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# Computer-supported collaborative learning with digital video cases in teacher education: The impact of teaching experience on knowledge convergence

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**Abstract:** Case-based learning is ascribed high potential with respect to the education of pre-service teachers as well as the further education of experienced in-service teachers, as it can provide opportunities for the application of professional knowledge to authentic classroom situations. In addition to the application and acquisition of knowledge, the aspect of knowledge convergence (i.e., increasing similarity of collaborative learners with respect to their knowledge) should be taken into account when homogeneous benefits are desired for all participants of a case-based training. A field study with 29 pre-service teachers and 24 in-service teachers from adult education was conducted to examine effects of different levels of teaching experience on knowledge application, knowledge acquisition, and knowledge convergence in a computer-supported collaborative case-based learning environment. An innovative approach to measuring knowledge convergence was introduced, using the positions of annotations (i.e., flags placed on the timeline of the case video) made by learners during their case analyses as an indicator of their shared focus of attention. This measure was found to positively correlate with the application and acquisition of professional knowledge. Teaching experience affected both processes and outcomes of case-based learning, suggesting different means of instructional support for pre-service and in-service teachers.

**Keywords:** case-based learning; teacher education; knowledge convergence; collaborative learning; measurement

## 1. Introduction

In the ongoing discussion about the professionalisation of teachers and teacher education, analytical skills are regarded as a central prerequisite for professional performance and as an inseparable part of their ability to understand and analyse classroom situations (Nittel, 1998). A certain level of knowledge about concepts, principles, and theories is mandatory for professional analyses of classroom interactions, but professional teachers obviously need more than that. Of particular importance, teachers must be able to apply abstract knowledge to concrete phenomena (see Mostert, 2007; Schrader, Hohmann, & Hartz, 2010). Against this backdrop, a key problem within teacher education is the theory-to-practice gap that novice teachers (henceforth referred to as pre-service teachers) encounter regularly. When confronted with a real classroom setting and exposed to its full complexity, pre-service teachers face enormous difficulties to draw upon the professional knowledge they acquired during teacher education (e.g., Korthagen & Kessels, 1999; Koury et al., 2009). Experienced teachers (henceforth referred to as in-service teachers) may experience similar problems – albeit for different reasons. They might have difficulty in applying research-based knowledge, such as when parts of their knowledge have remained inert over the years (Renkl, Mandl, & Gruber, 1996) or when their professional education has been "washed out" in the process of adapting to the reality of the school environment (see Ruohotie-Lyhty & Kaikkonen, 2009).

Methods of case-based learning have repeatedly been proposed for implementation in teacher education because learning with cases and problems is ascribed high potential for promoting analytical and problem-solving skills as well as for overcoming inert knowledge (e.g., Levin, 1999; Merseth, 1996). Case-based learning has been recommended for the education of pre-service teachers as well as for the further education of experienced in-service teachers (e.g., Levin, 1999); however, little empirical work to investigate to what extent teachers with different levels of teaching experience benefit from working with complex classroom cases has been done. Also lacking is a systematic examination of how groups of

teachers interact and influence each other during collaborative phases of case-based trainings. Therefore, this empirical study investigates the impact of teaching experience in computer-supported collaborative learning with digital video cases within the scope of a field study with pre-service and in-service teachers.

## 2. Research background

### *2.1 Case-based learning in pre-service and in-service teacher education*

In a comprehensive overview on cases and case methods in teacher education, Merseth (1996) noted that case materials have a long history in the educational field (also see Doyle, 1990). They play a major role in the fields of law, medical, and business schools. However, a common definition of what constitutes a case does not exist. A case can be any "chunk of reality" and may be given at differing levels of "immediacy": Some authors emphasise this aspect and regard only actual situations as cases. Others would also consider simulations to be capable of presenting cases. Cases may also be represented by means of text, pictures, videos, and the like. Hence, realism and authenticity appear to be essential varying features of cases. Cases may be used as exemplars for the demonstration of theoretical principles, as stimulants for fostering personal reflection, or as opportunities to practice analysis (Merseth, 1996; see Shulman, 1992). Case-based learning approaches aim in general to foster the application of knowledge for problem-solving (Zumbach, Haider, & Mandl, 2008). Approaches of case-based learning are claimed to foster critical thinking, reflection, and decision making, as well as analytical and problem-solving skills (e.g., Levin, 1999; Merseth, 1996; Mostert, 2007).

An approach closely related to case-based learning is problem-based learning (PBL). Originating in North American medical schools in the 1960s, PBL has spread over many countries and different fields of professional education. It aims at the initiation of self-directed processes of knowledge acquisition with a focus on professional competencies (see Barrows, 1996). In PBL, learners apply theories to analyse richly contextualised problem cases and

propose possible solutions (Derry & Hmelo-Silver, 2005). As there is no consensus about the exact definition of "case" or "case-based learning" (see Koehler, 2002; Moreno & Valdez, 2007) and in the light of the fact that multiple perspectives on PBL exist in parallel (Ochoa & Robinson, 2005), the relationship of PBL and case-based learning requires further clarification. PBL may be regarded as a specific subset of case-based learning. Most variants of PBL prominently feature the use of cases (e.g., Cognition and Technology Group at Vanderbilt, 1992; Hmelo-Silver, 2004). In principle, however, a case might also be used as a vehicle for demonstrating or studying exemplary practice or specific solutions if they are presented as part of the case instead of having learners engage in problem-solving. Hence, there can be instances of case-based learning that are not instances of PBL (see Merseth, 1996). Yet, many instances of case-based learning involve problem-solving on part of the learners and thus also fulfil the definition of case based learning, and vice versa. Therefore, the empirical studies conducted in the area of PBL should not be easily dismissed by researchers interested in case based learning because of the different terminology.

