

Development of motivation referring KCS and KCT in professional development courses

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In this paper, we discuss pre-test's results of a research project aiming to investigate the impact of a professional development course on teachers' motivation and teachers' pedagogical content knowledge (PCK). For this purpose, we propose a brief review of research on teachers' professional development. We further refer to the main characteristic of the professional development course, i.e. to integrate examples of students' solutions of tasks that the teachers were asked to collect in distance phases of the course. Afterwards, we discuss the main theoretical constructs for our research, i.e. motivation, PCK and a combination of motivation referring to different aspects of PCK. Based on an adapted questionnaire motivation in this context is measured in two professional development courses. Results of pre-tests (at first meeting) show that teachers consider situations to acquire PCK as challenge and are interested to do it on a medium level.

Professional development, pedagogical content knowledge, motivation, beliefs

INTRODUCTION

There is a consensus that university studies and internships are not enough to prepare future teachers for all challenges with which they will be confronted in their professional career (Mayr & Neuweg, 2009). For this reason, professional development (PD) is understood as being a key factor for innovating and reforming mathematics teaching in school (Garet, Porter, Desimone, Birman & Yoon, 2001). However, research referring to teachers' professional development implies that PD must have several characteristics for being effective (Desimone, 2009).

For example, Kedzior and Fifield (2004) sum up characteristics of high quality teacher PD: If a PD course is content-focused, extended, enables active learning (Garet et al., 2001), supplies follow-up support or reflecting students' learning results (Franke et al., 1998) teachers' learning will be sustainable (see also Timperley, 2007, 2008).

However, Yoon et al. (2007) criticised the absence of studies that focus on different aspects of efficient professional development courses in an experimental or quasi-experimental setting. For this reason, the actual efficiency of aspects of successful PD like reflecting student learning results is not clear (Lipowsky 2010, 2011). For example, the research program of cognitively guided instruction (CGI) by Franke, Carpenter, Fennema, Ansell & Behrend (1998) is an often cited example of an effective

PD program. However, CGI fits several of the characteristics of effective PD. Since this is the case for several PD programs that are found to be effective, the impact of a specific characteristic of a PD course on teachers' knowledge, beliefs or motivation is not investigated yet.

Therefore, a research project named PROFIL (<http://profil.ph-bw.de/wiki/Hauptseite>) is started in Germany to prove different aspects of professional development programs. The main purpose of this project as a part of PROFIL is to investigate the impact of a characteristic of a PD course that we call "reflecting on students' learning results" (cf. also Timperley, 2008) that was indicated to be an effective characteristic of PD programs. "Reflecting on students' learning results" could be a characteristic of PD courses that include more than one face-to-face-meeting and a distance phase between the face-to-face-meetings: Teachers were introduced in a specific issue of mathematics teaching in the PD course and develop tasks or lessons referring to this specific issue. In distance phases they integrate the developed tasks or lessons in their teaching and collect examples of students' works, e.g. solution of tasks. The solutions are sent to the facilitators of the PD course. Some of the students' works are integrated in the next PD course as topic of reflecting students' learning results referring to a specific mathematical subject.

In our study, we focus on the impact of this reflecting on students' learning results on the teachers' learning in PD courses, and, especially on the teachers' pedagogical content knowledge, beliefs and motivation. In this paper we report about measures on motivation according to pedagogical content knowledge and results of the pre-test. For this reason, we analyse the construct of motivation itself, i.e. its value in different groups or correlations among different aspects of the construct of motivation.

THEORETICAL BACKGROUND

An impact of a PD course could firstly refer to teachers' professional knowledge. According to Shulman (1986) pedagogical content knowledge (PCK) is a central part of teachers' professional knowledge. Further, PCK can be divided in "knowledge of content and students" (KCS), "knowledge of content and teaching" (KCT) and "knowledge of content and curriculum" (Ball, Thames & Phelps, 2008). We are going to consider primarily KCS and KCT in this study. These aspects of teachers' knowledge include on the one hand knowledge about students' mathematical concepts and typical mistakes or misconceptions (KCS). On the other hand, it consists of knowledge referring to most appropriate representations of mathematical concepts, decisions about teaching style or basic ideas for mathematical concepts (KCT).

Besides knowledge, motivation is a crucial part of teachers' mathematics related affect (Hannula, 2012) and, thus, a crucial part of teachers' professional lives. For this reason, a main aim of our study is to investigate teachers' motivation. Motivation in general is used to explain human behaviour. Accordingly, it determines orientations of goals, persistence and intensity of actions (Schiefele & Schaffner, 2015). For this reason,

motivation is considered as a psychological process which initiates, maintains, directs and evaluates actions to achieve a positive valued state (Dresel & Lämmle, 2011; Rheinberg & Vollmeyer, 2012). Following Lewin (1946) motivation emerges out of the combination of components of a person and environmental attributes. Based on this model, Rheinberg, Vollmeyer and, Burns (2001) conclude that every performance, especially learning performance, requires motivation.

