Journal for Educational Research Online
Journal für Bildungsforschung Online
Volume 7 (2015), No. 2, 34–58

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Noticing and reasoning of teaching and learning components by pre-service teachers

Abstract

It is important for pre-service teachers to develop professional vision – the ability to use professional knowledge to notice and reason about specific aspects of teaching and learning processes in classroom situations. Noticing and reasoning are considered to be interrelated processes; however, to date few studies have explored the interplay between them. To bridge this gap, we selected a video, on which experts in the field of teaching and learning research agreed on, that two pedagogical strategies – relevant for student learning – can be noticed and reasoned. After N = 109 pre-service teachers observed and commented on the video, we analyzed the quality of their noticing and reasoning abilities using an open question and a qualitative analysis approach which was validated by comparing the results to a second, quantitative measure of reasoning. Our results indicate that pre-service teachers intuitively noticed important classroom events representative of the two pedagogical strategies under investigation. However, they struggled when reasoning about those pedagogies and attempting to match their explanations and predictions with those of experts. The validation showed positive correlations between pre-service teachers' reasoning as measured using the two approaches. Our study provides specific insights about the importance to consider both: the interrelation between noticing and reasoning as well as the content of reasoning and its match with expert opinions.

Keywords

Teacher education; Teacher knowledge; Professional vision; Video; Expertise

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Wie Lehramtsstudierende lernwirksame Unterrichtsbedingungen erkennen und interpretieren

Zusammenfassung

Professionelle Unterrichtswahrnehmung in Bezug auf allgemein didaktische Merkmale des Unterrichtens stellt eine zentrale Voraussetzung für Handlungskompetenzen von Lehrpersonen dar. Damit wird beschrieben, ob Lehrpersonen ihr professionelles pädagogisch-psychologisches Wissen über Lehren und Lernen nutzen, wenn sie Ereignisse im Unterricht identifizieren (Noticing) und interpretieren (Reasoning). Noticing und Reasoning werden als eine Fähigkeit betrachtet. Bis heute fehlen Studien, die das Zusammenspiel zwischen den beiden Fähigkeiten in Bezug auf die Anwendung in authentischen Klassensituationen untersuchen. Deshalb haben wir bei Lehramtsstudierenden (N = 109) anhand eines speziell ausgewählten Videoclips deren Fähigkeiten für Professionelle Unterrichtswahrnehmung untersucht. In Bezug auf den Videoclip bestanden umfangreiche Informationen zu allgemein didaktischen Aspekten des Lehrens und Lernens, die Experten identifizierten und interpretierten. Als methodischer Ansatz wurden offene Fragen zum Videoclip und qualitative Analysen genutzt. Diesen Ansatz validierten wir über einen Vergleich mit einem zweiten, quantitativen Instrument. Die Ergebnisse zeigen, dass Lehramtsstudierende bereits eine Reihe relevanter Ereignisse identifizieren, die repräsentativ für Lehr-Lern-Komponenten sind. Allerdings haben sie Schwierigkeiten, zu Erklärungen bzw. Vorhersagen zu kommen, die denen von Experten entsprechen. Die Validierung zeigt positive Zusammenhänge zwischen beiden methodischen Ansätzen. Die Studie stellt damit Wissen zur Bedeutung des Zusammenspiels zwischen den beiden Fähigkeiten des Identifizierens und des Interpretierens bereit. Darüber hinaus macht sie deutlich, dass man nicht nur die Qualität der Interpretationen beachten sollte, sondern auch ob die Inhalte der Interpretationen mit denen von Experten übereinstimmen.

Schlagworte

Lehrerbildung; Lehrerwissen; Professionelle Unterrichtswahrnehmung; Video; Expertise

1. Introduction

Classrooms are highly dynamic, constantly changing, and characterized by concurrent interactions among multiple persons and events (Bromme, 1997). To be effective, teachers must develop the ability to create and/or act upon supportive learning opportunities in the moment (Eilam & Poyas, 2006). Kersting, Givvin, Sotelo, and Stigler (2010) showed that professional vision is an important prerequisite for effective teaching, as the ability of mathematics teachers to analyze videos of classroom instruction systematically predicted the ability of their students to learn.

Teachers' professional vision refers to their ability to direct attention to relevant classroom elements and respond flexibly to events that influence student learning (Berliner, 2001; Star & Strickland, 2008; van Es & Sherin, 2002). In the context of classroom teaching, some events are superficial and easily noticed, such as the speech patterns of a teacher or the interior design of the classroom. Situations and pedagogical strategies that are especially relevant to student learning, however, often occur in underlying classroom structures and can only be inferred from more in-depth analysis and the use of professional knowledge about teaching and learning (Berliner, 2001). Because of the complexity of the cognitive processes involved, professional vision is seen primarily as a characteristic of experienced teachers (Sherin, 2007; Sherin & van Es, 2009). Differences have been identified in the ways expert and novice teachers allocate their attention and process information about classroom situations, with experts showing superior abilities (Berliner, 2001; Seidel & Prenzel, 2007). Professional vision is a knowledge-guided process that draws on both generic and domain-specific expertise (Shulman, 1987; Blomberg, Stürmer, & Seidel, 2011). As Blomberg et al. (2011) point out, significant advances have been made in the study of domain-specific knowledge. Teachers' professional vision in the context of generic pedagogical knowledge, however, has not been studied intensively.