Whereas claims about the effects of PBL seem to rely heavily on literature from medical education (see Albanese & Mitchell, 1993), empirical research has substantiated the superiority of PBL compared to traditional forms of instruction in other fields as well (Hmelo-Silver, Duncan, & Chinn, 2007). For example, Dochy and colleagues (2003) addressed the main effects of PBL on knowledge and skills in their meta-analysis of 43 quasi-experimental empirical studies. In line with earlier literature reviews (e.g., Albanese & Mitchell, 1993; Hmelo-Silver, 2004), their analysis concluded that there is a robust positive effect of PBL on skills acquisition. In recent years, PBL has become broadly accepted beyond the medical field (e.g., in business, law, and engineering), and not surprisingly, it is considered a promising approach for teacher training and teacher education nowadays (e.g., Albion & Gibson, 2000; Levin, 2001; Porath & Jordan, 2004). However, empirical research on the benefits of

authentic problems in the domain of teacher education is unsatisfactory (see Hopperdietzel, Eberle, Kiel, Kahlert, Haag, & Steinherr, 2008).

Case-based learning is considered a particularly promising approach when it comes to the professional development of teachers because it offers opportunities for learners to apply their knowledge to authentic classroom situations. Applying professional knowledge to case information to better understand a pedagogical situation at hand is considered a central component of the analytical competency of teachers (Zottmann, Goeze, Frank, Zentner, Fischer, & Schrader, 2012). Cases appear to be ideal for the exploration of the multidimensional nature of what students and teachers do in the classroom (Levin, 1999; Mostert, 2007). Thus, complex and authentic cases are expected to help narrow the aforementioned gap between knowledge from teacher education courses and actual classroom practice. This is especially true for pre-service teachers when they have to respond immediately to a situation at hand and do not have the time to carefully weigh educational principles (Derry, Hmelo-Silver, Nagarajan, Chernobilsky, & Beitzel, 2006; Hewitt, Pedretti, Bencze, Vaillancourt, & Yoon, 2003; Korthagen & Kessels, 1999). As a consequence, individual learning prerequisites such as prior knowledge – including *teaching experience* (i.e., pre-service versus in-service teachers) – are important factors that need to be taken into account when implementing cases.

Several authors have proposed that the professional development of teachers can best be fostered with situations in which they can work with cases collaboratively, such as within the scope of case discussions (Levin, 1999; Schrader, Hohmann, & Hartz, 2010). The aspect of social interaction during case discussions has been described as the "source of changes" (Levin, 1999, p. 143) in teachers' thinking. To this end, the concept of *knowledge convergence*, which is an important outcome of collaborative learning when homogeneous benefits are desired for all group members, is elaborated in the next section.

### *2.2 Knowledge convergence in collaborative case-based learning*

With respect to collaborative case-based learning in teacher education and trainings for adult educators, two central issues arise: (1) Whether members of a learning group benefit from collaboration to a similar or the same extent (see Weinberger, Stegmann, & Fischer, 2007) and (2) whether group members really share a common appraisal of which situations are important from the perspective of knowledge after their interaction. The concept of knowledge convergence from Computer-Supported Collaborative Learning (CSCL) deals with these issues. Knowledge convergence is "the process by which two or more people share mutual understanding through social interaction" (Jeong & Chi, 2007, p. 287). In other words, social interaction that takes place during collaboration is assumed to lead to a higher "degree of similarity" (Strijbos, 2011, p. 62) of the collaborative learners with respect to cognitive representations.

Previous research has demonstrated a positive relation between knowledge convergence and knowledge acquisition. Fischer and Mandl (2005) found that learners converging in knowledge benefitted more from collaboration than learners who did not converge. According to these researchers, learners engaging in collaborative problem-solving or case-based learning need to establish a *shared focus of attention*. In the context of learning with cases in teacher education, the shared focus of attention relates to particular situations in teaching settings. An increase in shared focus of attention can be regarded as a prerequisite of knowledge convergence during the learning process. In this respect, shared focus of attention is related to the concept of "grounding" (Clark & Brennan, 1991), i.e. the collective process by which collaborative learners try to reach mutual understanding of each other by monitoring their interaction partner. In collaborative learning with complex cases, for example, learners are supposed to develop a similar understanding of which aspects or situational cues of the given case are important and then apply appropriate principles to these (see Choi & Lee, 2009). The next section briefly outlines the potential of digital media to enhance case-based

learning and explains how collaborative case-based learning can be fostered with a computer-supported learning environment.

### *2.3 Computer-supported collaborative learning with digital video cases*

The use of digital video technology is valued in various theories of learning and instruction that assume that structuring learning around digital content, presented in a non-linear and multi-perspectival way, enables learners to acquire open and flexible knowledge structures and helps them to overcome the problem of inert knowledge (e.g., Spiro, Collins, & Ramchandran, 2007). Studies argue that hypermedia environments that incorporate digital video cases represent powerful instructional tools for multiple educational settings, including teacher training (e.g., Koury et al., 2009). Moreno and colleagues found video cases to be more beneficial than text-based case narratives when examining the effects of different case presentation formats on the motivation of learners, their perceptions of learning, and the ability to transfer their educational knowledge to novel situations (e.g. Moreno & Ortegano-Layne, 2008; Moreno & Valdez, 2007). Digital media also allow for a more authentic representation of classroom cases (Putnam & Borko, 2000). However, pre-service teachers with little classroom interaction experience might particularly be overwhelmed and subsequently confused by the number of detail presented in an authentic and highly complex video case (e.g., Sherin, 2004; Mostert, 2007).

