CHALLENGING PARENTAL BELIEFS ABOUT MATHEMATICS EDUCATION

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While the crucial role of beliefs in the teaching and learning of mathematics is widely acknowledged, the focus of previous research mainly lies on teachers’ and students’ beliefs. Parental beliefs, however, have been rather neglected. Considering current trends in mathematics education and its institutional integration the question arises to what extent parental beliefs correspond to these concepts of mathematical education. Therefore, the need occurs to investigate parental beliefs more closely. Against the background that a more active parental involvement in their children’s mathematical education is an agenda for several countries, including Germany, a further aim is to encourage an enrichment of these parental beliefs. Herein, the focus lies on parents of secondary school students. This paper gives insights in underlying theoretical aspects as well as possible future activities.

INTRODUCTION

The idea for investigating parents’ mathematical beliefs is based on a previous study where one part of an inquiry focussed on parental experiences with and attitudes towards mathematics (Albersmann, 2011). One question in this study was: “When you think of mathematics, what do you spontaneously think of?” Some responses like “hard to understand, lots of practice, horror before the lessons, private tutoring, didn’t get it” give cause for further investigations on parental beliefs about and attitudes towards mathematics. The mentioned quotations, for example, particularly indicate persistent experiences of incompetence expressed in a highly emotional way. One question that arises out of this is, which feelings do parents actually have regarding their mathematical competencies and resources to support their children? Altogether the study revealed, that, indeed, several parents feel uncertain about their abilities to help their children with mathematics. Other responses to the question mentioned above referred to mathematics as “formulas and numbers or calculations”, which express a one sided view on mathematics. In the literature, this view has been labelled as toolbox aspect (Grigutsch, Raatz & Törner, 1997). Even aversions towards mathematics were stated such as “anxiety and cold sweat”. All in all, the need to examine parental views and beliefs about mathematics more properly and to think about possible supportive interventions emerged.

On the level of educational policies, a statement given by the German Conference of Ministers of Education and Cultural Affairs (KMK) recommends the integration of
parents. In 2009, a decision was made in order to strengthen the so-called “MINT” subjects implying scientific, mathematical and technical education. In particular mathematics is met with little enthusiasm from young people as a school subject, course of studies or career choice. One of the KMK’s consequent interventions is to foster cooperative work with parents. More precisely, this is about encouraging and empowering parents to support their children’s scientific, mathematical and technical education (Kultusministerkonferenz, 2009).

While several European countries like Scotland, Finland or Norway have already established concrete initiatives to integrate parents more actively in the mathematical education of their children, those activities are lacking in many other countries, especially in Germany (Eurydice, 2011). However, parental support in mathematics can not at all be taken for granted. Considering current trends in mathematics education and the institutional embedding, for example, in national curricula or educational standards, the question comes up to what extent parental beliefs correspond to current concepts of mathematics education.

The critical role parents play in their children’s development is undeniable and their mathematics-related beliefs are likely to be one decisive parameter for their resources to support their children. However, existing research on parental beliefs about mathematics and mathematical education could hardly be found. Most of the research refers to elementary school students and their parents’ attitudes (Pritchard, 2004) and in one case even considers family involvement in mathematics (Onslow, 1992). Another research found on that topic investigates, indeed, beliefs of secondary school students and their parents, but refers only to one family (Krassnig, 2009). Hence the need to investigate parental beliefs especially from secondary school students more closely arises. Besides the investigation of parental beliefs another issue would be to challenge those beliefs and to encourage their development. This paper gives insights in underlying theoretical aspects and draws a conclusion for future research activities.

