SITUATION-SPECIFIC AND GENERALIZED COMPONENTS OF PROFESSIONAL KNOWLEDGE OF MATHEMATICS TEACHERS: RESEARCH ON A VIDEO-BASED IN-SERVICE TEACHER LEARNING PROGRAM [1]

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We report on first results of a study with mathematics teachers from Germany and Switzerland who took part in a video-based in-service teacher education program. We wanted to find out whether the interpretation of videotaped classroom situations was influenced by the teachers' professional knowledge and instruction-related beliefs. The findings indicate that cognitive constructivist or direct-transmission views of teaching and learning might have an impact on situated beliefs of teachers and their interpretation of videotaped classroom situations. For video-based reflections of teaching in teacher learning projects, the results emphasise the importance of finding and defining a way how to look at classroom situations in cooperation with the participating teachers.

THEORETICAL BACKGROUND

The video-based analysis of teaching might encourage mathematics teachers to reflect on the quality of their instruction and to improve it. Confronted with videotaped instructional situations, teachers will activate their professional knowledge and their instruction-related beliefs in the process of interpreting the classroom situations presented. Accordingly, this study refers to a theoretical background on domains of professional knowledge and their instruction-related beliefs. According to Shulman (1986, 1987) and Bromme (1992, 1997), one can distinguish between different domains of professional teaching knowledge: subject matter knowledge, pedagogical knowledge and curricular knowledge. These domains include both declarative knowledge and individual beliefs. For example, constructs like the cognitive constructivist or the direct-transmission views of teaching and learning (Staub & Stern, 2002; Stern & Staub, 2000) can be described as pedagogical content beliefs on a rather generalized, non-situation-specific level. Similarly, epistemological beliefs (Grigutsch, Raatz & Törner, 1995; Klieme & Ramseier, 2001) concern beliefs on mathematics as a whole. Diedrich, Thußbas & Klieme (2002) as well as Lipowsky, Thußbas, Klieme, Reusser & Pauli (2003) found that there was an interdependence of such constructs in the form of "syndromes".

Beyond those generalized constructs, professional knowledge also encompasses episodically organized, situation-specific and content-specific cognitions and beliefs

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(Bromme, 1997; Leinhardt & Greeno, 1986; Escudero & Sanchez, 1999). For instance, knowledge on specific contents can be linked to mental representations of instructional situations concerning these contents. Because of its relevance for instructional practice, professional knowledge also plays an important role for in-service teacher learning: The making of decisions by the teacher involves general, situation-specific, and content-specific cognitions and beliefs (Malara, 2003). In particular, this seems to be the case for decisions teachers make in instructional classroom situations.

For the interpretation of instructional situations, teachers' individual theories on instructional quality might also play an important role: For example, individual criteria for observable characteristics of "good mathematics lessons" could influence judgements on classroom situations. As a reference for criteria of instructional quality, we took the study of Clausen, Reusser & Klieme (2003), in which four basic dimensions of instructional quality were established in a Swiss-German video study using high-inference rating methods.

On this theoretical background, we assume the following model for describing possible interactions between the judgements of classroom situations and components of professional knowledge:

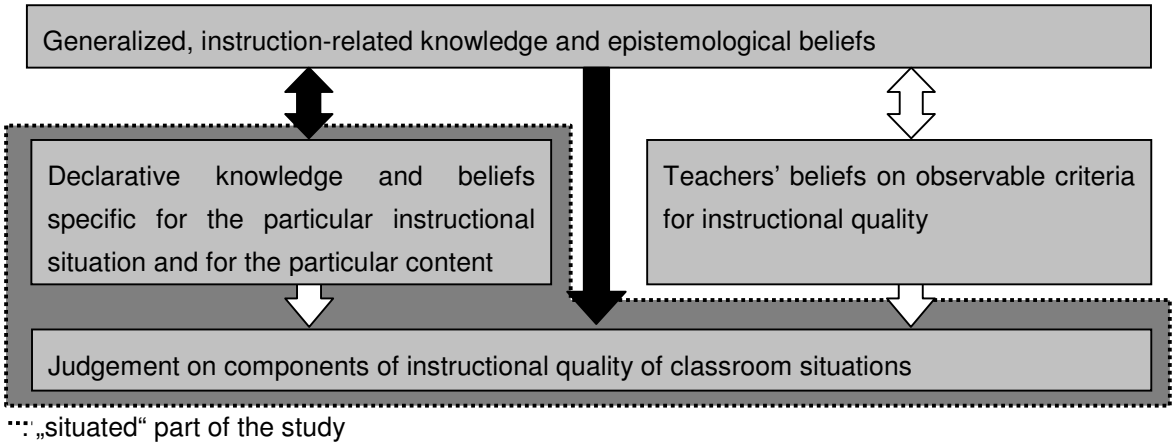

Figure 1: Model for possible interactions between the judgements of classroom situations and components of professional knowledge

In the following, we focus on observations linked to the black arrows in Figure 1.

The part of the video-based teacher learning project in which this study took place concentrated on the situation-specific context of geometrical proof (Reiss, Klieme, & Heinze, 2001; Kuntze & Reiss, 2004). As a consequence of this orientation and based on the results of Clausen, Reusser, & Klieme (2003), we focused on "cognitive activation", "intensity of argumentation in the classroom", and "learning from mistakes" for the teacher learning project and for the judgements teachers were to make on the classroom situations in this study.

RESEARCH QUESTIONS

The study aims at providing evidence for the following research questions:

(i) Is there a correspondence between situation-specific instruction-related beliefs on geometrical proof and more general components of professional knowledge?

(ii) How do teachers judge the quality of instruction in videotaped mathematics lessons? Do these judgements depend on professional knowledge and instruction-related beliefs?

DESIGN OF THE STUDY AND METHODS USED FOR THE ANALYSIS OF RESULTS

In our study, 53 Swiss and German teachers were asked to complete several paper-and-pencil questionnaires.

Before the start of the project, a first questionnaire focused on professional knowledge and instruction-related beliefs. The part of this questionnaire dealing with cognitive constructivist or direct-transmission views of teaching and learning was an adaptation of the instrument used by Staub and Stern (2002) which is based on a questionnaire by Fennema et al. (1990) and scales by Peterson et al. (1989).

Before the presentation of the videotaped classroom situations, the teachers had to answer a second questionnaire and to activate situated components of their professional knowledge about introductory lessons on proof in geometry. For instance, the teachers were asked about preferred characteristics of instruction when introducing geometrical proof, like e.g. the importance they would attribute to exactness. Sample items of three of the scales are shown in table 1.

Scale	Sample item	Number of items	Cronbach's α
argumen-tational discourse	"It is important to me that many students report on their prior knowledge about argumentation and proof and integrate it in the discussion on proof problems, even if it is probable, that misconceptions appear in the classroom without being corrected instantly."	3	.66
advancing by small steps	"In order to encourage students' contributions to the development of proofs, I would divide the argumentation into small steps, so that the students can contribute that steps in the classroom."	2	.44
initial tolerance with respect to exactness	"It is important to me that the students find ways of argumentation that are relevant to them, in order to encourage them to share the ideas of the argumentational problem. Exact proofs can be approached later."	3	.64

Table 1: Three scales on situated instruction-related beliefs (geometrical proof).

After having activated their content-specific and situation-specific pedagogical knowledge, the teachers were shown two videotaped classroom situations, both dealing with introductions to geometrical proof. According to our approach (Kuntze & Reiss, 2004), video A showed patterns of interaction marked by discourse and argumentational exchange between the students and the teacher, whereas video B could be characterized as a teacher-centered interaction comparable to the dominant teacher script in Germany described in the TIMS Study (Baumert, Lehmann, et al. 1995).

Immediately after having seen the videos, the teachers had to give judgements about these two classroom situations in a third questionnaire. In multiple-choice and open items, the teachers were asked about particular components of instructional quality, about how similar their own instructional practice was to the classroom situations and about further observations.

In the following, we concentrate on the quantitative results of the multiple-choice items. We focus on the group of German teachers (N = 42) in order to be culture-fair.