Computer-supported learning environments enable learners to work with video cases in new and innovative ways, such as by annotating case videos (Fu, Schaefer, Marchionini, & Mu, 2006). Recent studies that compared annotation-based environments with discussion boards have provided some evidence that the ability to easily link annotations to specific passages of a primary document can positively influence the quality of subsequent discussion through an increase of task-directedness and deeper elaboration of content (e.g., Wolfe, 2008). The question regarding how the *annotation behaviour* of learners is affected by factors such

as learning prerequisites remains open. This aspect was therefore explicitly included in the research questions for the present study.

## 3. Research questions

In this study, annotations made by the participants during individual case analyses in a computer-supported learning environment served as reference points for subsequent collaborative case discussions and as visible indicators for a shared focus of attention of the learners. The following research questions were investigated:

(RQ1) To what extent does teaching experience affect learning processes regarding the application of knowledge, the annotation behaviour, and the shared focus of attention in computer-supported collaborative case-based learning?

(RQ2) To what extent does teaching experience affect learning outcomes regarding the acquisition of knowledge, the annotation behaviour, and the shared focus of attention in computer-supported collaborative case-based learning?

(RQ3) To what extent are the application and acquisition of knowledge and the shared focus of attention related?

We hypothesised that both the outcomes and processes of case-based learning would be affected by different levels of teaching experience, although prior research does not suggest a clear direction of the effect. We further hypothesised that there would be positive correlations among knowledge application, knowledge acquisition, and the learners' shared focus of attention.

## 4. Method

### *4.1 Participants*

In total, 53 subjects participated in the study (46 female, 86.8%). Twenty-nine were pre-service teachers and 24 were in-service teachers from adult education. As this was a field

study, not all of the participants attended all training days (resulting in varying degrees of freedom for the analyses reported in section 5). Furthermore, 9 in-service teachers dropped out of the course. This observation is in line with average dropout rates in German adult education (Nuissl, 2010). Because the knowledge convergence of learners dropping out of courses is hardly practically relevant and we were interested in knowledge convergence during genuine participation in entire courses, we excluded these participants from all analyses. Hence, our findings pertain to the knowledge convergence among pre- and in-service teachers who complete courses involving computer-supported collaborative case-based learning. The completion rates may differ between these two groups, but the feature of course completion is held constant across them.

The sample included in the analysis comprised 29 pre-service and 15 in-service teachers. These groups did not differ significantly with respect to the distribution of gender, $\chi^2(1) = 0.09$, $p = .767$. However, pre-service teachers were significantly younger than the in-service teachers, $t(17.06) = -10.74$, $p < .001$, $d = 6{,}90$. The pre-service and in-service teacher groups also differed significantly regarding the distribution of mother tongue, $\chi^2(1) = 7.28$, $p = .007$. The in-service teacher group contained fewer native German speakers than the group of pre-service teachers. The following subsections describe both groups in more detail.

*4.1.1 Pre-service teachers*

The group of pre-service teachers ($n = 29$) consisted of 26 female and 3 male students who studied at the University of Tübingen to become school teachers of English as a foreign language. They were 20 to 35 years of age ($M = 23.66$; $SD = 3.65$) in their third to ninth semester ($M = 5.55$; $SD = 1.76$). Twenty-seven pre-service teachers were native German speakers and two indicated Polish as their first language. There were no drop-outs in this group, and all 29 subjects were included in the data analysis.

*4.1.2 In-service teachers*

The group of in-service teachers ($n$ = 24) initially consisted of 20 female and 4 male foreign language teachers from German adult education centres. As mentioned previously, there was a considerable drop-out in the in-service teacher group, and only 15 of the 24 participants completed the training. The professional background of these in-service teachers differed considerably and their teaching experience in adult education ranged from 2 to 35 years ($M$ = 14.00; $SD$ = 9.75). They were between 32 and 61 years of age ($M$ = 47.07; $SD$ = 8.02). Of the 15 in-service teachers, 9 were native speakers of German, 6 were native speakers of English. The in-service teachers who dropped out of the training were excluded from all analyses. Findings of the study are thus restricted to in-service teachers who actively participated in learning activities.

### *4.2 Curriculum and learning material*

The field of foreign-language learning (English as a second language) was chosen as the domain of study, because this domain features well-developed subject-specific educational principles serving as a basis for teacher-competency criteria (Kelly, Grenfell, Allan, Kriza, & McEvoy, 2004), as well as operationalised levels of learner-competency, which proved helpful when selecting the case material. Participants in both conditions participated in the same training.

*4.2.1 Digital video cases*

The cases used for the study comprised authentic video recordings from intermediate course lessons in adult education. Five experts from educational sciences, English studies, linguistics, and teacher education evaluated a total of 16 cases. The general focus of these cases was the issue of listening comprehension. In collaboration with the experts, we finally selected six cases for the study. We subsequently asked the experts to assign grades from

A = “excellent” to D = “sufficient” to the selected cases with respect to three characteristics with the concept of analytical competency in mind (see Schrader, Hohmann, & Hartz, 2010; Zottmann, Goeze, Frank, Zentner, Fischer, & Schrader, 2012): Connectivity, complexity and ambiguity.

*Connectivity* refers to the requirement that learners can connect the case to various models and theories. The more theoretical concepts related to teaching foreign languages or teaching in general that could be applied to the case, the better the grade that should be given by the experts.

