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Professional reflective competence of prospective primary school teachers in mathematics based on video vignettes

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Reflective competence is a key component of professional action in teaching situations (Lindmeier et al., 2020). The qualitative study provides insights into the reflective competence of German prospective primary school teachers in mathematics. Video vignettes created by the participants themselves were used for this purpose. These showed videotaped teaching sequences in which the participants instructed a group of primary school children (grades 1 to 4) in self-created open-ended mathematical tasks. In addition, the vignettes show the children's working processes. In a stimulated-recall interview based on the participants' own video vignette, the prospective teachers reflected on their teaching actions as well as the observed learning processes of the children. First results show that prospective teachers address several requirements for reflective competence, such as references to the task, to children's behaviour, and to their own role as teachers, which are complexly related.

Keywords: Reflective competence, prospective teachers, primary school, video vignettes, qualitative study.

Teachers' knowledge and competence

Shulman (1986) described different domains of professional knowledge that teachers basically need for successful teaching. Those domains are namely *content knowledge* (CK) and *pedagogical content knowledge* (PCK). Various frameworks have been developed to specify PCK. Baumert et al. (2010), for example, described the requirements for PCK as

the selection of tasks, the choice of representations and explanations, the facilitation of productive classroom discourse, the interpretation of student responses, the checking of student understanding, and the swift and correct analysis of student errors and difficulties. (Baumert et al. 2010, p. 139)

However, the assumption that this knowledge automatically guides action in the teaching situation is challenging (Jeschke et al., 2019; Lindmeier et al., 2020). In this respect, reference can be made to phenomena of inert knowledge (Lindmeier et al., 2020), that means, knowledge that is not applicable in the classroom situation. Knievel et al. (2015) argued for a requirement-related description of subject-specific professional competence of teachers. These are defined as "context specific and cognitive performance dispositions" (Knievel et al., 2015, p. 312) for coping with concrete subject-specific professional requirements. Consequently, teachers' professional competence should be considered in the light of the specific domain as well as in the context of applied practice.

Lindmeier (2011) developed a structure model for domain-specific teachers' knowledge and competence, in which CK and PCK are extended to include context-specific situations and professional areas of demand. The model consists of the components *basic knowledge*, *reflective competencies* and *action-related competencies*. Lindmeier (2011) underlines the applicability of her

model to any teaching domain. At the same time, she relates further detailed explanations of the model to mathematics teachers. The *basic knowledge* component includes the fundamental knowledge of teachers to educate mathematics as a subject. This refers to the subject knowledge, but also to the didactic knowledge of for example basic principles of mathematics teaching. In Lindmeier's (2011) description of concrete tasks for teachers, it is shown that CK and PCK are constituent elements of this component. However, CK and PCK are not considered separately in the model here, but as mutually influencing knowledge.

The *reflective competencies* component further refers to teachers' abilities to reflect critically on teaching situations. This involves both pre-instructional didactic and methodological considerations as well as post-instructional analyses of teaching. Lindmeier (2011) summarises further requirements for professional reflective competence: evaluation of actions and reactions of both teachers and learners, assessment of children's learning processes, estimation of the difficulties of tasks, materials and representations as well as general learning obstacles for a mathematical topic. It is obvious that these requirements are closely related to the *basic knowledge* component. For example, when it comes to reflecting retrospectively on the use of a task, references to CK and PCK also take place. These requirements are primarily about a considered retrieval of semantic and declarative knowledge when analysing teaching situations (Lindmeier et al., 2020).

The *action-related competencies* component is about the demands on teachers in actual interactive teaching situations. Lindmeier (2011) summarises some requirements for this: evaluating a student's work while teaching, spontaneous explanations if the learner has difficulties in understanding, immediate recall of examples and so on. Lindmeier et al. (2020) emphasise that while CK and PCK are also a basis for action-related competence, knowledge does not influence this component as much. Rather, the teachers' beliefs as well as professional reflective competence could have an influence here (Lindmeier, 2011). Thus, reflective competence seems to have a 'mediating character' between basic knowledge and action-related competence.

If we take a closer look at teachers' pre- or post-instructional reflections and the fact that teachers also have to perceive corresponding situations, a connection to the term *teacher noticing* can be found. According to Sherin et al. (2011), teacher noticing refers to both teachers' attention to relevant classroom situations and interpretations of these situations. Such interpretations are based on their knowledge. At the same time, these interpretations lead to decisions for alternative learning situations. In summary, this means that reflective competence and perception are quite mutually dependent.