REVIEW OF LITERATURE

Defining beliefs

In mathematics education, beliefs came to the fore when in the United States the National Council of Teachers of Mathematics (1980) called for more problem solving activities in the 1980s (Schoenfeld, 1985). In the meantime various empirical studies and theoretical considerations have contributed to deepen the insights into this complex construct. Nevertheless, there has not yet been, and probably should not be expected, a generally accepted definition of beliefs (Furinghetti & Pehkonen, 2002; recently brought forward again by Goldin, Rösken & Törner, 2009). Whereas some researchers strongly recommend the necessity to clarify the meaning of beliefs by giving a definition (Goldin, 2002; Pajares 1992; Thompson 1992), others emphasize
“that the absence of consensus around definitions is not necessarily counterproductive, since beliefs constitute a very flexible and accommodating construct” (Goldin, Rösken & Törner, 2009, p. 3). Without attempting to formulate an all-embracing definition, we nevertheless point out some aspects frequently discussed in the literature that are especially relevant for parental beliefs.

One approach to define beliefs is to interpret them as a structure of attitudes, like it is described in the “three-component-model” by Triandis (1975). This model distinguishes between the components cognition, affection, and conation. While the cognitive component contains knowledge and concepts of the belief object, the affective component refers to the emotional relationship a person has to a belief object. Finally, conation means behavioural intentions and tendencies. These components mutually influence each other. They mostly are consistent, stable and lasting. Existing or arising inconsistencies among the three components influence the stability of the attitude structure and, thus, it gets open for change (Triandis, 1975).

Pehkonen and Törner (1996) define beliefs in a similar way: They distinguish between the two components of cognition and affection but take a closer look on the strength of each component in form of their consciousness.

An individual’s mathematical beliefs are the compound of his subjective (experience-based) implicit knowledge and feelings concerning mathematics and its teaching and learning. Conceptions could be understood as conscious beliefs, and thus differ from so-called primitive beliefs which are often unconscious. [...] In case of conceptions, the cognitive component will be stressed, whereas the affective component is emphasised in primitive beliefs. The spectrum of an individual’s beliefs is very large, and its components influence each other. [...] An individual’s beliefs will form their own structure which we call his belief system (Pehkonen & Törner 1996, p. 102).

Furthermore, Pehkonen and Törner (1996) take up the approach by Pehkonen (1995) and divide the compound of beliefs into four main categories. These categories can be divided further into smaller elements. Here, some examples are given:

- beliefs about mathematics, e.g. beliefs on the nature of mathematics or beliefs on the subject of mathematics (as it is taught at school)
- beliefs about oneself within mathematics, e.g. beliefs concerning someone’s self-confidence or beliefs regarding someone’s mathematical competences
- beliefs about mathematics teaching, e.g beliefs about the nature of teaching mathematics or about what the degree of autonomy given to pupils is
- beliefs about mathematics learning, e.g. beliefs about the nature of learning mathematics, beliefs about what the degree of autonomy expected from pupils is or beliefs about who sets the criteria for correctness.

This distinction clearly defines several elements of a person’s mathematical belief system.
Beliefs are not only referred to as a complex, but sometimes also as a messy construct (Furinghetti & Pehkonen, 2002; Pajares, 1992). However, focusing on the composition of beliefs, some of this “messiness” can be reduced. Following Dionne (1984) and Ernest (1989), Törner and Grigutsch (1994) describe three components of mathematical beliefs: the toolbox aspect, system aspect, and process aspect. In the toolbox aspect, mathematics is considered as a set of rules, formulas, skills, and procedures. In the system aspect, mathematics consists of logic, rigorous proofs, exact definitions, and a precise mathematical language. In the process aspect, mathematics is seen as a constructive and creative process where the invention or re-invention of mathematics plays an important role. Later, Grigutsch, Raatz and Törner (1997) add the usefulness, or utility, of mathematics as another important component.

Changing beliefs

As mentioned above, beliefs are considered as a complex construct and the formation of belief systems has not yet been clarified completely. However, as stated by Ball (1988) or Skott (2001) for teacher beliefs, parental beliefs about mathematics, its learning and teaching as well as themselves within mathematics are probably to a large extent based on their own experiences as students. Hence, these beliefs are robust and consequently difficult to change (Schommer-Aikins, 2004). In the context of changing preservice teacher beliefs, one promising approach consists in involving them as learners of mathematics, usually submersed in a constructivist environment enabling them to discover mathematics for themselves (Ball, 1988; Feiman-Nemser & Featherstone, 1992; Liljedahl, 2005).