For the learning performance of teachers' in professional development courses, we refer to the construct of actual motivation considered by Vollmeyer & Rheinberg (1998) that consists of four dimensions: probability of success, apprehension of failure, challenge and interest. The first three sub-dimensions belong to achievement motivation. A central aspect of this motivation type is the comparison with an achievement scale. On that account, an individual compares itself with an individual, a social, an objective or an external determined norm (Heckhausen, 1974). Atkinson (1957) divided achievement motivation into an approaching and an avoiding component which is considered as "motivation to approach success" and "motivation to avoid failure". Both components belong to an expectation component.

By contrast, challenge and interest are considered as a value component. Therefore, challenge depends on subjective success probability. According to individual performance a person estimates task difficulty. Challenging tasks were considered as those that have medium difficulty. The learners are able to handle these, but they have to make an effort (Rheinberg & Vollmeyer, 2012).

The fourth sub-dimension "interest" is characterized by the person-object-theory of interest (Vollmeyer & Rheinberg, 1998). In this context interest is conceptualized as a special relationship between a person and an object (i. e.. physical things, tasks, special topics of knowledge or activities) that is characterized by positive emotional states and high subjective object values (Dresel & Lämmle, 2011; Krapp, 1999). Based on a survey involving 287 teachers, Schiefele, Streblow and Retelsdorf (2013) confirmed three dimensions of teacher interest. These belong to all three dimensions of teachers' knowledge (content knowledge, pedagogical content knowledge and general pedagogical knowledge). *Subject interest* is considered as interest referring to content knowledge taught in the classroom. Besides, it includes knowledge beyond school related content knowledge. By *pedagogical content interest* the authors understand interest to prepare lessons well, to acquire new methods for teaching and to read specialized literature. *Pedagogical interest* belongs to every aspect of pedagogy in school situations.

Eccles and Wigfield (2002) suggest a positive relationship between expectation (probability of success) and value (interest) component. According to these two aspects, we focus in this paper on the following two questions referring to motivation:

(1) Which effects show reflecting on students' learning results in professional development courses on teachers' achievement motivation towards KCS and KCT?

(2) Which effects show reflecting on students' learning results in professional development courses on teachers' interest towards KCS and KCT?

METHODS

In this study we want to investigate, whether reflecting on students' learning results (see above) is a feature of sustainable and effective professional development. For this reason, we follow a quasi-experimental design whereas "reflection on student learning results" is the independent variable and motivation the dependent variable.

Referring firstly to the design of the whole research approach, we use a pre-post-test design which includes three groups of teachers. The first one takes part in a professional development course with reflecting on students' learning results. The second also takes part in a professional development course without reflecting students' learning results. Instead of reflecting on students' learning results, these teachers examine the issues of a theoretically driven task design. For example, in a current course, the first course got an input about problem solving. They developed problem solving tasks referring to given criteria. In the distance phase of the PD program, the teachers were asked to give the problem solving tasks to their students, to collect students' solutions, and to send these solutions to the facilitators. The second group follow the same program. However, they were not asked to collect students' solution, but to improve the tasks on the basis of the teachers' overall impression of the lessons where the tasks were integrated. The third group, i. e. the control group, do not get any intervention.

In this paper we only refer to the first two groups. The first group consists of 21 teachers and the second group consist of 15 teachers. The teachers of the two groups stem from different towns, but stem from the same region in Germany. Thus, the school system, the curriculum and partly also the teachers' education is identical or at least similar. The geographical distance made it difficult for teachers to interact. Both groups showed a similar distribution of gender and age. For this reason, although we did - for pragmatic reasons - not used a randomization, there was no hint for systematic differences between both professional development groups in our quasi-experimental study. For the region we chose (the German federal state "Sachsen-Anhalt") there is further the specific characteristic notable that most of the teachers in this region have none or little experiences with PD.

In the first meeting in the PD course, the first and second group completed a questionnaire involving items concerning motivation referring to KCS and KCT and concerning KCS and KCT and also beliefs. The second test will take place at the last meeting of the professional development course. There is a six-month time span between pre- and post-test which is equal to the overall duration of the PD course. In this paper, we restrict the focus on the pre-test and further to results referring to the teachers' motivation.