RESULTS

The results concerning the situation-specific pedagogical knowledge on teaching geometrical proof asked in the second questionnaire indicate that these situation-specific domains correlate with the general cognitive constructivist or direct-transmission views of teaching and learning. According to these views of teaching and learning, we divided the teachers in thirds of a lower, mediocre, and higher cognitive constructivist or direct-transmission view, respectively. Boxplots of the different scales of situation-specific beliefs are shown in figures 2, 3, and 4. Some of the tendencies in these figures are reflected in significant correlations between the variables (cf. table 2).

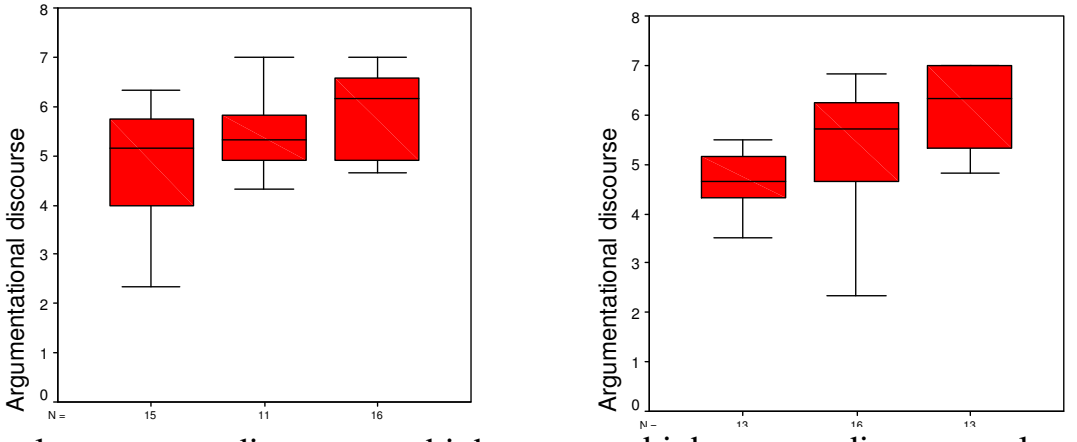

Figure 2: Argumentational discourse

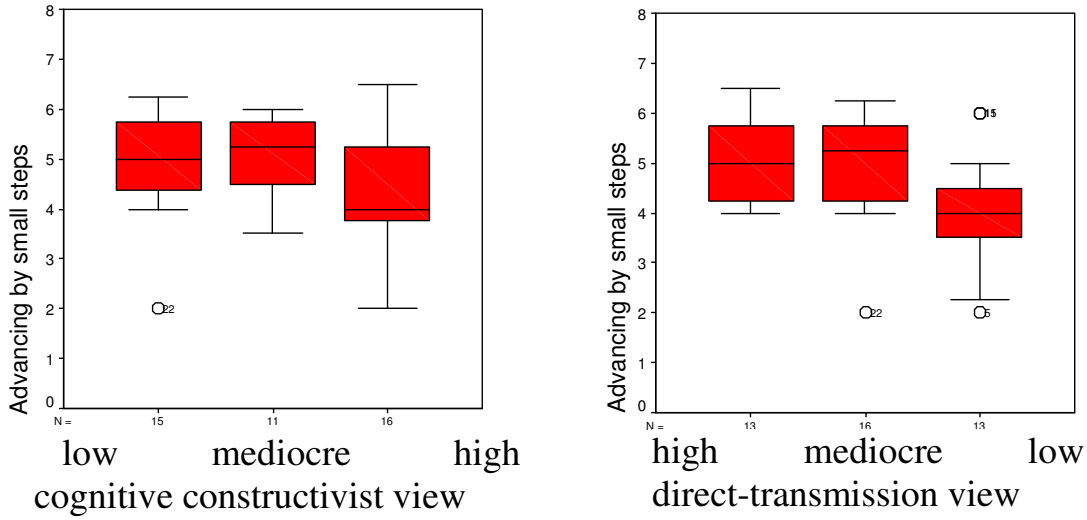

Figure 3: Advancing by small steps

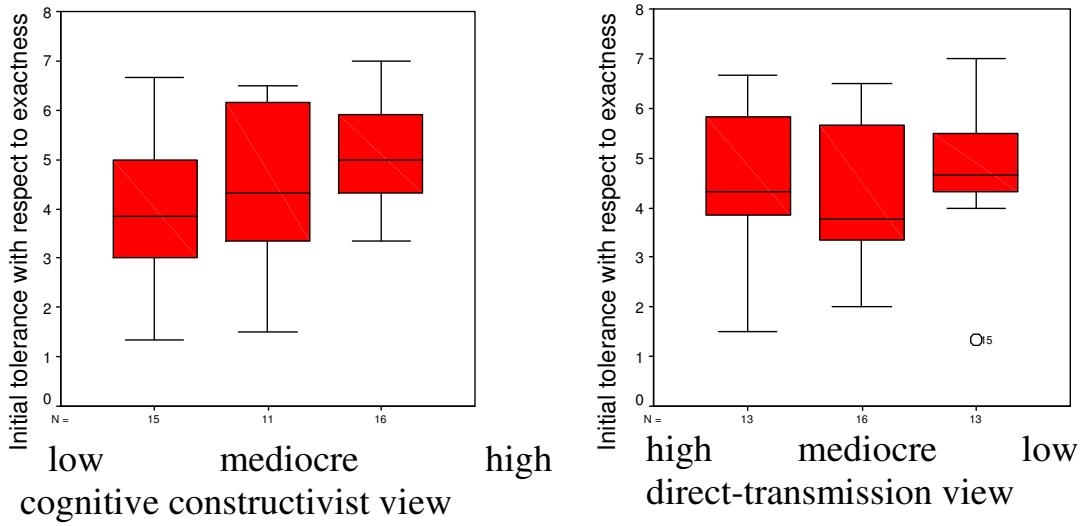

Figure 4: Initial tolerance with respect to exactness

	cognitive constructivist view	direct-transmission view
direct-transmission view	-.400**	
argumentational discourse	.482**	-.503**
advancing by small steps		.449**
initial tolerance with respect to exactness	.362*	

Table 2: Correlations between generalized and situation-specific components of professional knowledge.

In the third questionnaire, the teachers were asked to judge on the instructional quality of the two videotaped classroom situations. In Figure 5, we give two examples for the obtained results. These examples concern video B, in which was shown a situation very close to the dominant teacher script in Germany. The two subgroups of the participants seem to have judged the videotaped classroom situations differently according to their cognitive constructivist or direct-transmission views of teaching and learning: Teachers with a low direct-transmission orientation in their view of teaching and learning rated video B to contain less cognitively activating situations, less argumentational exchange, and less possibilities for the students to learn from their mistakes than teachers with a high direct-transmission orientation. The differences between the groups distinguished in Figure 5 are highly significant for the judgements on cognitive activation.