The differentiation between noticing and reasoning has proven useful both for studying pre- and in-service teachers' learning (van Es & Sherin, 2002) and for designing learning environments in teacher education (Santagata & Angelici, 2010). Thereby, video has become a useful tool (Blomberg, Renkl, Sherin, Borko, & Seidel, 2013; Brophy, 2004; Krammer et al., 2006). Noticing and reasoning are studied using an open-format as state-of-the-art approach. The content of the noticed elements and the reasoning that ensued are put into categories which include aspects of active persons (teacher, students), content (pedagogical or general), or student thinking processes. These categories are developed based on the context of the subject under investigation (e.g., mathematics education). However, the analysis of whether the content of the noticed and reasoned aspects is in line with the expert view is left wide open. For example, a teacher might notice an event and reason that student thinking was encouraged in the video (which would be classified as student thinking) but an expert in the field of teaching and learning viewing the same video would reason that student thinking actually was not being encouraged. This example should demonstrate that research on the interrelation between noticing and reasoning as yet has not provided comprehensive information about the content of the video material shown and the kind of noticing and reasoning one would expect of an expert. In the context of professional development across disciplines, Gruber and Hascher (2011) remarked that teacher education research should be more lion-hearted and define more precisely what we want teachers to know and be able to do in the classroom while teaching.

In addition, the methodological approach chosen as state-of-the-art for investigating the interrelation between noticing and reasoning is qualitative. Videos as representations of classroom practice are presented, followed by open questions

about what the teachers noticed. The written comments then are analyzed using qualitative methods in categories as outlined above. This approach has contributed significantly to the advancement of research on professional vision. However, multiple methodological approaches should be combined in future research to avoid making measurement errors due to the use of a single approach.

We conducted our study because we were interested in learning more about pre-service teachers' abilities to notice and reason about classroom situations from a general pedagogical point of view (Blomberg, Stürmer, & Seidel, 2011). This is researched with regard to one particular video. Specifically, we wanted to investigate pre-service teachers' noticing and reasoning with regard to a video, which provides comprehensive information from the viewpoint of experts in the field about the specific aspects of teaching and learning to be noticed and reasoned about. The video was part of a large-scale video survey in Germany and Switzerland and had been analyzed according to a number of specific observation instruments (Seidel et al., 2007). In addition, we wanted to validate the state-of-the-art qualitative approach by comparing the results achieved with the results of a second, quantitative measure of pre-service teachers' reasoning.

2. Professional vision of pre-service teachers

2.1 Noticing

A teacher's ability to attend intentionally to classroom events that are important to the processes of teaching and learning, for example, events that influence student learning in a positive or negative way (Sherin, Jacobs, & Philipp, 2011), is referred to as noticing. In conjunction with Endsley's (1995) theory on situational awareness, the ability to notice is achieved, acquired, and influenced by two alternating information processing mechanisms: data-driven (bottom-up) and goal-driven (top-down). Teacher knowledge influences both processes, allowing more sensitivity to relevant aspects of classroom situations and their classification against the background of theoretical principles (Palmer, Stough, Burdenski, & Gonzales, 2005; Seidel, Stürmer, Blomberg, Kobarg, & Schwindt, 2011).

A teacher's professional knowledge is made up of a combination of content, pedagogical content knowledge, and general pedagogical knowledge (Shulman, 1987). In our research we focus on the last; it refers to comprehension of generic pedagogical principles and strategies. These principles can be applied to different subjects and teaching contexts and teachers need to be familiar with them to create and optimize teaching-learning situations (Blomberg et al., 2011; Voss & Kunter, 2011). Knowledge about effective teaching components and their significant relationship with student learning is an important aspect of generic pedagogical knowledge (Grossman & McDonald, 2008; Seidel & Stürmer, 2013). Such knowledge represents a basic component of initial university-based teacher education (Hammerness, Darling-Hammond, & Shulman, 2002; Voss & Kunter, 2011).

Research has identified a number of the components of effective teaching and learning principles. In this study, we focus on goal clarity and learning climate, two general pedagogical components that repeatedly have been shown to be relevant to student learning (i.e., Seidel & Shavelson, 2007). Goal clarity (clarifying teaching and learning goals, structuring the lesson), for example, is relevant particularly with regard to cognitive and motivational aspects of student learning, since ideally students would activate their knowledge and be motivated to learn (Seidel, Rimmele, & Prenzel, 2005). The learning climate in a classroom also is of particular relevance to student learning since it provides an important motivational and affective background in which learning can take place (Alexander, Fives, Buehl, & Mulhern, 2002). Kobarg (2009) showed that teachers who intuitively noticed these effective teaching and learning components in the analysis of videos of their own teaching also were more likely to have incorporated them into their own classroom teaching.

Noticing is not regarded as an isolated step in the process of a teacher's development of professional vision; rather, it shows a circle of interplay with the second component of professional vision – reasoning about noticed events.

2.2 Reasoning

How teachers direct their attention has an impact on their reasoning, which in turn affects further noticing processes (Bromme, 1992; Endsley, 1995; van Es & Sherin, 2002). Reasoning involves the process of making sense of what has been noticed by linking observed situations to knowledge, in this case, about teaching and learning. Thus, knowledge is used to explain noticed situations as well as to predict further learning processes. The linking of observation to knowledge is often described as integration, meaning combining observations with existing knowledge, again in this case, about classroom teaching and learning (Borko, Jacobs, Eiteljorg, & Pittman, 2008). Further elaboration of the process of integration has shown three qualitatively different aspects (Berliner, 2001; Borko & Livingston, 1989; Sherin & van Es, 2009; Seidel & Stürmer, 2013): (a) description; (b) explanation; and (c) prediction. If they want to describe their observations, teachers must be able to focus on noticed events and differentiate between them without making further judgments. Explanation refers to the ability of teachers to use what one knows to reason about a situation. This means linking classroom events to professional knowledge and classifying situations according to the components of teaching involved. The ability to make predictions requires teachers to draw inferences about what might be happening with regard to student learning; thus, they are required to link the noticed situation to broader concepts about teaching and learning (Seidel & Stürmer, 2013).