*Complexity* refers to the suitability of the case for learners with high as well as low analytical skills. Learners with different levels of teaching experience should be able to find access to the case. Thus, the situations shown to them should be neither too obvious for experienced teachers nor too obscure for novices.

*Ambiguity* refers to the amount of possible distractors included in the cases that may hinder a goal-oriented, theory-driven analysis. For example, the course teacher in one of the cases (case 3) was not a native English speaker and spoke with a heavy accent. The experts suggested that the attention of learners working with that case could easily shift to this aspect of the case, which was not really relevant for a theory-driven analysis.

The experts were asked to agree on how the cases should be rated and compared along the three aforementioned characteristics. Table 1 illustrates the final ratings by the experts after group discussion. These expert ratings enabled us to determine in which order the cases would be presented to the learners during the training and which cases were most similar and thus suitable for pre- and post-test purposes.

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Insert Table 1 about here

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*4.2.2 Learning materials*

The experts also helped to identify which theories might be applicable to the selected cases. We then summarised these theories and sent relevant reading materials to all participants for preparation prior to the training. These reading materials included approaches related to teaching foreign languages, such as the audio-lingual method or focus on form (versus focus on meaning). In addition, theoretical concepts included in the reading materials were related to teaching in general, for example the cognitive apprenticeship approach (Collins, 2006) and the choreographies of teaching (Oser & Baeriswyl, 2001). We requested that the learners apply these approaches to the cases throughout the training.

*4.2.3 Computer-Supported Learning Environment*

The cases were implemented as digital videos in a computer-supported learning environment. Each video case consisted of two videos of the same situation filmed from different camera angles (one angle focussing on the learners, the other on the teacher), which were played synchronously on the same screen. The learning environment offered the commonly known video-player functions (e.g., stop, start, rewind, forward). In addition, learners could jump to any part of the video by clicking on the timeline below the video window, and learners could annotate the case videos by placing little flags above the timeline (see Figure 1). Participants also could remove the flags as well as take notes in a text box on the lower right side of the screen during each individual learning phase. The learning environment allowed a display of the annotations and notes of all group members on one screen during the collaborative phases (i.e., discussion of the training cases in small groups), assigning different colours to the individual learning partners.

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Insert Figure 1 about here

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*4.3 Procedure*

The study, implemented in the context of a 4-day teacher training event, included individual and collaborative phases of case-based learning. Table 2 provides an overview of the training phases and the specific activities that were conducted on each day. The training was moderated by a full-time professional trainer for pre-service school teachers.

Day one started with an introductory phase in which the participants learned about the general approach of learning with cases as well as the computer-supported learning environment. Next, we asked the participants to complete a short questionnaire covering demographic data. Then the learners viewed the first case analysis, the pre-test case (case 1), in a plenary format (participants were asked to remain silent), followed by 50 minutes of individual analysis in the learning environment. The annotation feature was available at this point and could be used by the learners, but its purpose would not be explained to them until the second day. After this individual phase, participants received the opportunity to exchange their views on the pre-test case in a plenary session. The first training day ended with a phase that was supposed to re-activate the professional knowledge of the participants. For that purpose, we prepared learning stations on the theoretical concepts from the reading materials. Participants spent about an hour with the learning stations at the end of the first day.

At the beginning of the second day of training, participants spent another hour with the stations, followed by a knowledge pre-test. Before work on the training cases started, the moderator explained the annotation function in the computer-supported learning environment. Next, we presented two training cases (cases 2 and 3) to the participants. We first showed each of the cases to all the participants in the plenary, who then analysed and annotated individually and independently for 40 minutes. Learners then discussed the case in small

groups of three on the backdrop of their individual analyses for 65 minutes (see Figure 2). For each collaborative phase, the composition of the groups changed. At the end of the second day, a plenary exchange took place with respect to the first two training cases (cases 2 and 3). On the third day, participants worked on two additional training cases (case 4 and 5).

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Insert Figure 2 about here

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The fourth and final day started with the post-test case viewed in the plenary, and then the learners analysed it individually. There was no subsequent collaborative phase for the post-test case, but the individual phase was directly followed by a knowledge post-test. Next, we asked the participants to complete an evaluation questionnaire that included items assessing a variety of control variables (e.g., how the participants had perceived working on the cases). We also provided the learners with the solutions for the knowledge post-test. We then conducted a plenary discussion of the collaborative small group phases in which open questions from the previous training days could also be addressed. The subsequent plenary discussion of the post-test case (case 6) included a sample solution proposed by the trainer. We then provided the participants the opportunity to reflect upon their experiences when working with the cases. The training concluded with a feedback session.

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Insert Table 2 about here

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### *4.4 Measures*

#### *4.4.1 Shared focus of attention*

The shared focus of attention (i.e., the degree of similarity among the learners with respect to which scenes they identified as central) was measured by using the positions of annotations made during the individual learning phases. For each pair of learners within a group, we determined an indicator for the overall proximity of these annotations between the two learners.

