After explaining a teaching and learning component and providing pre-service teachers with principles or "rules" that have been shown to be effective (e.g. explicitly addressing learning goals or posing open questions to students) the instructor presented a video clip in order to illustrate classroom practice. Thereby, the instructor modeled how observed behavior can be described, explained and predicted by thinking-aloud. Participants were then asked to use their knowledge about this rule in order to describe, explain and predict the observed situation in the video clip. The analysis of this first video clip was then continued with one or two additional videos representing the teaching and learning component as addressed in the session. For each video clip, the learners wrote their own observation protocol and shared their observations with the class.

Accordingly, in the *rule-example condition* the level of complexity to which learners were exposed was limited and close guidance was offered; learners were provided with as much information and guidance as possible, and they were offered explicit principles which they could rely on when observing and analyzing video.

2.2.3. Unique elements in the example-rule strategy

In the example-rule course the six sessions focusing on the teaching and learning components were structured as follows: First, the instructor started the session with supportive information about general skills in observing video clips. The content of this supportive information was the same as in the rule-example course. It dealt with the importance to describe observed situations without prior judgment and to use educational knowledge for explaining and predicting. Next, the pre-service teachers watched two or three video clips without providing specific knowledge about the teaching and learning component under investigation. After the presentation of a video clip pre-service teachers first wrote an observation protocol and then shared their observations with the class. The class discussion was guided by the instructor, with minimal influence on the learning processes of the students. The instructor, for example, only intervened if the discussion was too evaluative and reminded the student about general observation

skills. After discussing two or three video clips the instructor asked the class to elaborate on observed elements that specifically stood out with regard to teaching and learning. If necessary, the instructor guided the discussion to some extent by posing questions that address important aspects of teaching and learning components. Based on this second round of discussion the instructor finally summarized the results (by using a flip chart and memo cards) and related them to the teaching and learning component under investigation. Thereby, the instructor pointed to results that addressed this component and provided the class with a definition or explanation of this concept. If the class did not address important aspects of the teaching and learning component under investigation the instructor added these elements to the summary of the group discussion.

Accordingly, in the *example-rule condition*, learners started with a higher level of complexity and guidance was more indirect. In many cases, multiple perspectives on instructional situations were provided, and guidance and information were generally offered indirectly. Emphasis was placed on cooperative learning and problem solving.

2.2.4. Implementation of the two strategies

To ensure that the instructional features were implemented as intended, all sessions were videotaped and coded as reflecting either the rule-example or the example-rule strategy. Rating items checking the implementation of the rule-example strategy were:

- rules are presented first
- conceptual knowledge about teaching and learning component is directly instructed
- explicit information about teaching and learning component is always present; research perspective is taken
- pedagogical strategy: low to high complexity

Rating items checking the example-rule strategy referred to:

- video clips are presented first
- rules are derived by participants and their discussion
- conceptual knowledge is acquired in cooperative settings
- explicit information about teaching and learning component is not present at any time, ambiguous perspectives are allowed, multiple perspective are applied
- pedagogical strategy: high to low complexity

Next to checking whether these elements were present in the video-taped sessions raters also had to assign each video clip to one instructional strategy. If unsure they could also opt for a third category, stating that the clip could not be assigned. Two raters (blindly, without knowledge about the assignment of courses to the instructional strategy) as well as the developer of the course (Blomberg, with knowledge about the intended implementation) rated all sessions of the two courses. Mean rater agreement (1 = hit, 0 = miss) showed a Cohen's kappa of .83, which—according to Landis and Koch (1977)—can be considered a high level of agreement. This agreement between raters and developer showed that the treatment conditions were translated into distinct courses that can be distinguished without knowledge of the treatment conditions.

2.3. Measures

Three measures were implemented at the end of the modules to assess the impact on the criterion variables: (a) a test of *factual knowledge* about teaching and learning components, (b) an online tool requiring the *observation and evaluation of videotaped classroom situations*, and (c) a *lesson planning* task that required participants to mentally simulate instructional action. The three measures were selected as possible elements of 'approximations of practice' (Grossman & McDonald, 2008).

2.3.1. Test of factual knowledge

The test of factual knowledge of teaching and learning components consisted of nine multiple-choice items, each with four response alternatives, one of which was correct. The test referred to the content of the courses, and its reliability was satisfactory (Cronbach's alpha: .71). An overview of the items and descriptive information on mean item difficulty and standard deviation is given in Table 1.

