Reflection: An Opportunity to Address Different Aspects of Professional Competencies in Mathematics Education

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Abstract One major challenge in early mathematics childhood education is to support children's constructive learning. For this, different professional competencies are necessary. Nearly 100 years ago, Dewey already pointed out the impact of reflection on professional development in education. Reflection is still seen as an essential component or a key element of professional development, because in the reflection process, different aspects of professional competencies are interweaved like pedagogical content knowledge and action-related competencies as well as other aspects like beliefs and emotions. In this paper, an innovative in-service and pre-service education bachelor course for early mathematics education is presented. It is designed to give both professionals and students the possibility to develop various professional competencies. One major component can be identified in reflection. Therefore, selected evaluation results of the reflective modules will be presented.

Introduction

For a long time, mathematics education has not been part of pre-service education in early childhood education in Germany and other countries. After changing curricula and educational policy, a need for designing new components of mathematics education in pre-service education arose. Moreover, there is also a need for developing in-service education for early childhood, because for many of the professionals currently working in kindergarten or preschool, early mathematical education was not part of their own pre-service education.

The long-term in-service project 'Children and Adults Explore Mathematics together'—which is linked to the innovative structures in pre-service education within the Karlsruhe Bachelor of Arts (BA) course 'Childhood Pedagogy'—acts an answer to these new demands. The different components of an in-service

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and pre-service education for early mathematics education are designed to give both professionals and students the possibility to connect various professional competencies.

In this paper, firstly, results of empirical studies are analysed regarding requirements that professionals are supportive in early mathematics education. Then, the important role of reflection in developing competencies—in order to meet these requirements—is emphasised. In the analysis of the long-term in-service project and the innovative structures of pre-service education courses, the focus is on the reflection component.

Theoretical and Empirical Background

Competencies to Support (Mathematical) Learning in Early Childhood Education

The results of the British EPPE study (Effective Provision of Preschool Education) which is linked to the project Research in Effective Pedagogy in the Early Years (REPEY) reveal the importance of social interaction for children's learning. The studies show that positive outcomes 'are closely associated with adult–child interactions … that involve some element of sustained shared thinking' (Siraj-Blatchford and Sylva 2004, p. 720).

> Sustained shared thinking occurs when two or more individuals 'work together' in an intellectual way to solve a problem, clarify a concept, evaluate an activity, extend a narrative etc. Both parties must contribute to the thinking and it must develop and extend the understanding. (Sylva et al. 2004, p. vi)

This highlights the important role of a supportive interaction between adults and children, which is characterised by the connection between instructive and constructive moments. Using instructive aspects, constructive learning is supported. As well, professionals' various attitudes and performances that promote children's learning were revealed (Siraj-Blatchford 2007): Supportive professionals observe children's activities systematically, give feedback during activities, ask and interact with children, instruct and provide playing and learning environments, offer group and individual activities, provide a choice of games, create a balance between activities initiated by adults and by children and possess knowledge of children's development. Strehmel (2008) describes similar competencies, which are fundamental for supporting children's learning in early childhood education. She highlights that a high quality of pedagogical processes will rely on giving stimuli and making suggestions for self-directed learning and being sensitive and careful to the children and responsive to the individual needs, interests and educational background—the latter ones require diagnostic competencies. As one of the main competencies, other researchers point out the ability to observe and interpret complex situations in pedagogical daily routine (Nentwig-Gesemann 2007) as well as the ability to understand

and design processes of interaction of adults and children (Kasüschke and Fröhlich-Gildhoff 2008). All descriptions contain different aspects of instruction and construction as complementary aspects. Through sensitive instructional approach, children's constructive learning will be supported.