Noticing and reasoning are both assumed to be knowledge-based. Professional knowledge guides attention processes and reasoning about observed events. Experienced teachers, therefore, show a higher level of reasoning ability than

novice teachers. This indicates that experienced teachers are more able to differentiate and integrate knowledge and apply it flexibly to various teaching situations (Berliner, 2001; Jacobs, Lamb, Philipp, & Schappelle, 2011; Seidel & Prenzel, 2007). Inexperienced teachers are less able to classify and interpret situations against the background of knowledge. So far, we know that pre-service teachers have difficulty focusing on students' (rather than on teachers') actions and tend to view lessons merely as chronological but disconnected sequences of events (Borko et al., 2008; Kersting, 2008; Sherin & van Es, 2009; Star & Strickland, 2008).

When professional vision is applied to pre-service teacher education, it has to be taken into account that the acquired professional knowledge is not yet very elaborated and still is determined by naïve judgments and subjective theories about teaching and learning (Hammerness et al., 2002; Schwindt, 2008). In investigating the interrelation of noticing and reasoning, whether the events noticed indeed are relevant to teaching and learning also has to be taken into account, as well as whether the teacher's reasoning about noticed events is adequate when compared to how experts would judge those situations. Pre-service teachers, for example, might notice events involving goal setting but their interpretation of whether goals have or have not been set might be inadequate (e.g., about what constitutes learning goals and how they might differ from merely telling students how the lesson will be structured).

3. Video-based assessment of the professional vision of pre-service teachers

Using video as a tool is quite common in teacher education research (Santagata, 2009). The way pre-service teachers observe sample videos provides an opportunity for researchers to investigate what events attract their attention and how they reason regarding them (Goldman, Pea, Barron, & Derry, 2007). Moreover, studies have reinforced the design of video-based assessment instruments through the use of various methodological approaches (Jacobs et al., 2011; Kersting, 2008; Santagata, Zannoni, & Stigler, 2007; Sherin & van Es, 2009).

Qualitative approaches focus on the description of changes in noticing and reasoning over time, taking individual as well as group conditions into account (Borko et al., 2008; Sherin & van Es, 2009). Advances also have been achieved in developing quantitative measures (Kersting, 2008; Seidel & Stürmer, 2014); findings indicate that the standardized use of videos and rating items is a valid approach to measuring teachers' abilities to reason regarding classroom situations and to assess their knowledge. So far, the approaches have not been applied in combination to allow the results gathered using the different methods to be compared. Neither do previous studies use video material which provides comprehensive information what actually could be noticed and reasoned from an expert point of view. Given

the advancements in the field, we argue for future research so findings on the basis of mixed-method approaches can be validated.

4. Research questions

In view of the research gaps identified above, the present study was designed to yield new insights into pre-service teachers' noticing and reasoning abilities about a pre-selected excerpt of classroom teaching and learning based on expert judgments. The following research questions were addressed:

1) What do pre-service teachers notice when they observe a pre-selected video of a classroom situation? To what extent do pre-service teachers notice relevant pedagogical strategies in teaching and learning components such as goal clarity and learning climate?
   We expect pre-service teachers to be able to notice a number of events that are representative of teaching and learning components as identified by experts. At the same time, we assume that pre-service teachers still will have difficulty noticing aspects of events that require a deeper understanding of teaching and learning processes. Because of this, pre-service teachers often focus on other, more superficial aspects of classroom teaching and learning (e.g., interior design, teacher speech habits/clothing).
2) Do pre-service teachers base their reasoning about noticed teaching and learning components on professional knowledge?
   a) Is professional knowledge integrated with regard to linking classroom observations to explanations and predictions based on principles of teaching and learning?
      We expect that only a small number of pre-service teachers will show elements of using professional knowledge in an integrated way when reasoning about noticed elements. In comparison, most reasoning about noticed elements is based on naïve assumptions and beliefs.
   b) Is the content of pre-service teachers' reasoning comparable to expert reasoning about the video?
      Due to the limited professional knowledge of pre-service teachers we expect little agreement with the judgments and conclusions of experts.
3) Is pre-service teachers' noticing systematically related to their reasoning about teaching and learning components? Are results of the qualitative analyses validated by comparing them to a second, quantitative measure of teacher reasoning?
   We assume a systematic interrelation between noticing and reasoning. However, with respect to pre-service teachers, we also conjecture various kinds of interrelations. Pre-service teachers might be able to notice aspects of teaching and learning components and show a pattern of reasoning that uses some kind of knowledge integration but still may not come to conclusions similar to those of

experts. Therefore, we ascribe various kinds of interrelated noticing and reasoning abilities to pre-service teachers.

With regard to validation, we expect to find a positive correlation between teacher reasoning as measured by the qualitative analysis and as measured by the second, quantitative measure.

5. Method

5.1 Research design and data collection

The present study took place over two weeks during lectures on core principles of teaching and learning at a German university in winter 2009/2010. Participation was an obligatory course requirement. None of the pre-service teachers had previous experience observing videos of classroom teaching.