2.3.2. Online instrument requiring participants to observe and evaluate classroom situations

Participants completed the Observer instrument that measures pre-service teachers' ability to apply knowledge about teaching and learning to videotaped classroom situations (Seidel, Blomberg, & Stürmer, 2010a; Seidel & Stürmer, 2012). The six clips as used in the instrument were similar to those shown in the courses. In this study, participants were shown six video clips and asked to evaluate these situations by means of rating items. The items focused on the same three teaching and learning components that were dealt with in the courses: goal clarity, scaffolding, and learning climate. Example items for the three components are as follows: "In the excerpt I saw, the teacher explains how the students are to carry out the task"; "In the excerpt I saw, the students are given space for their own thoughts"; "In the excerpt I saw, the students are shown that learning can be fun." The students used a four-point Likert scale ranging from 1 (*disagree*) to 4 (*agree*) to indicate how they interpreted the video clips. The Observer instrument took approximately 90 min to complete. Participants' ratings of the video clips were compared with expert ratings (hit = 1/miss = 0).

Table 1
Test on factual knowledge about teaching and learning components.

Nr.	Item	M	SD
1	Which three main components of instructional quality were focused? *Correct answer: goal clarity, scaffolding learning, learning climate.*	.84	.37
2	What does the term "orientation towards a goal" mean? *Correct answer: students know how their activities relate to the learning goal.*	.53	.50
3	What does the term "clarification of tasks" mean? *Correct answer: students know what to do.*	.29	.45
4	What is understood with regard to "organization of learning content"? *Correct answer: teachers use, for example, overviews and summaries.*	.80	.40
5	What should be particularly noticed with regard to "lesson coherence"? *Correct answer: there is a clear train of thought during the lesson course.*	.88	.33
6	What aspect can be observed with regard to "cognitive activation of students"? *Correct answer: the teacher poses open questions.*	.73	.45
7	How can a teacher guide learning during seatwork? *Correct answer: The teacher is ready for help without providing immediate solutions.*	.84	.37
8	What is a key moment in dealing with student mistakes? *Correct answer: constructive feedback that helps students to learn about their misunderstanding and to be able to correct.*	.90	.31
9	How can you recognize a positive learning climate? *Correct answer: clear distinction between learning and achievement.*	.31	.47

On this basis, item response theory (IRT) models were used to generate estimates of each participant's ability to apply their knowledge. Given the application of IRT models, estimates range around the mean of 0. In our sample, the estimates ranged from a minimum of −2.57 to a maximum of .74, showing that pre-service teachers typically have low abilities in evaluating classroom sequences (cf. Seidel & Prenzel, 2007). The test proved to be highly reliable (Cronbach's alpha in the present sample: .96, Seidel & Stürmer, 2012).

2.3.3. Lesson planning task

The lesson planning task developed for the present study comprised two subtasks. First, participants were given 60 min to plan an introductory lesson on a subject of their choice as well as for a grade and learner group of their choice. Our aim was to investigate how well pre-service teachers in the two treatment groups were able to use their knowledge for lesson planning and thus mentally simulating instructional action. Thereby, we explicitly asked participants to use their knowledge about teaching and learning components as addressed in the courses (Fig. 1).

Research on teacher expertise shows that lesson plans (especially those formulated by novices) tend to focus on the content of the lesson, whereas methodical decisions are made spontaneously in the classroom (Hammerness et al., 2002). Consequently, the lesson plans produced would neither be directly comparable nor allow us to assess the pedagogical content knowledge applied in teaching action. In a second step lasting an additional 30 min, we also asked the participants to choose the five most important instructional actions in the planned lesson and to reflect on challenges they posed for them.

A coding system was developed to determine whether the actions identified were challenges related to the teaching and learning components as addressed in the two courses. Lesson planning of novice teachers is also characterized by having the tendency to be rather general and naïve (Hammerness et al., 2002). For novices, an important learning step, therefore, is to be more specific and situative in lesson planning. Thus, the identified challenges were also categorized as either general (generalizing over all instructional situations) or situational (adapted to the situation and practically relevant). An example of a general challenge is "Group work creates disturbances in the classroom"; an example of stating this challenge in a situational way is "As a teacher, I need to carefully time the phases of group work to ensure that students' attention remains focused." Two trained raters independently identified and coded the challenges. The level of agreement between the coders was substantial (Cohen's kappa = .81) (Landis & Koch, 1977).

3. Results

A significance level of .05 was used for all statistical tests. Effect size was measured by means of Cohen's *d*, with effect sizes of about

This is not a test. This task serves the purpose of an exercise on which you will receive individual feedback with regard to your skills in lesson planning.