Video vignettes as a promising tool

Video vignettes are generally very well suited for examining or fostering teachers' professional knowledge and competence (Jeschke et al., 2019; Sherin & van Es, 2009). In particular, the consideration of teachers' professional knowledge as context-specific and application-oriented dispositions according to Knievel et al. (2015) motivates the use of video vignettes. Lindmeier (2011), for example, emphasises that items for assessing reflective competence should be based as closely as possible on real-life demands. Open formats also lend themselves to giving teachers enough freedom to answer. For the operationalisation of action-related competencies, Lindmeier (2011) even suggests the use of videotaped material such as recorded answers from students. Moreover, video vignettes

provide additional information about the actual conditions that can be included in the teachers' reflection processes (Lindmeier, 2011). All in all, video vignettes realistically reproduce classroom situations so that spontaneous reactions can be better captured (Sherin & van Es, 2009).

Abendroth-Timmer and Frevel (2013) used video vignettes with prospective teachers. They emphasise that through the use of video vignettes, in particular, subjective and unconscious own action-guiding theories about teaching are shown in reflection processes. Furthermore, Abendroth-Timmer and Frevel (2013) embedded video vignettes in a stimulated-recall interview. That means that the prospective teachers watched the video vignette and independently stop at the corresponding sequence they want to comment on. The interviewer itself only asks follow-up or comprehension questions and otherwise remains in the background. Abendroth-Timmer and Frevel (2013) found that a stimulated-recall interview based on video vignettes triggers professional reflection processes in which the participants focus on different aspects. These areas of perception range from the focus on the learners to the teacher himself and the teaching situation as a whole.

Aims of the study and research questions

The study focuses on a qualitative description of reflective competence of prospective primary school teachers in mathematics. As the study is still in its early stages, the current research questions target two areas: On the one hand, theoretical references to reflective competence are to be discovered in the collected data material. In doing so, these references will be differentiated for the group of prospective teachers. On the other hand, methodological questions about the use of video vignettes in the context of a stimulated-recall interview are of particular interest. The research questions are:

- What facets of professional reflective competence emerge in prospective teachers when they watch their own video vignette?
- To what extent are own video vignettes in the context of a stimulated-recall interview suitable for surveying the reflective competence of prospective teachers?

For a better understanding of the intended research interest, it is important to know that – at the time of the study – teachers in Germany are obliged to teach mathematics in primary school, regardless of whether they have studied mathematics as a main subject or not. To prepare the prospective teachers, each of them receives basic training in didactics of mathematics for primary school during their university studies. An investigation of the reflective competence, as the basis of later professional action in teaching, represents a particularly exciting field of research. In summary, the overall aim of the study is to provide empirically based conclusions about the compatibility of university education in the area of primary mathematics teaching and the corresponding professional demands in primary school. That means, the study focuses on insights into how the preparation of mathematics teachers for primary school might be better supported within the context of university education.

Methods

Sampling and conditions

The sampling comprises German prospective teachers in the 7th or 8th semester of their teacher training programme for primary education. This means that they were near the end of their studies and about to start their traineeship (in German: *Referendariat*). At the time of data collection, the

participants attended a course with the author on the design of open-ended mathematical tasks (cf. Sullivan & Lilburn, 2018) for primary school as part of their studies. Thereby they learned about theoretical references to the conception of open-ended tasks. In addition, they were given a variety of examples for the use of these tasks in primary school mathematics lessons. The aim of the course was to develop an open-ended task in the area of arithmetic or geometry and to carry it out with children in primary school (grades 1 to 4). In order to keep the workload manageable for the prospective teachers and for mutual support, the participants were allowed to form groups of two during the phase of conception and implementation. Afterwards, during the course, the groups reflected together on the implementation at school and revised the tasks used. In terms of time, the course extended over one semester, i.e., approximately 15 weeks.

At the beginning of the course the prospective teachers were asked to take part in the study presented here. They were informed about the research interests and agreed to be interviewed. A total of 16 participants took part in the study. The participants were all female, on average between 21 and 23 years of age and for the most part not studying mathematics as a main subject. They attended the usual four-week internships in primary schools during their university studies. Furthermore, they did not have a longer professional experience as a primary school teacher.

Creating the video vignettes

The open-ended tasks, which the prospective teachers developed together in groups of two, were carried out in primary school mathematics lessons. One participant in the group carried out the teaching with the class during this process. The other participant usually separated three to four children from the class, took them to an extra room and worked with them through the open-ended mathematical task. After the task and all the necessary material was presented to the children, they went into the working process. The children usually first worked alone and then discussed their ideas in the small group. Meanwhile, the prospective teacher videotaped this sequence. No further editing of the video material was done by either the participants or the author.