5.2 Sample

5.2.1 Pre-service teachers

N = 109 German pre-service teachers participated. The mean age was 21.42 (*SD* = 1.42), 66.1 % were female and on average they were attending the 5th semester (*SD* = .21). All participants were asked how many courses they already had attended in the field of teaching and learning during their teacher-education program. On average, participants had been enrolled in three courses focusing specifically on teaching and learning (*M* = 2.55, *SD* = 1.13).

5.2.2 Experts

N = 3 independent experts in the field of teaching and learning, who were not part of the research team, but provided comprehensive information on the content of the selected video material, were also involved in the study. All of them had at least 5–10 years of experience in teacher education and systematic classroom observation.

5.3 Instruments

5.3.1 Pre-selection of a video-clip

We adapted the video-based tool *Observer* to our study, as the video clip selection is based on the identification of teaching and learning components (Seidel,

Blomberg, & Stürmer, 2010a). We used one video clip, that the Observer instrument's research team selected from a German and Swiss video survey and which represented – based on video analysis instruments of these studies – the teaching and learning components of goal clarity and learning climate (Seidel, Prenzel, & Kobarg, 2005). The video shows a three-minute excerpt from a seventh-grade physics lesson in which the teacher introduces the topic of optics. The video is a typical example of how physics is taught in German and Swiss classrooms (Seidel et al., 2007). The lesson sequence is dominated by teacher activities. The teacher introduces the new topic by giving an overview of the lessons that will follow and the students listen to the teacher. For this study, findings of extensive video analyses were provided by the video survey mentioned above. In the video survey a number of researchers provided detailed analyses on the way teachers were clarifying goals and providing a positive learning atmosphere. In this study, three additional independent experts were asked about this pre-selected video clip. They also agreed on the two identified teaching and learning components and gave similar judgments about the pedagogical strategies and the consequences for future learning processes (Seidel, Blomberg, & Stürmer, 2010b). Furthermore, pre-service teachers working with the video in another study of this project agreed to a large extent that the selected video clip is a valid example of the two teaching and learning components of goal clarity and learning climate (Seidel & Stürmer, 2014).

The expert information was used for further qualitative analyses, which are in detail described below.

5.3.2 Noticing and reasoning as captured with an open format

After watching the pre-selected video, participants were asked in an open question to write down what they had observed (Instruction: "Please note everything down, what you have observed while watching the lesson sequence."). The written statements were analyzed qualitatively and compared to the judgments of the three independent experts.

5.3.3 Reasoning as captured using a standardized format

In addition to watching the video, participants completed standardized rating items connected to the selected video. The rating items are part of a standardized instrument using video called Observer (Seidel et al., 2010a). In this instrument participants' ratings are compared with those of experts (Seidel et al., 2010b). These experts are not identical to the ones who were involved in this study for the qualitative analyses of participants' responses; nevertheless each of them had 100 to 400 hours of experience in observing classroom situations according to the teaching and learning components under investigation. The calculation of Cohen's Kappa (κ) with a mean Cohen's κ of .79 across all experts' ratings indicated a satisfactory

level of consistency. In cases where they disagreed, agreement was reached by consensus validation (Seidel et al., 2010b).

In this study and with the video under investigation, participants filled out 36 standardized rating items of the instrument on a four-point Likert scale (1 = "disagree" to 4 = "agree") after answering the open question. The rating items also target goal clarity and learning climate and refer to three scales of expert-like description, explanation, and prediction of classroom events. Results of a scaling study have shown that this quantitative measure provides a valid and reliable assessment of the reasoning abilities of pre-service teachers (Seidel et al., 2010b; Seidel & Stürmer, 2014). For the present study we replicated the scaling procedure, resulting in good reliabilities for the four scales of reasoning in total (α = .92), description (α = .83), explanation (α = .85) and prediction (α = .88).

5.4 Data analysis

5.4.1 Qualitative analysis of noticing (Research Question 1)

5.4.1.1 Identification of analysis units

As preparation for coding, the written comments were segmented into analysis units (Mayring, 1999). Each statement or sentence was regarded as one segment, whereby a statement was rather defined in a logically than in a grammatically correct way. The data revealed that a lot of comments were written in common speech rather than in grammatically correct sentences: lack of words, punctuation marks, or orthographic mistakes. After a training phase and satisfying training results, a group of four people segmented the statements independently. Based on the definition what constitutes an analysis unit, they agreed on 97 % of the coded segments. For the ambiguous 3 %, consensus was achieved through discussion and consensus validation. Overall, 605 segments were identified.

5.4.1.2 Coding

Based on Kobarg (2009), each segment was coded as to whether goal clarity or learning climate was addressed. The category "goal clarity" included statements about the clarification of goals, objectives and requirements. The category "learning climate" was coded if a segment addressed aspects such as teachers taking the needs of their students seriously, balancing between closeness and distance with students, or using humor as an element to establish a positive atmosphere in the classroom. To assign a segment to one of these categories, it was not imperative to adhere to scientific terminologies or underlying concepts. Statements referring to superficialities or irrelevancies (e.g., clothing/speech/habits of the teacher; interior

design) were assigned to a third category called "irrelevant aspects". In Table 1, examples of each sub-category are shown.

Table 1: Noticing of teaching and learning components: Coding categories and examples

Category	Examples
Goal clarity	"Students know more or less what is expected of them in the following lesson."
Learning climate	"Some students may feel uncomfortable with the remark that it is a typical children's story and the indirect devaluation of it."
Irrelevant aspects	"Too much 'eh' in the teacher's language (particularly because of the conspicuous subtitle)."