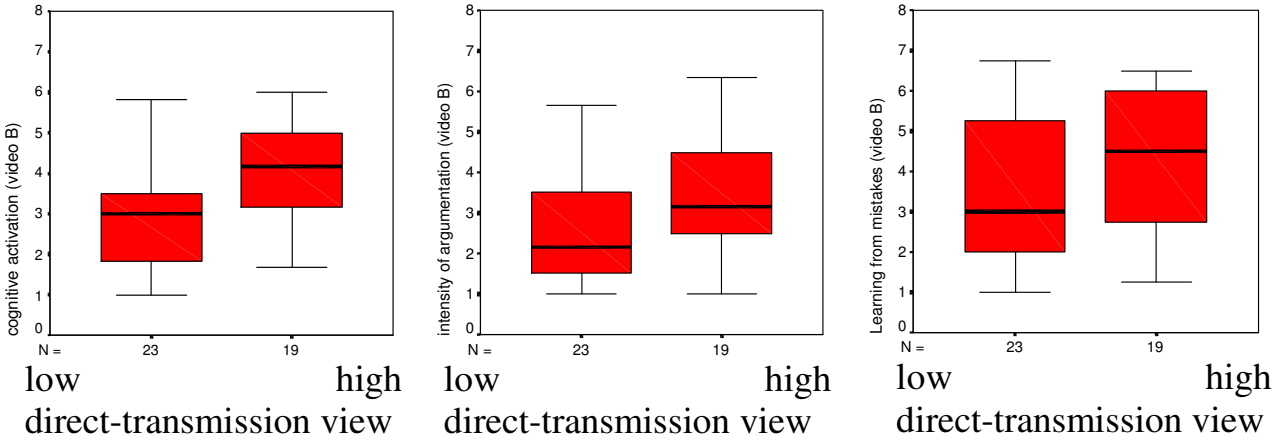

Figure 5: Examples for judgements on instructional quality

When asked to compare the videotaped classroom situations to their own teaching, all subgroups of teachers agreed on average that video B was closer to their own instructional practice than video A (cf. figure 6). Moreover, there is a correlation of .410** between the direct-transmission view of teaching and learning and the reported similarity to video B.

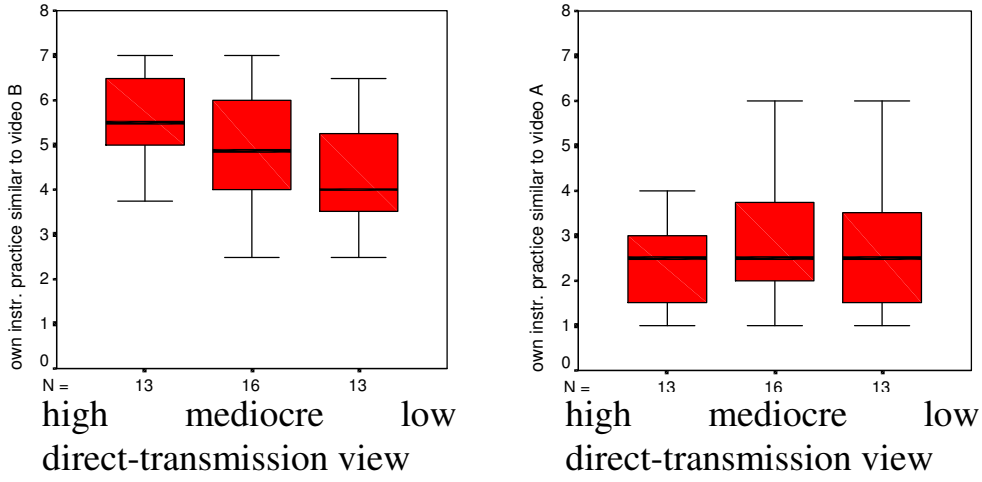

Figure 6: Comparison to the teachers' own instructional practice

INTERPRETATION OF THE RESULTS AND IMPLICATIONS FOR THE THEORETICAL AND PRACTICAL CONTEXT

The results indicate that situation-specific components of pedagogical knowledge on geometrical proof seem to reflect cognitive constructivist and direct-transmission views of teaching and learning, which belong to more generalized components of professional knowledge and their instruction-related beliefs.

Similarly, the ratings of instructional quality in videotaped classroom situations seem to be interdependent with the individual professional knowledge of the teachers. For this reason, video-based reflection of teaching in teacher learning projects should take into account that the participants might see videotaped classroom situations differently according to components of their professional knowledge. The cognitive constructivist respectively the direct-transmission views of teaching and learning could have explanatory power for differences in judgements about the instructional quality of classroom situations.

Comparisons teachers make to their own instructional practice might play a role, too: Own instructional experiences probably serve as a reference for instruction-related beliefs and situation-specific components of professional knowledge. The findings indicate for instance, that the teachers' reported own instructional practice in comparison to video B correlates with the direct-transmission view of teaching and learning.

On the theoretical level, the results on teachers' rating of instructional quality in the videotaped classroom situations could also contribute to explain why cognitive constructivist or direct-transmission views of teaching and learning might have an impact on instruction and on achievement gains like those reported by Staub & Stern (2002).

Practical implications of the results concern video-based teacher learning projects: For video-based reflection of teaching, it might be of primary importance to develop a common basis of reference shared by the participants, in order to get a guideline for observation, interpretation, and reflection of classroom situations.

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