Although these descriptions are not specific to mathematical learning competencies, many components are also described in models of teachers' competencies concerning mathematics education in school (Baumert and Kunter 2011). As well in regard to research about the competencies of professionals in supporting preschool mathematics education, similar components are identified:

> To implement early mathematics education in natural learning situations and to ensure that children with different levels of knowledge and skills can profit, early childhood educators need wide-ranging knowledge and competencies. First of all, they need content knowledge. They have to see the relations between mathematics in the early years and later on to guarantee coherent mathematical learning. (Gasteiger 2014, p. 278)

Further, Gasteiger points out that professionals need pedagogical content knowledge and—as a part of content knowledge—diagnostic knowledge as well as action competencies (Gasteiger 2014; see also Chen and McCray 2014). Referring to other studies (Baumert and Kunter 2006; Stipek et al. 2001), Gasteiger also highlights the influence of beliefs, attitudes and motivation. Synthesising the results of the different empirical studies and existing models of professional competencies concerning mathematics education, the following categories of competencies or orientations seem to be relevant for supporting children's early mathematical learning:

1. *Content knowledge, pedagogical content knowledge and knowledge of children's development* constitute the basis for fostering children's mathematical competencies. Professionals need this kind of knowledge in order to notice children's mathematical competencies in their activities in order to initiate sustained shared thinking processes or other kinds of supporting interactions between children and adults concerning mathematics education.
2. Professionals need *action competencies* in order to notice, initiate and design interactions, which support mathematical competencies. Because of the informal nature of preschool settings, identifying 'teachable moments' is quite challenging for preschool teachers (Ginsburg et al. 2008). This special ability can be seen as one major aspect of action competencies of preschool teachers.
3. The relevance and influence of attitudes, beliefs and motivational and volitional tendencies concerning action-related competencies are highlighted in the description by Weinert (2001):

> The theoretical construct of action competence comprehensively combines those intellectual abilities, content-specific knowledge, cognitive skills, domain-specific strategies, routines and subroutines, motivational tendencies, volitional control systems, personal value orientations and social behaviours into a complex system. (p. 51)

When designing in-service and pre-service education, these different aspects of professional competencies have to be considered.

One major challenge is to support professionals so that they can develop these different competencies. As Dewey (1910) and Schön (1983) point out, reflection

can serve as a bridge between these different competencies. The role of reflection is discussed in the next section.

The Role of Reflection in Professional Development of Preschool Teachers

Dewey emphasises the importance of reflection for learning in general as well as for pre-service and in-service teacher education more than a hundred years ago. In his work *How We Think*, Dewey (1910) defines reflective thoughts as

> active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends. (Dewey 1910, p. 9)

He highlights the importance of reflection for learning processes in general and identifies different components as steps in reflection. Referring to Dewey, Kolb (1984) describes in his experiential learning model not only different steps or stages but constitutes a circulation model of sequential components as following: concrete experience, reflective observation, abstract conceptualisation and active experimentation. The reflective observation constitutes the connection between practical and theoretical abilities. In other words, pedagogical content knowledge and knowledge of children's development and action-related competencies interweave in the phase of reflection.

The third aspect described above *attitudes, beliefs and motivational and volitional tendencies* is not included in the model of Dewey and Kolb. Nevertheless, the importance of emotions is taken into account in the model by Zull (2002, 2004). He sees the experiential model of Kolb as an overlay over the structure of the brain and points out the importance of emotions. 'Even if we experience something that has happened to us before, it is hard to make meaning of it unless it engages our emotions' (Zull 2002, p. 166). Barrett (2005) explains that Zull

> also points out that reflection is a search for connections (2002 p. 167) and suggests that we have to seriously consider the role of emotion if we want to foster deep learning (2002 p. 169). (Barrett 2005, p. 20)

It therefore seems that the different aspects of professional competencies in early childhood can be addressed in the process of reflection. Above all, reflection can play an important role in preschool teachers' practice to support early mathematics learning in preschool: 'the teachers must be able to reflect on children's co-constructing learning processes. This encloses the ability to discover educational abilities for mathematical learning in children's activities' (Thiel 2012, p. 1253).

Therefore, in a common model of preschool teacher's competencies, Fröhlich-Gildhoff et al. (2014) highlight the ability *to analyse and evaluate* situations as one

important part of performance competencies. Next to the ability to *analyse and evaluate* concrete situations, the authors emphasise the *role of (self-)reflection* in general for preschool teachers. Through reflection, preschool teachers become aware of their subjectivity, and they learn to take different perspectives and can analyse situations on the basis of theoretical knowledge and knowledge which is based on experiences (Fröhlich-Gildhoff et al. 2011, 2014).