This indicator was determined as follows: First, for each annotation of each learner the closest annotation of the other learner was identified as its reference point. The distance to the closest annotation is referred to as *dc*. Next, the maximum possible distance from its reference point, referred to as *dm*, was determined for each annotation. The maximum possible distance is provided by the distance of the midpoint between the two closest annotations of the other learner from the reference point (or between the reference point and the beginning or the end of the video if no annotations of the other learner were placed in between). The indicator for a shared focus of attention consists of the average ratio of the actual distance of an annotation from its reference point to its maximum possible distance across all annotations of the pair (the number of all annotations is *k*), then subtracting this value from 1. Displayed as a formula, the value for the shared focus of attention between two learners would be

$$1 - \left( \sum_{i=1}^{k} \frac{dc_i}{dm_i} / k \right).$$

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Insert Figure 3 about here

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Figure 3 provides examples of the calculation of the shared focus of attention. The examples in Figure 3 assume a length of 900 seconds (or 15 minutes) for a fictitious case video, resembling the actual playing time of cases used in this study. The exact positions of the annotations by learner A and learner B are shown in Table 3. The starting point for

*example 1* is annotation 2 by learner A. The distance to the closest annotation by learner B (annotation 3) is $dc_2$ = 30 seconds. With annotation 1 by learner B being the second closest annotation, the maximum possible distance is the mid-point between annotation 1 and annotation 3, which is $dm_2$ = 75 seconds. This leads to a relative proximity value of 0.40 for annotation 2. The starting point for *example 2* is annotation 5 by learner B. Here, the distance to the closest annotation by learner A (annotation 4) is $dc_5$ = 30 seconds as well. However, as learner A did not place any other annotations before the end of the case, the maximum distance is that between the reference point and the end of the video at second 900, $dm_5$ = 120, leading to a relative proximity value of 0.25 for annotation 5. The overall value for the shared focus of attention of learners A and B for the fictitious case video would be 1 – (1.30 / 5) = 0.74.

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Insert Table 3 about here

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For every case, an individual value for the shared focus of annotation was calculated for each learner. Initially, each learner in an experimental condition was compared to *all* other learners from that condition, leading to $n_{group}$ –1 shared focus values per learner. The mean of these $n_{group}$ –1 values was then used as the individual shared focus value for a learner. When a learner did not make any annotations at all during the case analysis, no shared focus value could be calculated. The shared focus of attention was measured at the beginning (pre-test, case 1), during the learning process (mean value of cases 2, 3, 4 and 5, Cronbach's $\alpha$ = .673), and at the end of the training (post-test, case 6).

Prior to its application, the shared focus of attention measure was validated by means of an expert panel. Ten international researchers from the field of CSCL were asked to assess

the similarity of the annotations of two learners on 16 examples of annotated cases that varied in the number of annotations, the ratio of the number of annotations between the learners, and the length of the video. These examples of annotated cases were represented simply as a timeline with the annotations of learner A placed above and the annotations of learner B placed below the timeline. The experts were asked to rate the degree of similarity of the two learners in each case. The ratings for each case were averaged across experts and correlated with the values of the indicator determined on the basis of the algorithm described above. The association between these two series of values was high ($r$ = .83), signifying the validity of this approach to the measurement of shared focus of attention.

### *4.4.2 Annotation behaviour*

Annotation behaviour of the learners was measured by counting the annotations (i.e., the number of flags) made by each learner for the pre-test case, all of the training cases (mean), and the post-test case.

### *4.4.3 Knowledge*

The knowledge of the study participants (i.e., their knowledge regarding the teaching approaches described in the reading materials) was assessed in various phases of the training. Prior to working with the training cases, we conducted a *knowledge pre-test* with 38 structured items (Cronbach's α = .86) that referred to the declarative knowledge of the participants.

To investigate the knowledge applied during the collaborative small group phases, we recorded the discussions of the cases on video. Following suggestions made by Chi (1997) as well as Stegmann and Fischer (2011) for quantifying qualitative data, the final collaborative phase of case-based learning in the training (i.e., training case 5) was segmented and coded by using the software tool Videograph.

The statements made by learners during the collaborative small group discussion were first segmented into units of analysis. A previously developed coding scheme for the assessment of analytical competency, which included the dimension "ability to apply knowledge to case information" (see Zottmann et al., 2012), was adapted for the video analysis. The statements made by the learners were then categorised according to whether they were made against the backdrop of knowledge related to the reading materials or based on personal experience or common sense. A statement was categorised as knowledge when it referred to the approach of cognitive apprenticeship that had been included in the reading materials (see section 4.3.2); for example, "The teacher in the video shows the students how she constructs a relative clause, which can be seen as the first phase of cognitive apprenticeship". Examples of statements that we categorised as common sense, personal classroom experience, or normative references were, "When writing on the blackboard, the teacher in the video does what teachers usually do in a classroom" or "These students cannot understand the teacher's remarks, because they are too lazy". We trained three coders to categorise the discussions until a satisfactory interrater reliability was achieved (Fleiss' $\kappa$ = .69). Once a satisfactory reliability was achieved, we divided the discussions equally among the three coders, who then coded individually.

We measured the acquisition of knowledge after completion of the post-test case by means of a *knowledge post-test* with 35 structured items (Cronbach's $\alpha$ = .77). This test was similar, but not identical, to the knowledge pre-test because it also included items that required learners to apply approaches from the reading materials to the post-test case.

## 5. Results

### *5.1 Preliminary analyses*

A t-test was performed for the pre-test case to examine to what extent learners differed regarding knowledge and shared focus of attention (see Table 4 for an overview of the results

of the study). Pre-service teachers ($M$ = 32.41; $SD$ = 3.38) scored higher than the in-service teachers in the knowledge pre-test ($M$ = 29.13; $SD$ = 6.10). Although this difference was not significant, $t(18.55) = 1.93$, $p = .069$, $d = 0.76$, the medium to large effect size indicates that the conditions may not be regarded as equal with respect to declarative prior knowledge.

The annotation behaviour of the pre-service teachers ($M$ = 13.46; $SD$ = 7.58) and the in-service teachers ($M$ = 15.90; $SD$ = 9.04) during the pre-test case did not differ significantly, $t(36) = -.830$, $p = .412$, $d = 0.29$.