5.4.1.3 Reliability

After training, the same team coded the segmented units using MAXQDA software (Kuckartz, Grunenberg, & Dresing, 2007). Of the data, 30 % was coded by all four raters independently, with a mean inter-rater agreement of 86.9 %. Codes without matches were then discussed and assigned to one category.

5.4.2 Qualitative analysis of reasoning (Research Question 2)

5.4.2.1 Identification of analysis units

For the analysis of pre-service teachers' reasoning abilities we used pre-service teachers' entire comments as analysis unit as the data revealed that one sentence was a proper idea unit for noticing but not for reasoning. Thus, 109 idea units built the basis for this coding process.

5.4.2.2 Coding

We refer to reasoning as whether the noticed event is based on knowledge, as well as whether pre-service teachers' reasoning about noticed events is adequate when compared to expert judgments. These two aspects are represented in two sub-codes that are described in more detail in the next paragraph. Further, the coding of reasoning distinguishes between different levels and reasoning abilities with regard to goal clarity and learning climate (Table 2). Regarding those levels it can be inferred that Categories 0 and 1 represent the two lower levels of noticing and reasoning abilities whereas Category 3 represents the optimal case. The two Subcategories 2a and 2b represent mixed forms of reasoning abilities either characterized by the use of knowledge without expert match or vice versa. Since we know too little about

the consequences of this mixed pattern in pre-service teacher education we collapsed the two categories as a mixed reasoning pattern for further analyses.

Table 2: Integration of qualitative analyses to five levels (0 = lowest level to 3 = highest level)

Level	Noticing	Reasoning		Noticing and reasoning ability
		Use of knowledge	Expert agreement	
0	No	-	-	No noticing and reasoning ability
1	Yes	Naïve assumptions	No match	Noticing and low reasoning ability
2a	Yes	Use of knowledge	No match	Noticing and mixed reasoning ability
2b	Yes	Naïve assumptions	Match	Noticing and mixed reasoning ability
3	Yes	Use of knowledge	Match	Noticing and high reasoning ability

Sub-code 1 – Use of knowledge (Research Question 2a). Based on Schwindt (2008), each unit on "goal clarity" or "learning climate" was coded along two categories: The category "use of professional knowledge" was coded when the statement shows that the observed event was linked to professional terms and central concepts of pedagogical strategies of the two teaching and learning components under study (e.g., "advance organizer" as a pedagogical strategy for goal clarity and coherence) and/or to theories related to the effects of the teaching and learning components on student learning (e.g., application of educational-psychological theories related to teaching and learning processes, such as Deci & Ryan's (1985) self-determination theory). An example would be, stating that the teacher misses clarifying learning goals with the consequence that the students are less likely to direct their learning towards the goals with negative consequences for motivation and knowledge acquisition.

As research on teacher expertise shows pre-service teachers who attempt to interpret a situation in the classroom without linking it to professional knowledge often provide naïve interpretations (Putnam & Borko, 2000; Schwindt, 2008). Thus, we coded statements identifying aspects of the classroom in a superficial and judgmental way with no connection to professional knowledge or theories to the second category of "naïve assumptions". An example for goal clarity would be, stating that the teacher starts the lesson by using language of everyday life with an evaluating character and without any further explanations ("Unfortunately, the teacher often used "eh" in his language and failed therefore"). Other examples for each sub-category are given in Table 3.

Table 3: Reasoning about teaching and learning components – Use of knowledge: Coding categories and examples

Category	Examples
Naïve assumptions	"I like that the teacher explained the syllabus of the next lessons to the students."
Use of knowledge	"To introduce the students to the field of optics the teacher tells a story, which can activate their thought processes. It also increases their motivation and provides a good plug."

Sub-code 2 – Expert agreement (Research Question 2b). With this code we wanted to explore the extent to which the reasoning of pre-service teachers regarding the noticed events agreed to the judgment as provided by three independent experts. In the case of the video used in this study, the experts agreed with regard to goal clarity that the observed teacher introduces the students to the topic of optics very quickly and provides a detailed description of the organization of the course and the tasks of the lesson. The teacher, however, fails to provide the students with learning goals. With regard to learning climate, the experts agreed that the teacher created a supportive learning atmosphere for the students. For instance, the teacher makes a funny joke during his introduction. At the same time the teacher shows that he takes his students seriously by communicating that he fully understands potential learning problems. With regard to the analysis of pre-service teachers' reasoning, we used this information and captured the extent to which pre-service teachers agreed with these expert judgments. Thus, the units on goal clarity and learning climate were coded into two additional categories: "no match with expert judgment" and "match with expert judgment" (Table 4).

Table 4: Reasoning – Agreement with expert judgment: Coding categories and examples

Category	Examples
No match	"I think the teacher's goal was clear."
Match	"He mentions that they [students] first should feel comfortable with the topic. This takes away the pressure on the students to perform."

5.4.2.3 Reliability of coding

After training, the analysis units (N = 109) were coded along the categories as described above and for the two teaching and learning components under investigation. Again, 30 % of the data was coded twice, with a mean inter-rater agreement of 94.83 % for goal clarity and 79.31 % for learning climate. All discordant codings (especially for learning climate) were discussed and validated.

5.4.2.4 Data aggregation (Research Question 3).

Finally, all codes were transferred and aggregated on the level of participants as analysis units.

5.4.3 Quantitative measure

To validate our analyses we compared the qualitative results with the indicators on teacher reasoning as provided by the Observer instrument (see Section 5.3.3). As indicators, scale scores for reasoning in total were used along with the three subscales of description, explanation, and prediction. All scores are provided for each of goal clarity and learning climate and as percentages of agreement with the criterion-referenced norm of the expert ratings (hit = 1/miss = 0).