Therefore, in many pre-service and in-service education programmes, such as the Victorian Early Years Learning and Development Framework (Kennedy and Stonehouse 2012), reflection is seen as an important or even the most important component.

Reflection can be distinguished as individual and collective reflection (Berkemeyer et al. 2011, p. 228), which can be divided further in content, object focused or focused on oneself. Research of professional competencies of teachers confirms positive effects of collective reflection on competencies of professionals (Beck et al. 2002; Schuster 2008) and on the development of teaching (West and Staub 2003) and especially on the teaching of preschool teachers (Bleach 2014). Marcos and Tillema (2006) provide a critical overview of empirical research results about reflection and professional development.

The long-term, in-service project 'Children and Adults Explore Mathematics together'—which is linked to the innovative structures in pre-service education within the Karlsruhe BA course 'Childhood Pedagogy'—highlights the need for reflection in professional development. The implementation of reflection is presented in the description of the pre-service course and in-service project in the next paragraph.

Design of the Innovative Pre-service Education Bachelor Course and In-Service Project

Designing Components regarding Different Professional Competencies for BA Course

Often there is a separation of modules focused on theory at university and modules focused on settings outside university. The students' options to gain practical experiences are bound to institutional conditions, e.g. time schedule, etc., which make it difficult to acquire action competencies in early mathematics education. Therefore, the construction of the BA course implements options for acquiring action competencies outside of the regulation of educational institutions, which can also serve as a basis for reflection.

Videotaped (Inter)Actions in a 'Sheltered' Room of Action

Apart from avoiding limitations by educational institutions, the establishment of good conditions for reflection was another module design principle. Pre-service education students are sometimes overwhelmed with the complexity of the possible actions in early mathematics education which inhibits their abilities to reflect on situations of action if theoretical aspects must be considered (Stokking et al. 2003). Therefore, 'sheltered' rooms of action set up particularly for observation and reflection are created in the BA course. This innovative element constitutes a setting where action competencies are not acquired outside university. Rather the practical field 'comes' to the university.

At the university, the sheltered room of action is called 'MachmitWerkstatt'—literally 'join-in-studio'. At this join-in-studio, preschool teachers can play together with their children in prepared playing and exploring environments and explore mathematical aspects together. As in section "Theoretical and Empirical Background" mentioned earlier, it is very challenging for preschool teachers to recognise teachable moments in children's play. So one important aspect of the join-in-studio is to 'provide' teachable moments through a prepared environment.

Another important element of the join-in-studio setting is the video recording of each visit to the studio. As a result of the video recording, the students can observe both children's activities in the playing environments and their own interactions with the children after the visit. Thereby they can develop and improve their diagnostic and reflection competencies. These competencies become the foundation to initiate and support children's mathematical discovery processes. Empirical studies have shown positive effects of the integration of video recording for the analysis of interaction between children and adults (Pianta et al. 2008; Downer et al. 2009). Empirical studies with professionals teaching in school proved also positive effects for their professional development (Nührenbörger 2009; Scherer and Steinbring 2006).

In contrast to the positive aspects mentioned, the prepared learning environment as an artificial situation has some limitations especially for children's learning, which will be discussed in section "Closing Remarks".

Implementation of Videotaped Practical Situations in the BA Course and In-Service Project

The implementation of video-recorded (inter)actions in a sheltered room of actions can be realised by a close connection and interplay with the in-service project 'Children and Adults Explore Mathematics' (Fig. 1).