In the pre-test case, the shared focus of attention of the pre-service teachers was not significantly different ($M$ = .587; $SD$ = .038) from the shared focus of the in-service teachers ($M$ = .583; $SD$ = .016), $t(34.88) = .463$, $p = .647$, $d = 0.13$.

### *5.2 Effects on learning processes (RQ1)*

Regarding the application of knowledge, analyses of the small group discussions revealed that pre-service teachers ($M$ = 9.65; $SD$ = 8.55) applied descriptively more knowledge during the discussions than did the in-service teachers ($M$ = 5.40; $SD$ = 6.31), $t(42) = 1.70$, $p = .096$, $d = 0.55$, although this difference was not significant at the 5% level.

With respect to the annotation behaviour of the learners during the collaboration, no significant difference was found between pre-service teachers ($M$ = 16.60; $SD$ = 7.53) and in-service teachers ($M$ = 15.67; $SD$ = 7.41), $t(41) = 0.384$, $p = .703$, $d = 0.13$.

Regarding the shared focus of attention in the process, an ANCOVA (with the score in the knowledge pre-test as covariate) revealed a significant difference between the pre-service teachers ($M$ = .587, $SD$ = .020) and the in-service teachers ($M$ = .556, $SD$ = .011), $F(1,40) = 4.71$, $p = .036$, partial $\eta^2 = .11$.

### *5.3 Effects on learning outcomes (RQ2)*

To control for the initial difference between pre-service and in-service teachers regarding knowledge, we computed ANCOVAs that included the knowledge pre-test score as a covariate.

The pre-service teachers ($M$ = 26.69; $SD$ = 3.60) scored significantly higher in the knowledge post-test than in-service teachers ($M$ = 20.00; $SD$ = 5.06), $F(1,41) = 19.87$, $p < .001$, partial $\eta^2 = .33$.

There was no significant difference between pre-service teachers ($M$ = 10.48; $SD$ = 3.74) and in-service teachers ($M$ = 10.00; $SD$ = 6.10) with respect to the annotation behaviour during the individual analysis of the post-test case, $F(1,40) = .001$, $p = .972$, partial $\eta^2 < .001$.

Teaching experience, however, had a significant effect of medium size on the shared focus of attention in the post-test case, $F(1,40) = 6.05$, $p = .018$, partial $\eta^2 = .13$. The shared focus of the pre-service teachers ($M$ = .605; $SD$ = .047) was higher than that of the in-service teachers ($M$ = .564; $SD$ = .025).

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Insert Table 4 about here

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### *5.4 Relations between learning processes and learning outcomes (RQ3)*

We calculated partial correlations with the score in the knowledge pre-test as a control variable. Knowledge application during the collaboration correlated with knowledge acquisition ($r$ = .50, $N$ = 40, $p$ = .001) and the learners' shared focus of attention during the collaboration ($r$ = .34, $N$ = 40, $p$ = .027). The shared focus of attention in the process also correlated with knowledge acquisition ($r$ = .47, $N$ = 40, $p$ = .002) and with the shared focus in the post-test case ($r$ = .34, $N$ = 40, $p$ = .030).

## 6. Discussion

The present study investigated the impact of teaching experience on learning processes and outcomes regarding the application of knowledge, the annotation behaviour, and the shared focus of attention in computer-supported collaborative case-based learning. In addition, we investigated the relations between the application and acquisition of knowledge and the shared focus of attention.

As expected, teaching experience had a strong influence on processes and outcomes of case-based learning. The in-service teachers showed less declarative knowledge at the beginning than the pre-service teachers. Training with the video cases did not decrease the knowledge gap between in-service and pre-service teachers. Controlling for prior knowledge by means of an ANCOVA showed that pre-service teachers benefitted more than the in-service teachers from the training with video cases. Results further revealed a substantial positive relation between the application of knowledge and knowledge acquisition. The differential effect of the training on pre-service and in-service teachers can therefore be explained by the difficulties in-service teachers seemingly faced when applying knowledge to the video cases during the collaborative phases of small group discussions, as well as in the knowledge acquisition test conducted at the end of the training. Even though the difference between pre-service teachers and in-service teachers regarding the application of knowledge to the cases did not become significant at the 5% level, the medium effect size indicates that in-service teachers' lower degree of knowledge application may be one explanation for their lower degree of knowledge acquisition.

With respect to the shared focus of attention, in-service and pre-service teachers did not diverge substantially as to which scenes of the video case they identified as central at the beginning of the training. This changed in the subsequent training cases, for which the in-service teachers became more divergent in comparison to the less-experienced pre-service teachers. The in-service teachers were more heterogeneous with respect to their prior

knowledge and previous teaching experience, so the collaborative discussions of the cases may have had a stronger impact on this group than on the pre-service teachers. The mutual exchange might have increased the number of perspectives as to which concepts (beyond knowledge in the reading materials) might be applied to the video cases.

At the end of the training, the pre-service teachers had still a higher shared focus of attention in comparison to the in-service teachers. The cases selected for the pre-test and post-test were highly comparable with respect to playing time as well as their connectivity, complexity, and ambiguity (see section 4.3.1), so we can argue that the in-service teachers in fact became more divergent over the course of the training.

The professional knowledge of the in-service teachers may have remained inert (see Renkl, Mandl, & Gruber, 2006) or may have been forgotten due to infrequent use over the years, preventing the in-service teachers from benefitting from learning with the video cases to the same extent experienced by the pre-service teachers. Also, a "bias against applying empirical research or theory" (Mostert, 2007, p. 437) often exists among in-service teachers when confronted with classroom cases. Considering the different backgrounds of the in-service teachers, however, it is possible that they never had much knowledge about the approaches described in the reading materials in the first place. Handing out reading materials prior to the training was perhaps not sufficient to help these in-service teachers to activate this knowledge. Research on simulation-based inquiry learning indicates that providing knowledge shows positive effects only if offered on demand, that is, *during* simulation-based or case-based learning, not before (de Jong & van Joolingen, 1998).