6. Results

6.1 Pre-Service teachers' noticing of teaching and learning components

Our first research question addressed the extent to which pre-service teachers intuitively noticed aspects of goal clarity and learning climate. In Table 5, results of descriptive analyses and the distribution of codes across the teaching and learning components under investigation (goal clarity, learning climate, irrelevant aspects) are presented.

Table 5: Pre-Service teachers' noticing of teaching and learning components – Descriptive analysis and distribution of codes (percentages)

	M	*SD*	Min	Max	%
Goal clarity	1.28	1.02	0	6	23.10
Learning climate	1.67	1.53	0	8	30.10
Irrelevant aspects	2.60	1.99	0	13	46.80
Total	5.55	2.94	1	22	100.00

Note. Aggregation of $N = 605$ analysis units to the level of $N = 109$ pre-service teachers.

The results show that pre-service teachers commented in about 5 to 6 analysis units on the video clip that they had observed. The standard deviation with 2.9 analysis units is substantial, with a range between a minimum of one and a maximum of 22 analysis units. In total, the pre-service teachers noticed a number of as-

pects in both of the two teaching and learning components (overall 53 % of analysis units per pre-service teacher). Of the written statements, 23 % referred to goal clarity (1.3 analysis units) and 30 % referred to learning climate (1.7 analysis units). Almost half of the statements (47 %, 2.6 units) referred to other, more superficial aspects of classroom teaching (such as the teacher's clothing, certain speech habits, or the interior design of the classroom). These findings support our assumptions that while pre-service teachers are able to notice relevant aspects of classroom teaching and learning, they also tend to focus on superficial and irrelevant facets.

6.2 Pre-service teachers' reasoning about teaching and learning components

6.2.1 Use of knowledge in reasoning about noticed events

We analyzed whether and to what extent pre-service teachers' reasoning was based on naïve assumptions or on professional knowledge about teaching and learning. Table 6 presents the frequency distribution for the two categories and the two teaching and learning components under investigation.

Table 6: Pre-Service teachers' reasoning: Use of professional knowledge. Distribution of frequencies

		Naïve assumptions	Professional knowledge
Goal clarity	*n*	59	22
	%	72.80	27.20
Learning climate	*n*	71	9
	%	88.80	11.20

Note. 109 Pre-service teachers; Min = 0 %, Max = 100 %.

The results show that for both goal clarity and learning climate, reasoning about noticed events was based mainly on naïve assumptions with judgmental character (e.g., "I like"; "I believe") about teaching and learning (73 % and 89 % respectively). Of the participating pre-service teachers, 27 % demonstrated the use of professional knowledge about aspects of goal clarity (such as writing about the importance of making learning goals explicit for students in order to activate knowledge and orient their learning) and 11 % of them used it in connection with aspects of learning climate (such as the importance of teachers taking the needs of their students seriously). Overall, pre-service teachers struggled to transfer concepts relating to goal clarity and learning climate, particularly strategies related to learning climate seemed to be more difficult compared to goal clarity.

6.2.2 Agreement with expert judgment

Next, we were interested in the extent to which the content of the pre-service teachers' reasoning about goal clarity and learning climate in the video they were shown matched that of experts in the field of teaching and learning. The frequency distribution for match/no match with expert judgment and the two teaching and learning components is provided in Table 7.

Table 7: Pre-Service teachers' reasoning: Agreement with expert judgment. Distribution of frequencies

Noticing		No match	Match
Goal clarity	*n*	51	30
	%	63.00	37.00
Learning climate	*n*	59	21
	%	73.75	26.25

Note. 109 Pre-service teachers; Min = 0 %, Max = 100 %.

The results show that the content of pre-service teachers' reasoning matched with that of the experts in more than a third of their statements for goal clarity (37 %) and about a quarter for learning climate (26 %). The higher proportion of matches for goal clarity indicates that it was easier for pre-service teachers to reason the same way as experts do about this component than about learning climate. The majority of the content of pre-service teachers' reasoning for both components, however, did not match the experts' judgments (goal clarity, 63 %; learning climate, 74 %). Thus, in reasoning about noticed events, for example, the pre-service teachers did not recognize that learning goals scarcely were mentioned by the teacher in the observed video, or that the teacher was able to take the needs of his students seriously.

6.3 Interplay between pre-service teachers' noticing and reasoning

6.3.1 Integration of qualitative analyses on noticing and reasoning

So far, our data suggests that pre-service teachers are able to notice some aspects of teaching and learning components but that their reasoning relies mainly on naïve assumptions about teaching and learning and their judgments do not match those of the experts. To clarify combinations of noticing and reasoning, each participating pre-service teacher was classified as belonging to one of four levels (see

methods section). The distribution across these four categories is provided in Table 8.

Table 8: Integration of qualitative analyses (N = 109 pre-service teachers) on noticing and reasoning: Distribution of frequencies

		No noticing	Noticing and low reasoning ability	Noticing and mixed reasoning ability	Noticing and high reasoning ability
Goal clarity	*n*	28	10	65	6
	%	25.70	9.20	59.60	5.50
Learning climate	*n*	29	17	59	4
	%	26.60	15.60	54.20	3.60

Note. 109 Pre-service teachers; Min = 0 %, Max = 100 %.