The goal of the in-service project lies in the evaluation of the in-service education in early mathematics education. The project consists of three phases: (1)

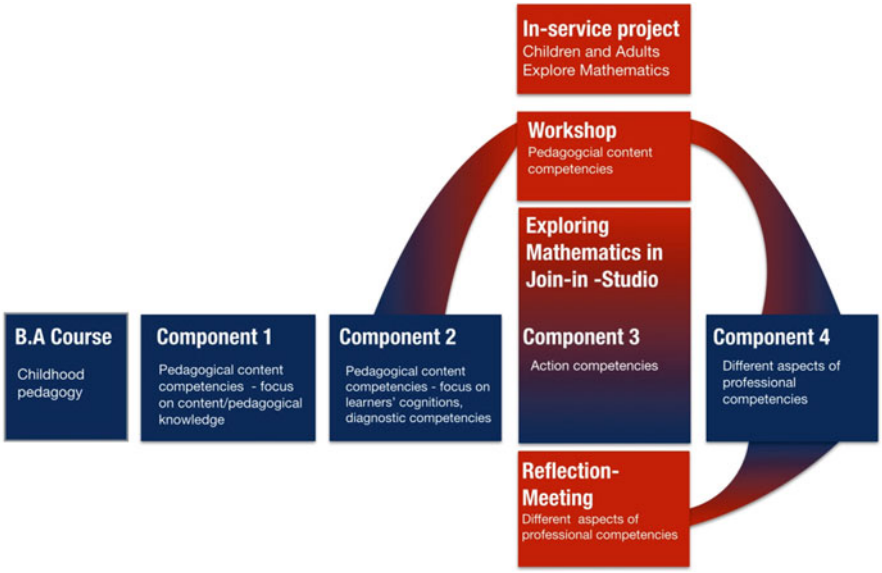

Fig. 1 Connection between in-service project and BA course

workshop for professionals in preschool, (2) children and adults playing and exploring mathematics together in the join-in-studio and (3) reflection meeting on the basis of video documents.

The three phases are conducted within half of a year (time period of a university term). After that period, different mathematical content becomes the focus, and the three phases start again.

Therefore, in each term in the workshop, a different mathematical content is focused on (e.g. counting and seeing, exploring patterns, comparing and measuring). In addition to exposing pedagogical content knowledge, playing environments, in which children can acquire different mathematical abilities, are analysed and created together with the preschool teachers in the workshop. The results of the workshops are reported in a handout for the preschool teachers, so they can implement these tried-and-tested environments in their daily life in kindergarten.

After the workshop, each preschool teacher has the possibility to visit the join-in-studio with the group of kindergarten children they daily work with throughout term time (see Fig. 1). The main focus lies in the possibility to explore mathematics together with their children. Only preschool teachers who attended the workshop are allowed to come to the studio.

As previously mentioned, the join-in-studio also serves as a sheltered room for student teachers to acquire action competencies. Acting in the join-in-studio constitutes the main connection between the in-service project and pre-service course. So not only the preschool teachers are interacting with the children, the student teachers also are interacting with the children in the join-in-studio. Thus, both preschool

teachers and student teachers have the possibilities to practise action competencies. As already mentioned, each visit at the studio is video recorded. The student teachers are responsible for the recording. The video-recorded actions and interactions serve later as a basis for the reflection.

The components of reflection constitute a further connection between the in-service course and pre-service project. There are different meetings of reflection for student teachers and for the preschool teachers. In preparation for their reflection meeting, the student teachers are asked to analyse the actions and interactions that occurred during the visits to the join-in-studio. After the analysis, the student teachers choose meaningful video clips for the reflection meetings. Likewise, the video clips are used in reflection meetings with the preschool teachers of the in-service project and for further workshops also. The reflection meeting with the preschool teachers is audio recorded only.

Thus, the three phases of the in-service project interweave with the components of the BA course in different ways.

Circulated Connection of Different Competencies in One Mathematical Content

Apart from the linking of the in-service project and pre-service course and the video-recorded interaction in the join-in-studio, the innovation further emphasises the element of reflection. The reflection component enables a circular model of connections of different phases, which focus on different competencies within one mathematical content. The different competencies can be acquired exemplarily on the basis on one specific mathematical content (Fig. 2).