Task 1)

In the following 60 minutes you are required to plan a lesson of 45 minutes in the subject of your choice. Please, plan for an introductory lesson of a topic of your choice. In planning the lesson you should consider the three teaching and learning components as addressed in this course: clarifying learning goals, scaffolding student learning, and providing a positive learning climate. Describe as precisely as possible how you want to make use of this knowledge in acting as a teacher in a lesson.

Task 2)

Consider the structure of the lesson and the teaching actions you have chosen. Select 5 aspects that are – to your knowledge – most important with regard to a high quality of the teaching and learning components at hand.

Elaborate on these challenges: What aspects are especially important to consider when you would implement your plan in actually teaching the lesson?

You have additional 30 minutes for this second task.

Fig. 1. Instruction for the lesson planning task.

.2 being interpreted as small, effect sizes of about .5 as medium, and effect sizes of .8 and higher as large (Cohen, 1988).

Comparison of the two groups (rule-example/R-E; example-rule/E-R) showed a differential impact of using video on the three outcome measures. Table 2 presents the means and standard deviations of the criterion variables in both treatment groups and the effect sizes of the group comparisons.

Comparison of the factual knowledge scores of the two treatment groups revealed that the R-E group ($M = 86.0\%$, SD = 9.0%) outperformed the E-R group ($M = 62.0\%$, SD = 19.0%), $t(40) = 5.87$, $p < 0.05$, Cohen's $d = 1.86$. Individual scores for knowledge application in the evaluation of videotaped classroom situations ranged from −2.57 (min) to .74 (max) in our samples, highlighting the rather low overall abilities of pre-service teachers. Comparison of the two treatment groups showed that the R-E group ($M = -.59$, SD = .55) outperformed the E-R group ($M = -.96$, SD = .79), $t(47) = 1.89$, $p < 0.05$, Cohen's $d = .55$.

The written responses to the planning task were analyzed in two steps. First, we determined the number of challenges identified by each pre-service teacher. Comparison of the two groups showed that the E-R group ($M = 3.46$, SD = 1.59) identified more challenges than the R-E group ($M = 2.00$, SD = 1.69), $t(46) = -3.08$, $p < 0.05$, Cohen's $d = .91$. Second, we used a category system to code the challenges identified as being either general or situational. The (fewer) challenges identified by the R-E group were more likely to be stated in a general way, and those identified by the E-R group to be stated in a situational way. There was no statistically significant main effect of the group differences in the general category, $t(41) = 1.52$, $p = 0.07$, Cohen's $d = .47$, but a large effect in the situational category, $t(26) = -6.13$, $p < 0.05$, Cohen's $d = 2.40$.

To summarize our findings, we found, as expected, that the rule-example module promoted the acquisition of factual knowledge (Hypothesis 1). In addition, members of the rule-example group were better able to apply their knowledge to evaluate videotaped classroom situations (Hypothesis 2). This finding provides further support for the idea that the rule-example strategy is better suited to fostering the initial acquisition of factual knowledge and its application in terms of concepts/schema-like knowledge in authentic classroom situations.

The example-rule module was expected to specifically address problem-oriented learning and, thus, enhancing pre-service teachers' ability to use this knowledge as heuristics when planning lessons. Indeed, the example-rule group identified more challenges than did the rule-example group (Hypothesis 3). To achieve a better understanding of this finding, we also investigated the quality of the challenges. Results showed that example-rule learners identified more challenges in total and that a higher proportion of these challenges were situational. In contrast, the rule-example group tended to identify more general challenges, which further underlines this group's focus on general concepts. Findings from the lesson planning task revealed a difference in the two groups' capacity to anticipate practice in a situative way, with the example-rule group being at an advantage.

Table 2
Comparison of the rule-example (R-E) and the example-rule (E-R) groups with respect to posttest measures.

Dependent variables	Range	R-E	E-R	Cohen's *d*
		Mean (SD)	Mean (SD)	
Factual knowledge	0–100%	86.0% (9.0%)	62.0% (19.0%)	1.86*
Observation and evaluation	−2.57 to .74	−.59 (.55)	−.96 (.79)	.55*
Planning: challenges	0–5	2.00 (1.69)	3.46 (1.59)	.91*
General challenges		87.5%	30.95%	.47
Situational challenges		12.5%	69.05%	2.40*

*$p < 0.05$.