The instrument for measuring motivation is based on a questionnaire from Rheinberg

et al. (2001) which measures actual motivation. To measure motivation according to KCS and KCT we adapted the questionnaire. Therefore, we developed seven tasks which represent specific educational situations (see figure 1). The dimensions KCS consists of three situations, KCT consists of two situations and there are two situations for general pedagogy. The first version of the adapted measure was tested to reduce the number of situations as well as the number of items for every situation (first version includes eighteen items for each situation). Based on the results we deleted a situation in each pedagogical content dimension. So the completed questionnaire consists of the following situations: Investigating students' mistakes, creating a diagnose test, solving students' social problems, finding appropriate basic ideas and finding appropriate representations for mathematical concepts.

To shorten the number of items in each situation, we excluded one sub-dimension of actual motivation. As a result, the completed questionnaire consists of items referring to apprehension of failure, challenge and interest. The participants have to rate the items on a seven point Likert-scale with categories from "I do not agree" to "I fully agree". There are five items for interest, five items for apprehension of failure and four items for challenge. The following figure shows an example of a situation of motivation referring to KCS (creating a diagnose test) with items of the sub-dimensions.

Diagnose test						
Introducing the topic of derivation, you are forced to make a diagnose test to measure students' performance on functions. Therefore, you create a diagnose test with eight tasks. For example, one task is:						
Explain what a function is.						
Please, rate the following statements:						
	I do not agree					I fully agree
1. I like it if it is a puzzle to create tasks for a diagnose test. (<i>interest</i>)	1	2	3	4	5	6 7
2. For me it is embarrassing to create tasks for the diagnose test that are not appropriate. (<i>apprehension of failure</i>)	1	2	3	4	5	6 7
3. For me, creating tasks for a diagnose test is an appreciated challenge. (<i>challenge</i>)	1	2	3	4	5	6 7

Figure 1: Example of a situation measuring motivation according to KCS

The adapted questionnaire of Rheinberg et al. (2001) was tested by the authors in pilot studies and results showed good reliabilities of the subscales measured by Cronbach's alpha. In particular, the values of Cronbach's alpha differed between 0,593 and 0,929 in pilot studies. These are in common with the values for reliability calculated by Rheinberg et al. (ibid.) Therefore, we used the questionnaire in our present study.

RESULTS

At this moment, we are able to report results of the pre-test from both professional development courses. So we present the results of motivation referring to KCS and KCT and also referring to general pedagogy for these teachers. The following table reports means and standard deviations for teachers who are in professional development course with reflecting on students' learning results:

	KCS			KCT			general pedagogy		
	I	F	C	I	F	C	I	F	C
μ	4,03	2,39	4,69	4,67	2,47	4,89	4,45	2,82	4,99
σ	1,01	0,80	0,98	1,09	1,19	1,00	1,25	1,37	0,99

Table 1: Mean and standard derivation for teachers (PD with reflecting on students' learning results)

The table illustrates that the means of apprehension of failure (F) are similar in each category (KCS, KCT and general pedagogy). Further analysis of the differences between the means does not show any significant discrepancy. We gained similar results for the sub-dimension "challenge" for every category. In contrast, the means of interest referring to KCS and KCT differ significantly. Although there is a significant difference, the interests concerning KCT and KCS are highly correlated ($r = 0,91$; $p < 0,01$). For this reason, we made a deeper analysis of correlations. The results of these calculations are shown in the following table 2:

		KCS			KCT			general pedagogy		
		I	F	C	I	F	C	I	F	C
KCS	I	-								
	F	-,34	-							
	C	,66**	-,35	-						
KCT	I	,91**	-,22	,66**	-					
	F	-,35	,61**	-,48	-,20	-				
	C	,86**	-,15	,83**	,86**	-,23	-			
General pedagogy	I	,63**	-,19	,47*	,53*	-,35	,59*	-		
	F	-,49*	,62**	-,41	-,33	,79**	-,23	-,45*	-	
	C	,38	-,19	,51*	,25	-,02	,45	,79**	-,29	-

Table 2: correlations between all sub-dimensions with are significant * $p < 0,05$ or ** $p < 0,01$

The results show that the correlation between general pedagogical interest and KCS is

0,628 (KCS) and the correlation between general pedagogy and KCT is 0,529. Although the correlations are lower, they are also significant ($p < 0,01$ for KCS respectively $p < 0,05$ for KCT). Referring KCS, the mean of interest was significantly lower than the mean of challenge, and significantly higher than the mean of apprehension of failure. Analysis of the means in the other sub-dimensions show similar results. One exception is the relation between the means of interest and challenge in the sub-dimension KCT. In contrast, interest correlates significantly with each dimension of challenge ($p < 0,01$) according to both dimension of PCK motivation.