In this way, the video vignette was created for each of the eight groups. The vignettes last an average of 20 to 30 minutes and show both the participant in her role as a teacher and the children working on the task as well as their verbal interaction. All necessary consent forms were obtained in advance for the recordings. In addition, the selected children were informed that these videos were important so that the prospective teachers could better reflect on their actions in teaching. In this way, the aim was to create an environment that was as authentic as possible.

Stimulated-recall interview

Since the prospective teachers were involved in the design and implementation of the open-ended mathematical task in pairs, the interviews were also conducted with the group of two. The basis for the interviews were the video vignettes created by the participants. That means, each group watched its own videotaped teaching sequence. Due to the fact that the participants should also be given as much free space as possible for a developing conversation about the video vignette, the interview was designed rather openly according to a guideline principle. In this way, the interviewer could remain in the background and ask follow-up questions of the group if necessary.

Overall, the interview was divided into two parts: The first part represented a ‘warm-up phase’. Questions were asked about the conceptual considerations of the participants in designing the open-ended task. In addition, expectations prior to classroom implementation were inquired about:

- *First, describe the open-ended task you designed for the children during your lesson.*
- *What was particularly important to you for the implementation in class?*
- *What potential difficulties did you anticipate for the children during your preparations?*
- *About which interesting ways of solving problems were you particularly curious?*

These questions allowed participants to mentally prepare themselves for the interview and become aware of their conceptual considerations over the past few weeks. Following, the second part of the interview was the actual stimulated-recall interview based on the video vignette. Participants were given the following prompt:

- *We are now going to watch your videotaped teaching sequence. I am interested in how you reflect retrospectively on the children’s thinking and understanding processes as they worked through the open-ended mathematical task. I am also interested in how you reflect retrospectively on your own teaching actions or those of your group member.*
- *In general, just pause the video if you notice something you would like to talk about or make a statement about. When you’re done talking, just let the video continue.*

In this part of the interview, participants watched their video vignette, stopping independently at a sequence that was relevant to them and sharing their retrospective observations with each other. Occasions for conversation were created here mainly by the distribution of ‘tasks’ during the survey in the school: One person from the group conducted the interview with the selected children while the other person carried out the classroom teaching. So, both participants brought their own experiences in implementing the open-ended task to the stimulated-recall interview. In addition, either one participant in the group or even both participants had not even seen the video themselves. This means that in particular spontaneous reactions of the prospective teachers became visible.

Data collection

Interviews with prospective teachers took place in December 2022 and early January 2023. For the participants’ reflection processes, it is important to place this point in time as well in the schedule of the author’s course described above. Of all the participants of the study, the author had the exact timelines for conducting the survey in the primary schools. Therefore, the interviews were scheduled to take place shortly after conduction in the classes. Because the joint reflection took place in mid-January as part of the author’s course, the participants were not to be influenced by this interaction.

The interviews were all conducted by the author herself in German language. For this purpose, the participants were seated at a table facing the computer screen, where the video vignette was shown in the second part of the interview. Using a mouse, the participants could pause the video. Meanwhile, a camera filmed the monitor screen and recorded the sound. The data collected shows at which sequences participants paused the video to interact. On average, data material with a length of approximately 45 minutes per group was created. Eight interviews were taken in total.

Analysis of the data material

The data material is provided in the form of video recordings. Transcripts of the recordings were made using the software f4. The transcript describes verbatim what was said during the interview by both the interviewer and the participants. These transcripts serve as a basis for the analysis of the spoken sequences. If it was necessary for the analysis of the statements, screenshots of the video vignette were made. The analysis of the data is currently carried out by means of the *summarizing content analysis* according to Mayring (2022). This involves a systematic and rule-guided analysis of primarily verbal material. Units that are coded already represent individual sentence fragments. The aim is a compact description of the data material.

It must be emphasized at this point that the author is still in the process of analysing the data. Since the analysis is still in its early stages, the categories are currently kept open – in the sense of summarizing content analysis – in order not to block the view for new phenomena that might be characteristic for prospective teachers. This means that inductive category building is currently taking place. In the process of the analysis, the inductively created categories are compared with deductive categories from literature on professional reflective competence and teacher noticing (cf. e.g., Jeschke et al., 2019; Kniesel et al., 2015; Lindmeier et al., 2020; Sherin et al., 2011). Finally, the overarching aim of this analysis is the extraction of types, based on the merged categories, for professional reflective competence of prospective primary school teachers for mathematics.