4. Discussion

We investigated the differential impact of two instructional strategies for integrating video into teacher education, using three dependent variables to represent aspects of applying pedagogical knowledge to practice. Novice pre-service teachers in initial university-based teacher education with limited practical teaching experience were targeted. In the study the perspective of 'approximations of practice' in initial teacher education was taken in the way that pre-service teachers have to acquire 'integrated knowledge', meaning well-defined and differentiated knowledge structures that are connected to multiple contexts of application (Borko, 2004; Putnam & Borko, 2000). Integrated pedagogical knowledge should thus help teachers to recall factual knowledge about principles of teaching and learning (first dependent variable), apply this knowledge to observe and evaluate authentic sequences of classroom instruction (second dependent variable, first context of approximations of practice), and to plan a lesson and identify possible challenges (third dependent variable, second context of approximations of practice). Our findings confirmed the expected differential impact: learning environments based on the rule-example strategy fostered the reproduction of factual knowledge and its application to observe and evaluate authentic classroom sequences (Hypotheses 1 and 2), whereas the example-rule strategy fostered the application of knowledge to plan a lesson and to identify challenges in a situative way (Hypothesis 3). Given the German context of a pre-service teacher education at universities that is followed by a two-year practical internship (Bauer & Prenzel, 2012) the focus of this study was not to show whether this knowledge also translates into teaching action. Further research is required in order to learn more about the long-term effects during a teacher education program and the transfer to teaching in classrooms (e.g. Kersting, Givvin, Sotelo, & Stigler, 2010).

Practitioners can draw on the findings of this study to design learning environments that correspond with their teaching objectives—and can thus facilitate innovative learning in teacher education by integrating video into teacher education in an informed way. However, the findings of this study are limited to the context of initial knowledge acquisition about general principles of teaching and learning. Therefore, further research should address different learner groups and also varying aspects of teacher knowledge (content, pedagogical-content, pedagogy/psychology).

Two of our findings are of particular interest for understanding the nature of initial teacher learning—and especially the relationship between the instructional strategies used to integrate video in teacher education, on the one hand, and teacher learning, on the other. The first relates to the relevance of acquiring basic factual and conceptual knowledge about principles of teaching and learning (Feiman-Nemser, 2001; Grossman, 2011). The principles as addressed in this study referred to basic components of teaching and learning: the importance to clarifying learning goals and to orient learning towards goals, the relevance of teacher questions and feedback for guiding and scaffolding learning, as well as providing a positive learning climate for motivational and emotional processes of learning (Seidel & Shavelson, 2007). Based on these principles, "rules" where derived in the sense to help pre-service teachers identify those aspects and to reason about them. The rules are guidelines or rules of thumb and should not be misunderstood as recipes for instruction. Both treatment groups were able to reproduce factual knowledge about the three components at the end of the term, but the rule-example group significantly outperformed the example-rule group not only in

reproducing that knowledge but also in successfully applying it to observe and evaluate video examples of classroom situations. This finding shows that the systematic use of video as an illustration of conceptual knowledge in the form of 'rules' resp. principles lead to the successful acquisition of this kind of factual knowledge. Moreover, participants were also able to apply this knowledge to observing and evaluating authentic classroom situations, which is regarded as a relevant objective in initial teacher education (Santagata & Angelici, 2010; van Es & Sherin, 2002). Similar findings have been shown by Stürmer, Könings, and Seidel (2013). In this study pre-service teachers visited three different courses on the topic of teaching and learning in their initial university-based teacher education program. The three courses all used a mixture of directed instruction and a problem-oriented instructional approach which resulted in high effect sizes with regard to the pre-service teachers' abilities to apply their knowledge to observe and evaluate videotaped classroom situations.

The second key finding relates to the way of knowledge acquisition in the example-rule group. The example-rule group was assumed to acquire their knowledge based on a problem-oriented approach and to use heuristics and implicit knowledge in this process. Given this situated approach (Borko, 2004) we found that this group outperformed the rule-example group in applying their knowledge to plan lessons and to identify challenges in a situative way. Despite the fact that the example-rule group had difficulties in reproducing factual knowledge (mean of 60% of solved items) they were better able to use this knowledge in planning a lesson and to be aware of possible challenges when encountering the teaching situation. This finding is striking at first glance because, from a cognitive perspective, one would assume that reproduction of knowledge is a pre-requisite for using this knowledge in contexts of application. However, the findings are not so surprising when we take the perspective of situated learning in teacher education into account (Darling-Hammond & Bransford, 2005). In this perspective it might well be that the students have acquired a conceptual understanding of the teaching and learning components as addressed in the course. This understanding might not be identical with regard to terms and facts as represented in educational science so that their recall of factual knowledge was lower compared to the rule-example group. The conceptual understanding combined with the heuristic strategies of knowledge acquisition in the example-rule group might explain the better performance in lesson planning. In the same vein, it has been shown that novices in medicine (medical students at an advanced stage of their studies) tend to outperform medical experts in recalling the facts of a clinical case, but not in the accuracy of their diagnosis (Schmidt & Boshuizen, 1993). Based on their experience, experts recall information selectively according to its relevance. This "intermediate effect" could explain why the rule-example group was better able to recall facts, but the example-rule group excels in identifying challenges (and stating those challenges in a situative way) (Kalyuga, Ayres, Chandler, & Sweller, 2003; Rikers, Schmidt, & Boshuizen, 2000).