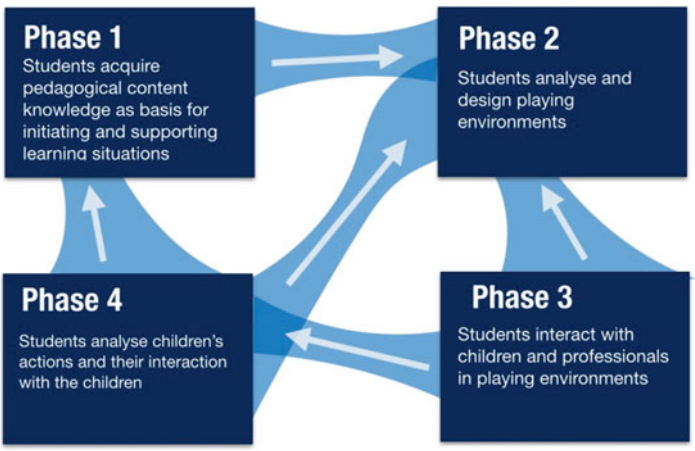

Fig. 2 Connection of competencies within the BA course

In Phase 1, student teachers acquire foundations regarding content knowledge, pedagogical content knowledge, knowledge in developmental psychology and pedagogy with regard to special conditions of preschool settings.

On this basis in Phase 2, the student teachers analyse materials and games and develop playing environments. In doing so, they have to take into consideration a need to balance free and instructed playing. The playing environment shall provide possibilities to accompany child-initiated interactions and prerequisites for sustained shared thinking. By designing playing environments, student teachers have to consider the interplay between instruction and construction.

The implementation into practice takes place in the interactions with alternating groups of children in the join-in-studio at the university. The student teachers are challenged to assess the mathematical potential of playing situations and to create challenging social situations in order to motivate children to play. Due to the alternating groups of children, the student teachers have the chance to intensively and exemplarily focus on one mathematical content both on theoretical and practical perspectives.

During the reflection phases, they can gain a deeper understanding of the mathematical pedagogical content. On the basis of this new insight and extended knowledge, they design and implement playing environments and learning possibilities again. From analysing their own actions, they connect theoretical and practical aspects. Theories can be compared with individual experiences of practical sessions. Mismatches between theories and observations can be used in a constructive way for further design and implementation.

From analysing the videos, a critical distance to their own interactions can be established. In collaborative phases of reflection, student teachers are able to analyse patterns of communication and solution processes of children on the basis of theoretical aspects. The student teachers can also think about alternative (re)actions. New insights can eventually lead to adaptations being made to the playing environments, which provide a connection to Phase 2. Also new theoretical insights can be obtained which connects to Phase 1. The video clips selected by the student teachers can be used to illustrate theoretical aspects in Phase 1 as well.

In the description of the innovative structure, it is postulated that different competencies of preschool teachers can be achieved through the focus on reflection. In the following section, a glimpse is provided of the ongoing analysis of the audio-recorded reflection meetings from the in-service project. It is analysed to determine the aspects of preschool teachers' competencies which are addressed in the reflection meetings.

A Glimpse into the Analysis of Reflection Meetings

The project lasted 4 years and included seven different reflection meetings. The number of preschool teachers at the reflection meetings varied between 10 and 25. Not every preschool teacher who attended the workshop and the join-in-studio took part in the reflection meetings.

Three selected extracts from the recordings are described in detail in order to show how the model of deductive category application of qualitative content analysis was used (Mayring 2007).

Reflective Statements Addressing Pedagogical Content Knowledge

Before reflecting on the video clips, the preschool teachers were asked to report on their impressions in an open discussion. One preschool teacher reported an interesting situation in which the children played buying and selling eggs. In doing so, the children used a rack, which contained 30 eggs with the structure of six rows and five eggs in a row (5×6). Fortunately this situation was recorded clearly on a video recording, and the student teachers made a clip for the reflection meeting with this situation. The preschool teacher commented on the video clip (Fig. 3):