An approach for documenting conceptual change is given by Appleton (1997) who refers to the constructivist theory, as well. He elaborated a model for describing and analyzing students’ learning. Therein he describes three different possibilities of what happens when learners, in our case parents, are confronted with new information and experiences.

The three possibilities Appleton (1997) distinguishes are:

- Identical fit: The new information is consistent with existing ideas. The learners are able to make sense of the new information in the context of their existing knowledge. However, this does not imply the correctness of the learners’ explanations. Learners who feel that they have achieved an identical fit are most likely to quit the learning experience.

- Approximate fit: The new information seems to fit approximately to an existing idea. Some aspects are seen to be related, further details, however, remain to be unclear. In this situation the learners will not reach the point where a cognitive conflict could happen because they may encounter new ideas but will not give up old ones.
Incomplete fit: The new information cannot be explained adequately by existing ideas or even is inconsistent with them. In the best case, this situation results in a cognitive conflict. The motivational factor that let the learners try to reduce the conflict is a feeling of dissonance or frustration.

In this model the main mechanism for change is cognitive conflict. Though, originally located in the context of knowledge change, this mechanism might be equally adaptable to the context of belief change (Rolka, Rösken & Liljedahl, 2007).

**Parental beliefs and influences on their children**

Parental participation in learning activities at home seems to decrease with their children growing up, like it is shown in the Michigan Childhood and Beyond Study or Maryland Adolescent Growth in Context Study (Eccles & Harold, 1996). The question is, why do parents withdraw from supporting their children’s learning increasingly? Eccles and Harold (1996) mention two reasons that are relevant for beliefs: On the one hand, parents’ efficacy beliefs, which means their confidence in helping their children with schoolwork especially when the subject areas get more specialised, and on the other hand, their attitudes towards school, which includes their previous history of positive and negative experiences at school or the role they believe the school wants them to play.

Moreover, whereas the cooperation between teachers and parents is much more distinctive in the earlier years of childhood, the collaborative relationship seems to decrease as children move into their adolescent years and into secondary schools, in particular in mathematics (Eccles & Harold, 1996).

Certainly, parents are not the only reference persons in childhood, but their influence on their children is crucial due to their omnipresence and emotional intensive relationship to them. The quality of a parent-child-relationship, however, is determined by the way parents get involved in their children’s lives and their learning, as well. A study by Wild and Remy (2002) about affective and motivational consequences of parental learning facilities and attitudes towards learning clarifies that children have a higher self-determined motivation to learn, if their parents concentrate their attention rather on the learning process than on the learning outcome and if parents support their children’s learning in an autonomous way. Those aspects build up key characteristics for parental support in their children’s learning in general and in mathematics learning, as well.

Parental experiences with mathematics can be considered as one parameter that influence and shape their beliefs. Beliefs in turn build a filter that influences almost all of their thoughts and actions concerning mathematics. Accordingly, beliefs have an impact on how parents will behave in a mathematical learning situation and on how they are able to support their children’s learning activities (Pehkonen & Törner, 1996). They form background factors for parents’ thinking and acting. Thus, parents,
who, for example, perceive mathematics as procedural drills, calculation strategies or for which the solution to a mathematical problem is more important than the process of finding the solution, probably are not able to support their children’s motivation towards learning mathematics in a positive way (Wild & Remy, 2002).

CONCLUSION AND OUTLOOK

The decline of cooperation between secondary schools and parents on the one hand, and of parental engagement with learning activities at home on the other hand, necessitates closer parental involvement at least in the first years of secondary school. Hence, the transition to secondary school is a breaking point for parent-teacher cooperation. Moreover, many parents seem slightly anxious about their children coping with the new school situation and are highly interested in facilitating the transition for their children. Thus, the 5th and 6th grades appear to be appropriate to encourage parents to get more involved in their children’s learning activities.

In order to incorporate parents in their children’s mathematical education a project combining several workshops, where parents experience mathematics together with their children, seems particularly suitable. The workshops should be launched by the schools themselves and the participation should be encouraged by the mathematics teachers, in order to encourage closer cooperation between schools and parents and to communicate the need for parental involvement and support in their children’s mathematical education.