With respect to their annotation behaviour, pre-service and in-service teachers did not differ regarding the amount of annotations made during the pre-test case, the training cases or the post-test case. It thus appears unlikely that the findings for the in-service teacher group may be explained by a general lack of commitment to the task on their part, particularly as the potentially less committed drop-outs were excluded from the analysis (if all 24 in-service

teachers who initially participated in the training are included in the analyses, the results from the tests of significance remain the same).

In general, the drop-out rate may be a highly relevant issue for instructors and teacher trainers who are planning to utilise cases. It is possible that the observed lack of knowledge may have made the training a frustrating experience for some of the in-service teachers when they could trust neither their own judgments nor those of their peers regarding the cases (see Mostert, 2007). Moreover, in spite of societal or institutional demands, adults may choose not to participate in further education training, given individual and subjective cost-benefit analyses (Bolder & Hendrich, 2000). Time and place constraints are major factors influencing drop-out in adult education in this regard. However, the drop-out rate might also be connected to the relevance of case-based training as perceived by in-service teachers (see Park & Choi, 2009).

Limitations beyond the ones already discussed include the focus on declarative knowledge and the ability of teachers to apply it to classroom cases, even though this is regarded as a crucial component of the professional skills of teachers. The results should not be interpreted as that the participating in-service teachers were “poor teachers”; after all, their performance in the classroom was not measured. Future studies should investigate the impact of case-based trainings on subsequent changes in actual teaching practices.

Overall, the diverse findings for pre-service and in-service teachers highlight a need for instructional support during case-based learning (see also Fitzgerald et al., 2009; Moreno & Valdez, 2007). The implementation of a collaboration script, for instance, could support learners in their efforts to reach a shared focus of attention (Fischer, Kollar, Weinberger, Stegmann, Wecker, & Zottmann, 2013). However, the present study clearly indicates that such instructional support when designed for teacher education should consider the level of (teaching) experience of the learners. In other words, to benefit from case-based learning, pre-service teachers may require different means of instructional support than in-service teachers.

Further research is needed to investigate how in-service teachers could best be supported in (re-)activating and applying knowledge to cases. For example, knowledge could be made available for long-time practitioners on demand (i.e., just in time) within a computer-supported case-based learning environment. Pre-service teachers, in contrast, may benefit more from instructional support that guides their attention during the analysis of complex and ambiguous cases and helps them focus on the relevant scenes within the case.

Methodologically, the shared focus of attention was successfully measured through the learners' annotations of the cases (i.e., whether they identified similar scenes in the video case). Although the shared focus measure was positively connected with the application and acquisition of knowledge, future studies may investigate this in conjunction with learners' annotations and an expert solution. Because this is a predominantly content-free measure, it could also be applied in other domains in which digital video technologies are frequently used for learning (e.g., in medical education; see Luengo, Aboulafia, Blavier, Shorten, Vadcard, & Zottmann, 2009). Whereas current natural language processing (NLP) technologies allow fully automated diagnostics of multiple dimensions of the quality of case analyses (see Mu et al., 2012), the measure for shared focus of attention could be directly derived from the annotation behaviour. Taken together, these advances may allow adaptive support of computer-supported collaborative case-based learning in the future.

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Table 1. Expert ratings for the cases used in the study

| | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 | Case 6 |
|---|---|---|---|---|---|---|
| (1) Connectivity | B | C | C | D | A - | A |
| (2) Complexity | A - | A - | C | C - | A | A - |
| (3) Ambiguity | A | C | D | A - | B | A |
| Playing time | 10:25 | 15.23 | 13:37 | 10:31 | 14:54 | 10:09 |