> We played with the eggs, the egg cartons and egg racks. Ina put 30 eggs on the rack. And she started to count them all by 2s, 2, 4, 6, 8, 10, 12 and so on till 30. Then during playing—I don't know why—the children discussed how many eggs half of this egg rack may contain. She did a thing which I never would have realised if I had not been here. They still debated how many eggs will be in half of this egg carton. Then Ina draws an imaginary line in the carton so that there were 3 rows, each with 5 eggs. She laid her hand on 6 six eggs and said, '6', really 6, then on other 6 eggs and said '12' and then on the last 3 eggs and said '15'. Because I didn't understand what was going on, I asked her to explain me again what she did, and then we considered that her explanation will be on the video.
>
> [Wir haben mit den Eiern, den Eierschachteln und -platten gespielt. Ina hat eine Eierpalette gefüllt, auf die 30 Eier passen. Dann beginnt sie zu zählen und dann zählt wirklich in Zweierschritten 2,4,6,8,10,12,14, und so weiter bis 30. Dann während dem Spielen—ich weiß nicht warum—die Kinder haben überlegt, wie viel Eier wohl auf die Hälfte passen. (…). Sie hat erst eine gedachte Linie auf dem Karton gezeichnet, so dass es 3 Reihen mit 5 Eiern waren. Beim Bestimmen der Hälfte der Eier auf der Eierpalette, legt sie ihre Hände zuerst auf 6 Eier, Und sagt dann ohne zu zählen erst mal 6, echt einfach 6 und dann auf andere 6 Eier und sagt 12, und dann auf die letzten 3 Eier und sagt 15. Weil ich nicht gleich verstand, was sie meinte, fragte ich sie, ob sie mir das nochmal erklären kann. Und dann haben wir aufgepasst, dass ihre zweite Erklärung auf Video aufgenommen wird.]

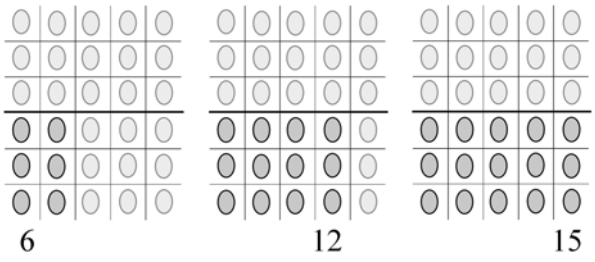

Fig. 3 Ina's process to determine the numbers of eggs

Different perceptions made by the children in regard to the quantity of numbers were reported by the preschool teacher, especially about decomposing a quantity into different parts and using different structures. First, the preschool teacher reports that Ina decomposed the quantity of all eggs into parts of two eggs. Later on, the preschool teacher recognises that Ina decomposed all eggs into two halves. Then she observed that Ina decomposed the quantity of half of the eggs (15) in a structure with 2×6 eggs and three eggs. Next to these different possibilities of decomposition, the preschool teacher also mentioned different processes for judging the quantity like counting in steps by twos and solving a very challenging calculation task like $6 + 6 + 3$.

After this video clip had been shown, the preschool teachers discussed that seeing structures is very individual and that the structures are not just there; they emerge when people look at them. Thus, it can be seen that the reflection meeting pedagogical content knowledge was addressed.

Reflective Statements Referring to Action Competencies

A precondition for action competencies or at least one major part of action competencies is identifying learning possibilities for children. Therefore, identifying learning possibilities or teachable moments in children's actions had a dominant role in the reflection meetings. This can be seen in expressions like 'I noticed especially in how many areas the children find mathematics and how eager they are with it' or 'I never saw so many mathematical situations'.

Acting in specific situations is also a part of action competencies.

> Preschool teacher:
> But I have learned so much from the student teachers; to say: 'Hold back, give the children more possibilities to try themselves'. Not only 'right' and 'wrong' to communicate. And focus on the procedure: 'How do you know this? How could you explain or say this more precisely?' To pick up such questions, that was quite interesting for me, to think in such a way.
>
> [Aber ich hab von den Studentinnen so viel gelernt, zu sagen ‚nimm dich zurück, gib den Kindern mehr Möglichkeiten sich auszuprobieren. 'Ja nicht das Richtig und Falsch, was wir vermitteln. So von der Vorgehensweise‚woher weißt du das jetzt? Wie kannst du das noch genauer sagen?' Solche Fragestellungen aufzugreifen, das war für mich ganz interessant, so zu denken.]