Insights into first results

Initial results on the first part of the interview ('warm-up phase') show that the prospective teachers made a variety of theoretically based, but also practice-relevant references and connected them in a reflective way. When designing open-ended tasks for mathematics lessons, the prospective teachers took into account both the learning conditions of the children and the embedding of the open-ended task in the teaching context as well as a fit in the curriculum of the primary school. In addition, they focussed on the theoretical foundations for the conception of open-ended mathematical tasks. In doing so, the participants were particularly concerned for the planning of their lesson/ teaching sequence to make the mathematical contents accessible to all children. This was done in order to develop the potential of open-ended mathematical tasks in the best possible way. The idea behind this, as expressed by the participants, was that all children have both access to the task and are sufficiently stimulated to engage with mathematics. Difficulties of specific children were equally built into their considerations. In particular, methodological decisions were influenced by these considerations.

In the second part of the interview (stimulated-recall interview based on the video vignette), initial results show that the prospective teachers focussed on the processing paths of the children observed in the vignette. In doing so, they retrospectively interpreted the children's answers and supposed thinking processes as well as placed these interpretations in the context of their own actions in teaching. It is remarkable that they even critically questioned their own actions while watching the vignette, such as "*Why didn't I react to that?*". Occasionally they were very critical of each other while interpreting the partners' actions, for example "*How come you hadn't seen that?*". It is also remarkable that the participants often concluded their interpretations of the situation perceived in the vignette by reflecting on alternative possibilities for action in the corresponding teaching situation,

such as *“I should have gone into the task again”* or *“Maybe I should have shown the material to the learner again”*. The participants also made expressions about future actions for an imagined re-performance of their open-ended task in classroom, for example *“Next time I would add an additional question on that point”* or *“In the future I would include a sharing period in the small group”*.

However, the prospective teachers paid particularly close attention to the mathematical correctness of the children’s answers. It was observed that the use of subject-specific terminology was often retrospectively judged by them to be ‘correct’ or ‘incorrect’. Statements such as *“The children seem to have understood the concept”* or *“Here the characteristics of the concept were not yet fully understood by the children”* were also made by them. In contrast, the correct use of subject-specific terminology by themselves was less focussed. Overall, it is noticeable that the prospective teachers mostly paused the video first to talk about their observations of the children. These observations then led them to reflect on their own actions. Consequently, both aspects were closely connected. It is also remarkable that the focus of the participants was predominantly on the difficulties of the children. Often the video was stopped when the children solved the task deviating from the participants’ expectations. Less often, the video was stopped to highlight positive observations.

Discussion and perspectives

First, the method-oriented research question will be considered: In general, the current findings show that the use of prospective teachers’ own video vignettes within a stimulated-recall interview provides them with particularly rich situations to stimulate wide-ranging reflective processes. In particular, the implementation as a group interview was very promising, as the interviewer could ‘disappear’ in the background and thus the participants could talk to each other rather informally.

The theory-oriented research question aims to explore what facets of professional reflective competence emerge in the data material. In the first part of the interview, the answers of prospective teachers refer to requirements that we already see subsumed under the term PCK in Baumert et al. (2010). The prospective teachers used their theoretical knowledge to design open-ended mathematical tasks as well as to deal with heterogeneity in the classroom. This content was also discussed in the author’s course, which all participants attended. Thus, it can be assumed that the participants retrieved this knowledge during the interview. Although, this knowledge was not reproduced in isolated form, but related to the specific context. Most participants observed one to two lessons in the classroom before conducting their open-ended task with the children. Their observations as well as details they received from the classroom teachers were integrated into their explanations during the interview. On this basis, they justify in detail the selection and conception of their task. Thus, a close connection between basic knowledge and reflective competence, as Lindmeier (2011) has pointed out, can be discovered in the data material.

The requirements for reflective competence presented by Lindmeier (2011) can be found in the data material as well. This does not only include references to the task, but also the critical reflection of methodological decisions or own actions or reactions. It must be emphasized that the prospective teachers made a connection between the children’s observed actions and their own role as a teacher. More generally, the observations of children’s learning processes actually initiate the critical reflection processes of prospective teachers. Thus, the use of self-created video vignettes in the

context of university teacher education seems promising for providing prospective teachers with meaningful occasions to reflect on their mathematics teaching. These findings must now be subjected to a more detailed examination in order to develop more general categories and conclusions.

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