Applying this approach, about a quarter of the pre-service teachers were assigned to the lowest level of noticing and reasoning. These participants did not notice elements of goal clarity or learning climate and, therefore, did not do any reasoning in connection with them. The majority of pre-service teachers did notice aspects of goal clarity and learning climate. In looking at their reasoning more closely, it can be seen that about 10 % (9 % for goal clarity, 16 % for learning climate) of the participants did not base their reasoning on professional knowledge and the content of their reasoning did not match that of the experts. The largest group of pre-service teachers (60 % for goal clarity and 54 % for learning climate) showed mixed reasoning abilities. This means either these pre-service teachers used professional knowledge to reason about the situation; however, they did not match the content of the experts. Or they showed a pattern in which the content of reasoning matched the expert judgments; their reasoning, however, was based on naïve assumptions. Finally, a group of about 5 % showed all elements of noticing and reasoning, noticing aspects of goal clarity and learning climate, using professional knowledge and matching with expert judgments.

6.3.2 Validation

Finally, we were interested if our qualitative analyses can be validated by a quantitative measure of teacher reasoning. Therefore, we examined pre-service teachers' reasoning scores assessed by the standardized format of the Observer instrument (total, description, explanation, prediction) and correlated it with the qualitative assignment.

As Table 9 indicates, pre-service teachers generally scored in the low third of reasoning abilities (total) as assessed by the Observer instrument (M = 30 % expert agreement). Pre-service teachers scored highest on describing relevant class-

room situations (M = 40 %), followed by the dimension of predicting consequences (M = 29 %), and explaining situations (M = 20 %). These findings are comparable to previous findings using the instrument with different samples of pre-service teachers (Seidel & Stürmer, 2013).

Table 9: Descriptive values of reasoning as measured with standardized rating items of the observer instrument based on percentages of expert agreements and bivariate correlations with the qualitative analyses (level of noticing and reasoning)

Observer instrument	Percentages of expert agreement		Qualitative analyses	
	M	*SD*	Goal clarity	Learning climate
Total	30.00	21.00	.21*	.12
Description	40.00	21.00	.10	.07
Explanation	20.00	23.00	.22*	.11
Prediction	29.00	29.00	.20*	.11

*$p < .01$.

The correlation pattern between the two measurement approaches shows the assumed direction of the relationships (Table 9). The higher the level of noticing and reasoning as measured by qualitative analysis, the higher the scores in the Observer instrument. The correlations are significant for goal clarity in total and, with regard to explanation and prediction, the two scales most strongly connected to the use of professional knowledge.

7. Discussion

7.1 Summary

The goal of this study was to enhance the understanding of noticing and reasoning abilities exhibited by pre-service teachers upon observing a video of a specific classroom situation. In the view of experts in the field, the video chosen contained specific information on goal clarity and learning climate, two general pedagogical principles of classroom teaching and learning. This kind of study is the first in which the noticing and reasoning processes of the participants have been compared with those of experts. To date, research has focused on describing noticing and reasoning in broader terms such as whether teachers notice elements regarding the teachers, students, or contents of the video or whether their reasoning is generally related to pedagogy, general content or pedagogical content (Borko et al., 2008; Sherin & van Es, 2009). However, no information is given on the type of aspects in those areas that actually are represented in the video, how experts explain the situation, and what kind of consequences experts would predict. This study makes a

first attempt at addressing this issue and exploring the possibilities of an approach that uses well-defined and pre-selected (video) examples of classroom situations.

Typically, the methodological approach taken is to use videos as prompts to activate teacher knowledge combined with open questions to learn about the noticing and reasoning processes involved. This approach was used in this study as well, but it was combined with a second methodological approach in which videos were rated by means of standardized items. This combination was used to validate the qualitative analyses through an additional measure.

The findings of this study showed that the participating pre-service teachers intuitively noticed quite a number of aspects of the two teaching and learning components under investigation. This finding confirms earlier work showing that expert-like professional vision (seeing relevant classroom events) already is being put into effect by pre-service teachers (Lefstein & Snell, 2010). In our study, pre-service teachers were half-way through their initial university-based teacher education with a mean of about three passed courses on teaching and learning. The pre-service teachers also were quite attentive to other, more irrelevant and superficial aspects of classroom teaching and learning. This shows that important events with regard to pedagogical strategies (such as clarification of goals or the learning climate) are inherently subtle, nuanced and difficult for pre-service teachers to notice. Furthermore, it indicates that determining what is and what is not important in a lesson is not a trivial task for teachers at the beginning of their professional careers (Oser, Heinzer, & Salzmann, 2010; Seidel & Prenzel, 2007; Star & Strickland, 2008).

The findings regarding our second research question reveal that although they could identify teaching and learning components, pre-service teachers struggled in their attempts to apply professional knowledge to reason about noticed events. This may imply either that pre-service teachers' knowledge structures still are too fragmented or that they lack the ability to link knowledge to actual classroom situations (Berliner, 2001; Putnam & Borko, 2000). We also found that about a third of the participating pre-service teachers matched the content of the experts' reasoning; however, in most cases, the content of the reasoning of the remaining two-thirds of the participants did not match that of the experts. A typical example where a match was missed was a situation in which the teacher only very briefly indicated a learning goal but elaborated in detail about the course of the lesson and the tasks for the students. Many of the pre-service teachers misinterpreted this advance organizer as clarification of learning goals. This finding shows again that many elements of classroom teaching and learning are subtle, and that it is important to acquire professional knowledge in order to link observed events to the respective pedagogical concepts.