This preschool teacher focused on the interaction between the children and the adults and identifies possibilities to initiate sustained shared thinking. Many preschool teachers also addressed the interplay between instruction and construction in the interaction with children.

> Preschool teacher:
> So, I then realised, I provide far too much. Not until here [*in the in-service project*] I realised that I should withdraw much more and that I can and should create much more free space, which is very difficult if one is in this job for such a long time. And I just became aware that we should rather help the children, but let them do it themselves—also in regard to mathematical content.

[Also ich hab dann gemerkt, ich gebe viel zu viel vor. Und hier [*in der Fortbildung*] habe ich dann erst gemerkt, dass ich mich viel mehr zurück nehmen muss, viel mehr Freiräume schaffen kann und sollte, was unheimlich schwierig ist, wenn man schon so lange drin ist. Und es ist mir dann aber immer wieder bewusst geworden, dass man den Kindern eher Hilfe geben soll, aber sie selber machen lassen soll—auch bei mathematischen Sachen.]

One preschool teacher told in the reflection meeting about a situation where she discussed different arrangements of five eggs in an egg carton, which can contain ten eggs in the structure of a ten frame. There were egg cartons with five eggs in a row, but Peter put two eggs in the upper row and three eggs in the lower row. The following discussion can be seen in the videotape:

Preschool teacher	Why can you see easily and quickly that Peter has 5?
Child 1	Because 4 plus 1 is 5.
Preschool teacher	Hmm, can you see how Peter put the eggs in the carton. Is that 4 and 1?
Child 1	Yeees?
Preschool teacher	Hmmmmm, yes, you could see that, too, right. But I've seen something else. Has anyone an idea?
(No child had an idea)	
Preschool teacher	How many are in a row?
Child 2	2 and 3
Preschool teacher	Yes, and 2 and 3 is 5, too. Ok.
[Erwachsener	Warum kann man beim Peter gut erkennen, dass es 5 sind?
Kind 1	Weil 4 plus 1 ist 5.
Erwachsener	Hmm, Siehst du wie es Peter gelegt hat? Ist das 4 und 1, was da der Peter da gelegt hat?
Kind 1	Ja?
Erwachsener	Hmmmmm, ja, das kann man auch erkennen. Stimmt. Ich hab was anderes erkannt, wer kann sich vorstellen, was ich erkannt hab. Hat jemand eine Idee?
(Kein Kind hat eine Idee)	
Erwachsener	Wie viele sind in einer Reihe?
Kind 2	2 und 3
Erwachsener	Ja, und 2 und 3 ist auch 5. Ok.]

The preschool teacher commented that only after the situation happened, she 'understood how the child could see four and one. Yes, it was the pattern of the dice of four and one. But in this situation I just couldn't see it'. This situation led to a broad discussion with the focus on understanding children's thinking and comprehension as well as about the problem that seeing structures is a very individual act.

Posing questions was another component of the reflection discussions. The preschool teachers jointly discussed appropriate and alternative questions and (re) actions in this situation.

Reflective Statements concerning Attitudes, Beliefs and Motivational and Volitional Tendencies

Preschool teacher:
I was extremely motivated through this (vocational) training to implement mathematics in kindergarten, but at the same time I was positively surprised how much material we were already using, where I was not aware about the mathematical learning opportunities.

[Ich wurde durch die Fortbildung extrem motiviert, Mathematik im Kindergarten umzusetzen, war aber gleichzeitig auch positiv überrascht, wie viel Material wir schon im Einsatz hatten, bei dem mir die mathematischen Lernchancen nicht bewusst waren.]

In this statement, motivational and volitional aspects are addressed by the preschool teacher. Many preschool teachers refer to their own view of mathematics and their experiences in their own school career.

Preschool teacher:
I am also very thankful because it changed something in me. I didn't really like maths in school and I thought children will start early enough with doing maths, so we don't have to bring it as such a concept into the kindergarten, I thought, because the 1×1 and $3 + 7$, they really learn that early enough in school. For myself, it really changed a lot, because I think that I got out of this that we do mathematics in the daily life and we only have to change our thinking a bit and I really liked it so that I really want to thank you heartily.