The workshops should be accompanied by research on parental beliefs. For such a research the differentiation of mathematical beliefs by Pehkonen and Törner (1996) comprises particular relevant aspects. Parental beliefs about themselves within mathematics, for example, point to their perception of their ability to support their children with mathematics. As well, parents’ beliefs about learning and similarly teaching mathematics give some indication of their strategies to support their children with mathematical problems. Additionally the four aspects of mathematical beliefs by Grigutsch, Raatz and Törner (1997), which fit into the earlier mentioned components by Pehkonen and Törner (1996), provide an analytical framework to classify parental statements about mathematics and its teaching and learning.

The key objective of the planned research is to unveil parental beliefs which run counter to current concepts of mathematics education like it is stated e.g. in national curricula or educational standards especially for secondary school. Furthermore, those beliefs need to be questioned, so that at best each parental belief system can be enriched or diversified. If we want parents to perceive mathematics as more than the procedural drills, calculation strategies or even a subject of aversion, then they must be provided with opportunities to experience and explore mathematics in a different way. Thus it is about reinforcing parents’ expertise and ability to help their children
with mathematical problems at home in a supportive way. This could happen through composition of the workshops which should reflect current concepts of mathematics and mathematical education in order to challenge parental beliefs and encourage their development.

An issue that has to be clarified is, how to encourage the development of parents’ pedagogical and mathematical knowledge, and, more critical yet, how to achieve a development of their belief systems. If parents have rigid views about how mathematics should be taught, they might get confused or will not open up to other approaches (Pehkonen & Törner, 1996). Hence, one question appears: Which stimuli are indeed necessary or useful to challenge established beliefs? Törner (2002), for example, states that stereotype approaches to mathematical problems foster limited and reduced perceptions. Here the approach of Ball (1988), Feiman-Nemser and Featherstone (1992) and Liljedahl (2005) mentioned above seems to be appropriate for parents as well.

With regards to content, including a great diversity in types of mathematical problems is essential. The composition of the workshop tasks should consider principles used in constructivist theories. This is about devising appropriate learning environments that address the subjective fields of experience of each person, but at the same time create new riddles. Consequently, the objective of the workshops is to create complex and authentic problems. It is essential that parents and their children are actively involved as learners in order to be able to develop their knowledge structure. The constructivist approach even seems particularly adequate for challenging parental beliefs and provoking a feeling of inconsistency, hence to provoke – in the terms of Appleton (1997) – an incomplete fit. Parents will go through an inner contradiction and will overcome it in a productive way during the experience of mathematics. Therefore, it is essential that the learning environments in the workshops reflect the nature of mathematics in a diverse way.

With regards to methods, one focus of such workshops should lie on the cooperative experience and exploration of mathematical tasks where parents work together with their children as a team. To accomplish this team spirit, it is necessary that parents let go of their typical roles; during the workshops they should not be the conveyer of knowledge or the director of operations but a learning companion and cooperate with their children in order to work on the problems together. Sometimes it is more fruitful to listen to children, to reflect on a problem, and to devise a problem-solving approach together. By this means parents can experience the importance of autonomy for a successful learning process. One possible method to develop a suitable learning environment is the “open approach”. The use of investigations and open-ended problems seem to offer the opportunity for a more meaningful teaching and learning experience (Pehkonen & Törner, 1996, p. 104).

Family math workshops as they are described above will be implemented for the first time in the school year 2012/13. The so called math-experience-days will start with parents and their children from an upcoming 5th grade of a Gymnasium in Cologne, Germany, and will take place three times a year on weekends for about three to four hours. The basic conditions are set, that means, the partner school agreed to promote the planned workshops and moreover is looking forward to integrate the project in its official school program. The first contact to the fifth-graders and their parents is established.

REFERENCES


Kultusministerkonferenz: Empfehlung zur Stärkung der mathematisch-naturwissenschaftlich-technischen Bildung, Beschluss. 07.05.2009.