With regards to achievement related motivation referring to KCS and KCT there are also significant correlation between them. In special, the correlation in the subscale challenge between KCS and KCT is 0,833 which is significant at $p < 0,01$. In addition, the correlation in the subscale apprehension of failure between KCS and KCT is 0,611 which is also significant at $p < 0,01$.

The results of the other teachers taking part in the professional development course without reflecting on students' learning results are shown in the following table 2:

	KCS			KCT			general pedagogy		
	I	F	C	I	F	C	I	F	C
μ	3,81	2,57	4,88	4,71	2,51	4,95	4,77	3,42	5,08
σ	1,27	0,99	1,13	0,50	1,05	1,00	0,90	1,18	1,04

Table 2: Mean and standard derivation for teachers (PD without reflecting on students' learning results; R = representation and BI = basic ideas)

Teachers' ratings from the second professional development course show similar means and standard deviations compared to the first group. Nevertheless, the main results of the second group are in common with those of the first group.

DISCUSSION

The main purpose of this paper is to determine teachers' motivation referring to KCS and KCT at the beginning of the professional development courses. This aim needs an analysis of the results referring different aspects of motivation and also correlations of different motivational aspects. Our first results show that values of motivation are similar in both groups, but there are some differences between them. Overall, the means of challenge and apprehension of failure demonstrate a positive perspective of teachers' achievement motivation. Teachers of both groups tend to be motivated for approaching success (Atkinson, 1957). Especially, the participants perceive the situations for KCS and KCT as challenges. According to interest, the means are on medium level for KCS and at a higher level for KCT. This is consistent in both groups. It could be explained by their existing knowledge structure and low PD experience.

Teachers' qualification based on seminars at the university and practical seminars. The main purpose of these were to prepare teachers for teaching mathematics. Therefore, they concentrate on representations, basic ideas, methods to teach, etc. For this reason, teachers' interest could be high in situations that are referring to these topics.

The results have shown correlations between aspects of achievement motivation and interest which are significant in most cases. This is in common with the assumption of Eccles and Wigfield (2002), because they suggest a positive relationship between interest and probability of success. Our results support this assumption in both groups for teachers. Although there is a distinction on a theoretical level, our data involving high and significant correlations did not show a distinction. Especially, the correlation between interest of KCS and interest of KCT suggests that these sub-dimension of pedagogical content interest could be only one dimension. The results of apprehension of failure and challenge support this assumption, because there are also high correlations which are also significant. These results of the pre-test have to be investigated to verify if the assumption is the correct.

FUTURE RESEARCH

Based on the data of the pre-test, we want to investigate the differences of teachers' motivation after taking part in the PD program. We assume that motivation of teachers who take part in PD with reflecting students' learning results will increase in the sub-dimension KCS. Especially, we expect a growth in interest referring to the appropriate situations, because in the course teachers investigate students' learning results. Therefore, they are engaged in identifying students' concepts of mathematical ideas and constructs, which is a part of KCS. In contrast, we assume that motivation of teachers who do not reflect on student learning results will increase in the sub-dimension KCT. In their PD course they focus on instructional ideas. So it is possible to expect that their pedagogical content knowledge about these ideas increases. In consequence, the motivation referring to this sort of knowledge should increase, too. Apart from both dimensions of pedagogical content knowledge teachers do not engage in general pedagogical situations. Therefore, they do not acquire new knowledge and experience according to pedagogy. As a result, their motivation referring to general pedagogy should not increase.

We hypothesize, that a change in motivation could in consequence result in a change of teachers' knowledge and beliefs, because the teachers will initiate activities around the knowledge of students, if they have higher interest (Rheinberg & Vollmeyer, 2012; Schiefele & Schaffner, 2015). This assumption is also in common with the results of Rheinberg, Vollmeyer and Burns (2001).

The results indicate that motivation to acquire knowledge of content and students and knowledge of content and teaching coincide in one dimension. Therefore, there may be only a dimension "motivation referring to pedagogical content knowledge". This assumption is in common with the differentiation of Schiefele et al. (2013). Further

investigations are necessary to prove the structure of motivation scale.

The study also includes measures of beliefs about teaching and learning mathematics as well as measure of KCS and KCT. So further analysis should provide insights in the network between the three categories of teachers' professional competence. Especially, the comparison of the results of pre- and post-test should ensure whether reflecting students' learning results is a feature of effective professional development. The analysis will show if the student-centred perspective enhances teachers learning (cf. Franke et al., 1998). Besides, there will be qualitative interviews with teachers of the course within reflecting students' learning results is a feature. Based on this data we want to provide insights in teachers' feelings and cognition referring to teaching out of a student-centred perspective and their motivation to analyse students' learning results.

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