[Also ich bin auch sehr dankbar, weil bei mir hat es selber einen Hebel umgelegt. Mathematik war mir ziemlich verhasst in der Schule und ich dachte, die Kinder machen noch früh genug Mathematik, das müssen wir jetzt auch nicht noch unbedingt so als Begriff in den Kindergarten bringen, fand ich, denn das 1×1 und $3 + 7$, das lernen sie noch wirklich früh genug in der Schule. Für mich selber hat es jetzt sehr viel umgelegt, weil ich denke, ich hier mitgekriegt habe, dass wir eigentlich Mathematik machen im Alltag und wir das einfach nur ein bisschen umdenken müssen und ich fand das so toll, dass ich mich echt herzlich dafür bedanke.]

On the basis of some transcripts, the categories are presented. In summary, the preschool teachers were able to use the shared space of the reflection meetings to discuss *all* the different aspects of professional competencies. Therefore, the postulation that different competencies of professionals can be addressed by reflection can be confirmed.

Closing Remarks

The important role of reflection was analysed on a theoretical and empirical basis for professional development especially in early childhood mathematics education. By a circular connection of different phases concerning different professional competencies and by other innovative aspects like the sheltered room for action and the use of video-recorded interactions, the role of reflections in teachers' learning of pedagogical content knowledge was considered. Still, different aspects of professional development have to be analysed in detail.

Concerning early mathematics education, it must be stated that an artificial sheltered room like the join-in-studio is not an optimal situation for children to learn mathematics. The children's ability to influence their activities can be quite limited if student teachers focus mainly on mathematical aspects. Children should have the chance to acquire mathematical competencies in their play, in their preschool setting or at home in natural learning situations (Gasteiger 2014; van Oers 2014). Nevertheless, many preschool teachers reported that the artificial and sheltered environment helped both the children and the preschool teachers to focus on the activities the children had chosen. This was because there were not so many other activities and possibilities available in the join-in-studio as in their normal preschool institution and so children focused longer on their own play and activities:

> Preschool teacher:
> We realised that children in a sheltered room are sometimes more concentrated on their play or activities, when they are not so distracted by other things which are going on around them. Some children don't get into it so much in their free play time, some need this protection. Here, they are completely concentrated, whereas in the institution, during times of 'free-play', there are rarely occurring such great scenes…
>
> [Wir haben festgestellt, dass die Kinder in einem geschützten Raum manchmal konzentrierten sind beim Spielen und Tun, wenn sie nicht so abgelenkt sind von anderen Sachen um sie herum. Manche Kinder kommen im Freispiel da nicht so richtig rein, manche brauchen das geschützte. Also wenn sie hier sind, dann sind sie voll konzentriert, während im Freispiel in der Einrichtung, kommen selten solche tollen Szenen einfach auf …]

The artificially created situation seemed to help the preschool teachers to acquire wide-ranging knowledge and competencies so that they are now able to identify children's mathematical competencies and teachable moments in their daily routine in the preschool setting. As one preschool teacher said: 'This, I had never perceived in everyday situations, if I would not have been here'. Another preschool teacher stated: 'My view for mathematical situations is now wider. I see more possibilities of exploring mathematics, of supporting children to find solutions'. This last statement illustrates how the different aspects of professional competencies are interweaved. Next to attitudes, beliefs and motivational and volitional tendencies—as seen in statements such as 'my view for mathematical situations is now wider'—growth in pedagogical knowledge was also identified: 'I see more possibilities of exploring mathematics, of supporting children to find solutions'. Seeing 'more possibilities of supporting children to find solutions' is also one part of action competencies. In order to support children constructing new mathematical knowledge, professionals need to recognise the mathematics in children's constructions or, more precisely, in children's statements and actions. Professionals also need to know how to interact with the children in these situations and expand their repertoire of action competencies. So in this statement, different aspects of professional competencies are connected. Furthermore, the complimentary connection of instruction and construction become apparent as well as knowledge of both aspects.

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