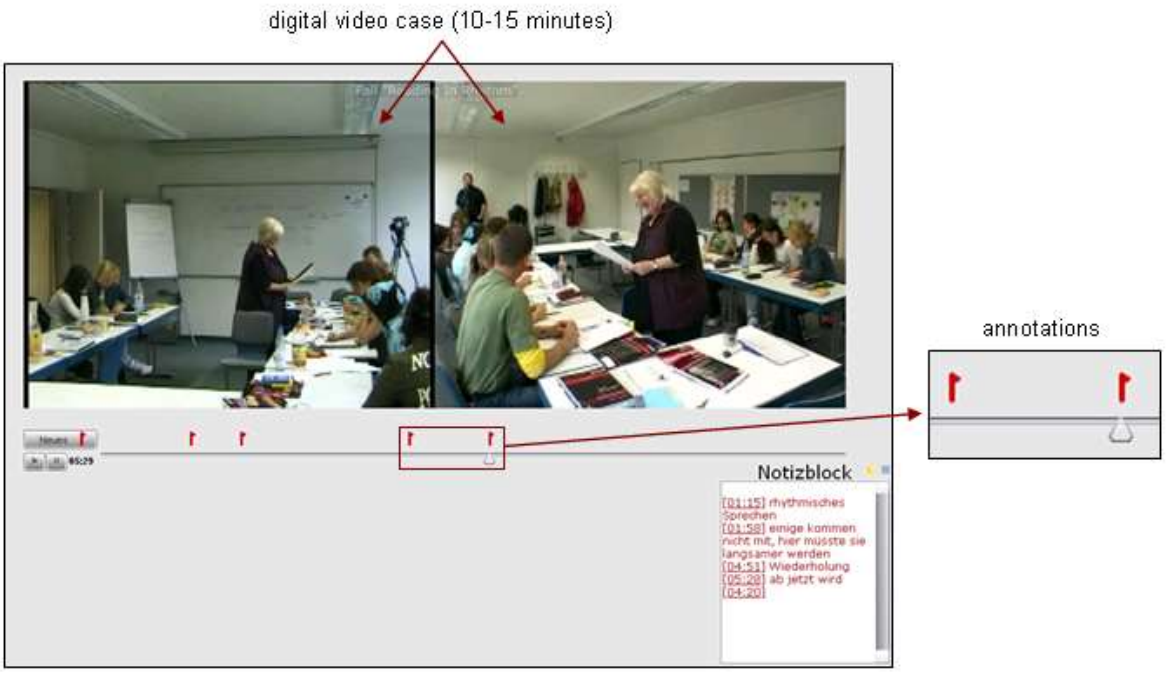


Figure 1. The computer-supported learning environment.


Figure 2. In-service teachers during the collaborative small group phase.

Table 2. Experimental procedure

| *Phase:* | *Duration:* |
|---|---|
| *Introductory phase* | |
| **Day 1** | |
| Introduction to case-based learning and the learning environment | 60 min |
| Questionnaire (demographic data, teaching experience) | 20 min |
| Individual analysis of the pre-test case 1 | 50 min |
| Plenary discussion of pre-test case 1 | 40 min |
| Learning stations on the approaches described in the reading materials (part 1) | 60 min |
| **Day 2** | |
| Learning stations on the approaches described in the reading materials (part 2) | 60 min |
| Knowledge pre-test | 15 min |
| *Training phase* | |
| Introduction to the annotation function in the learning environment | 20 min |
| Individual + collaborative analysis of training case 2 | 40 min + 65 min |
| Individual + collaborative analysis of training case 3 | 40 min + 65 min |
| Plenary discussion of training cases 2 and 3 | 40 min |
| **Day 3** | |
| Individual + collaborative analysis of training case 4 | 40 min + 65 min |
| Individual + collaborative analysis of training case 5 | 40 min + 65 min |
| *Post-test phase* | |
| **Day 4** | |
| Individual analysis of post-test case 6 | 50 min |
| Knowledge post-test | 35 min |
| Solution of the knowledge post-test, evaluation questionnaire | 45 min |
| Plenary discussion of the collaborative small group phases | 90 min |
| Plenary discussion of post-test case 6 | 60 min |
| Reflection and outlook | 60 min |
| Concluding feedback session | 60 min |

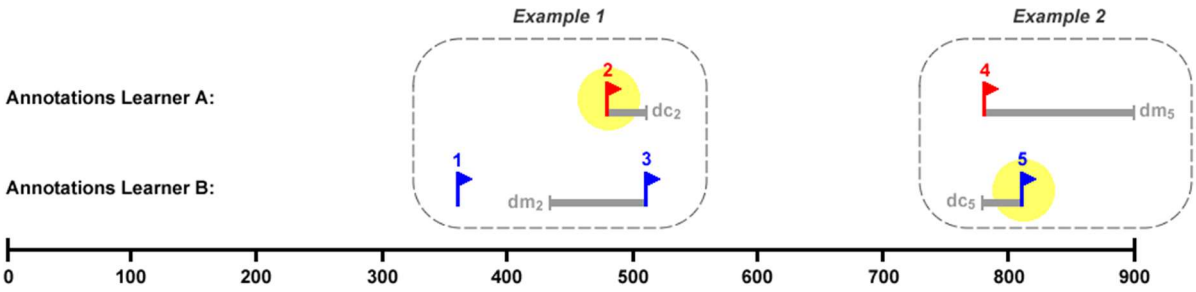


Figure 3. Examples for the calculation of the shared focus of attention between two learners

Table 3. Positions of annotations of two learners for the fictitious case displayed in figure 3

| Annotation | Learner | Position | Relative proximity |
|---|---|---|---|
| 1 | B | Second 360 | 0.25 |
| 2 | A | Second 480 | 0.40 |
| 3 | B | Second 510 | 0.20 |
| 4 | A | Second 780 | 0.20 |
| 5 | B | Second 810 | 0.25 |

Table 4. Overview of the results for knowledge and the shared focus of attention

| | | Teaching experience | |
|---|---|---|---|
| | | Pre-service teachers | In-service teachers |
| | | M (SD) | M (SD) |
| Knowledge | | | |
| | Pre-test | 32.41 (3.38) | 29.13 (6.10) |
| | | N = 29 | N = 15 |
| | Training cases | 9.65 (8.55) | 5.40 (6.31) |
| | | N = 29 | N = 15 |
| | Post-test | 26.69 (3.60) | 20.00 (5.06) |
| | | N = 29 | N = 15 |
| Annotation behaviour | | | |
| | Pre-test | 15.90 (9.04) | 13.46 (7.58) |
| | | N = 28 | N = 10 |
| | Training cases | 16.60 (7.53) | 15.67 (7.41) |
| | | N = 29 | N = 14 |
| | Post-test | 10.48 (3.74) | 10.00 (6.10) |
| | | N = 29 | N = 14 |
| Shared focus of attention | | | |
| | Pre-test | .587 (.038) | .583 (.016) |
| | | N = 28 | N = 10 |
| | Training cases | .587 (.020) | .556 (.011) |
| | | N = 29 | N = 14 |
| | Post-test | .605 (.047) | .564 (.025) |
| | | N = 29 | N = 14 |