To answer our third research question we explored the interplay between pre-service teachers' noticing and their reasoning. We were able to show that the majority of participating pre-service teachers attempted to use their professional knowledge as pre-service teachers showed mostly mixed reasoning abilities. The biggest challenge was to link the noticed situation to general pedagogical concepts

and simultaneously to match the content of reasoning with the way experts judged the situation. These findings are of particular interest for further research in teacher education and the design of learning environments.

Finally, the results of the qualitative analyses were compared to the results achieved by means of a second, quantitative approach. We found a systematic positive, though small, relationship in the measurements of pre-service teacher reasoning. Given the fact that the qualitative analyses included noticing and reasoning as well as different types of reasoning (use of knowledge, match with expert judgment), this finding is nevertheless promising. This study was a first attempt at mixing different methodological approaches and further research is needed to substantiate the results.

It is particularly interesting that pre-service teachers participating in the study showed better noticing and reasoning abilities in connection with goal clarity than with learning climate. There are two potential mechanisms that could explain this finding. First, it may indicate that pre-service teachers still lack the integration of underlying knowledge structures about learning climate that would allow them to notice and reason based on professional knowledge (Putnam & Borko, 2000). Second, pre-service teachers' subjective beliefs and their own experiences as students in school may have an influence on their noticing and reasoning skills. Kagan (1992) highlights the central role of pre-existing beliefs and prior experiences in filtering the content of lessons. Learning climate in particular might represent a component that activates prior personal experiences and beliefs. These activated intuitive assumptions and beliefs might in turn guide the pre-service teachers more strongly when reasoning about learning climate than about goal clarity.

7.2 Limitations and future research

Overall, we believe that this study provides promising evidence that it is necessary to define more precisely what we want future teachers to know using the expertise of professionals in the field more systematically. Further, we argue for the combination of multiple methodological approaches in research on professional vision. Despite its advantage this study also has some methodological limitations.

First, as we focused on the detailed description of pre-service teachers' noticing and reasoning regarding one specific video, the study remains exploratory and our argument remains a hypothesis. Yet, this study could serve as a basis for future investigations using this approach, by including a set of videos for which similar information is provided.

Second, further research should take design variations into account. Longitudinal designs, for example, would allow the investigation of changes in the interplay between noticing and reasoning over time (Santagata & Angelici, 2010; Stürmer, Könings, & Seidel, 2013). This is particularly important given recent research by Grossman et al. (2000) who stress not to make claims about pre-service teachers' learning based only on data from their first year of teaching. But with re-

gard to the nature of expertise development (Ericsson, Krampe, & Tesch-Romer, 1993), the implementation of such studies in teacher education is quite challenging.

Another methodological issue is of particular interest for future research: Pre-service teachers' noticing and reasoning abilities were assessed (within qualitative and quantitative measures) based on the viewpoint of experts. This approach is based on the assumption that experts are characterized by having acquired integrated knowledge structures while noticing and reasoning about a pre-selected video clip (Ericsson et al., 1993). Therefore, our experts came from the field of educational research and teacher education and had years of experience in the field of observing teaching and learning processes from a general pedagogical view – the knowledge aspect we were interested in. Nevertheless, further evidence is required for validating this expert-based criterion norm, for example, by investigating different samples ranging in their expertise (teacher educators, experienced teachers, or school inspectors) or relating our results to other criterion-related measures (cf. Kobarg, 2009; Lefstein & Snell, 2011). A first attempt in this direction was successfully accomplished in this study by comparing the results of our quantitative measure of reasoning with the level of reasoning as shown by the qualitative analysis. Further studies in the context of our project already validated the content of the pre-selected video clip by comparing experts' information about the identified teaching and learning components with pre-service teachers' opinion about the extent to which the selected video clip is a valid and authentic example of the two teaching and learning components. The results showed high agreement between both groups (Seidel & Stürmer, 2014).

In addition, the study was designed to make statements about the pre-service teachers' noticing and reasoning quality. It was not possible to explore specific challenges pre-service teachers encounter when applying knowledge about teaching and learning to the context of classroom teaching. Previous studies, however, suggest that these challenges are indeed related to teacher noticing and reasoning about video-taped classroom situations (Berliner, 1991; Roth, 2009; Kersting et al., 2010). Future research would benefit from examining cognitive processes potentially moderating pre-service teachers' reasoning in complex teaching situations more precisely. Furthermore, decisions about the selection of other methodological approaches have to be made, as it is obvious that the complexity of cognitive processes involved when observing classroom situations goes beyond what can be measured with an open answer format (Kane, 1994).

In the long run, an exploration of the relation between the quality of pre-service teachers' professional vision and their teaching action would further advance the understanding of how conceptual knowledge is transferred into teaching action. This could help to implement opportunities proximal to teaching practice, as university-based teacher education is often being criticized for not adequately preparing pre-service teachers for the reality of classroom teaching (Grossmann & McDonald, 2008).

8. Conclusion

The findings of this study support the importance of studying the interplay between noticing and reasoning as components of the acquisition of professional vision by teachers. Interpreting classroom situations like experts while simultaneously connecting it to existing knowledge seems to be a challenging task for pre-service teachers. Thus, the question arises how to support the different aspects of reasoning best to improve pre-service teachers' professional vision.

Acknowledgments

The Observe project (SE 1397/2-2) is funded by the German Research Foundation as part of the priority research program *Competence Models for Assessing Individual Learning Outcomes and Evaluating Educational Processes*. We would like to thank the pre-service teachers who participated in this study, as well as Dr. Kathleen Stürmer and Dr. Geraldine Blomberg for supporting us in the procedure of the study.

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