Despite this positive interpretation of the example-rule effects it still has to be noted that teacher education is required to provide teachers with a common professional language, a language that is shared at least to some extent in terms and facts so that an exchange between professionals is possible (Grossman, 2011; Grossman & McDonald, 2008). In this view it has to be studied further how this objective can be achieved in teacher education programs (Koster, Brekelmans, Korthagen, & Wubbels, 2005). Apart from that our findings also show the importance of using multiple measures and indicators for teacher learning in the various phases of teacher education, as well as to align outcome measures with regard to the learning objectives at hand. In this respect the study shows three potential indicators. However, these also have to be elaborated and expanded in future research (Cochran-Smith, 2003; Darling-Hammond, 2006).

In practice, various strategies can be used to implement video into teacher education, and the distinctions between them are often not clear cut (Paavola, Lipponen, & Hakkarainen, 2004). Our study attempted to systematically investigate the impact of two instructional strategies, translated into distinct learning environments. Thereby, the primary aim of our study was to facilitate the informed design of learning environments by providing insights into the relations between specific instructional strategies used to integrate video and specific learning outcomes. The findings of this study, however, are also limited since the two instructional strategies have not been combined or varied. With regard to future research, our findings may also be interpreted as supporting the idea of mixing strategies according to the primary learning goal at hand. Further research should investigate which strategies are better suited for different target groups; some who are in the early phase of their initial teacher education program and others who are more advanced.

Informed decision making in the design of learning environments means adapting learning environments to specific communities of learners. Different strategies for using video may be differently suited to certain phases in teacher education. Korthagen and Kessels (1999) argued that learning environments in teacher education should be carefully designed, with different approaches being taken in the different phases of teacher education, which have different learning objectives. Specifically, they suggested that more direct, guided approaches be implemented at the beginning of the learning process. In later phases, when teacher education programs can draw on pre-service teachers' own experiences and concerns, more realistic and less structured approaches should be used. In our study, participants were assessed relatively early in their initial training and showed fairly homogenous levels of prior knowledge and interest. It would therefore be important to replicate the present study with different learner groups and to develop techniques for adapting the use of video to heterogeneous learning communities.

In the present study we put special emphasis on the ecological validity of our setting (i.e. real teacher education courses). Well-controlled experimental studies on the effect of sequencing examples and rules are found in the literature for a long time (e.g. Tomlinson & Hunt, 1971). The added value of the present study is in particular to test the generalizability of these basic psychological findings to a professional application-oriented setting such as teacher education courses. However, in the context of our study it was ecologically not possible to also implement a control group in order to systematically compare treatment conditions to this kind of baseline. Thus, we cannot say to what extent other instructional approaches (i.e. written examples, without the use of video) would have resulted in similar or even better outcomes. Further research is required to learn more about the specific and differential effects of instructional approaches in teacher education.

5. Conclusions

We systematically explored the impact of two instructional strategies for using video on three aspects of pre-service teachers' general pedagogical knowledge: recall of factual knowledge, application to observe and evaluate authentic classroom situations, and application to plan a lesson and to identify challenges. We found the two instructional strategies to be differentially effective, making distinct contributions to initial pre-service teacher learning. The outcome variables we used represented the demands of different contexts of approximations of practice. The use of video in teacher education should therefore be adapted to the specific

learning goals. Our findings underline the importance of choosing an appropriate instructional approach when designing video-based learning environments.

This study attempted to address the gaps in the knowledge about effective instructional approaches in teacher education and, in particular, to inform decisions about the design of video-based teacher education (Borko et al., 2006). Our study has both theoretical and practical significance. Investigating what pre-service teachers learn in different learning environments can advance the scientific understanding of the nature of teacher learning and, in particular, of the relationship between instructional strategies and video-based learning. Our findings provide valuable insights for those responsible for designing and facilitating teacher education programs.

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