

Collaborative Learning Processes in Teacher Training: Benefits and Costs

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Abstract: The current pedagogical discussion emphasizes self-determined and cooperative forms of learning. The theoretical background stems from constructivist theories of learning, which interpret social exchange and reflecting on one's learning pathway as crucial points for construction processes. Consequently, self-regulation turns into a central condition for scholarly learning. This includes setting goals, planning and conducting the learning process as well as the evaluation of results. This paper focusses on the processes secondary school teachers use to implement newly acquired knowledge on self-regulated learning in their lessons. By means of qualitative research methodology, we wanted to explore how experienced teachers develop their own abilities for self-determined learning while teaching their own pupils to do so.

Method: In a transdisciplinary research-project between a secondary school and a university, a group of mathematic teachers participated in a two-day training course on self-regulated learning during which they discussed and developed ways to enhance self-regulation of learners. They were then tasked with implementing their newly acquired knowledge during their maths lessons (number of pupils = 270, 4 - 5 lessons per week) with eighth graders in the course of a twelve week teaching period. Two separate groups of teachers were asked to put their newly acquired skills into practice. The first group (N = 6) used a collaborative setting in which tasks, teaching activities and performance reviews had been clarified and discussed within the group. The second group (N = 4) fulfilled these tasks individually without seeking assistance. The teaching strategies were assessed by means of multiple semi-structured interviews and observations of classroom activities.

Semi-structured interviews were conducted with the teachers prior to the training and after 12 and 32 weeks respectively to explore their understanding of self-regulated learning and their experiences during implementation. A thematic analysis approach was used to identify the factors relevant for the implementation from the teacher's perspective. Observation sessions of classroom activities were undertaken four times during the project period in each class.

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Results: Both groups stated that the focus on self-regulated learning inspired them to change some of their habits in their own teaching. Teachers in the cooperative group increasingly reported a growing awareness for details of their own preparations when planning lessons or grading, more so than the teachers in the supervisory group. In the collaborative group concrete attempts were made to change some organizational factors so that collaboration could continue for a longer period.

Conclusion: The distribution of didactic innovations such as the implementation of self-regulated learning in teaching contexts requires a two fold perspective. Not only the teachers and their individual teaching have to be taken into account but also the school conditions under which the teachers work. The integral perspective on the analysis of these implementation processes proved to be fruitful.

Keywords: Collaborative practices, Cologne action model, Integral theory, professional learning communities, secondary education, self-regulation.

Introduction

Innovations in the education system such as the encouragement of self-regulated learning are normally initiated from the outside when a new curriculum is introduced, for example. Many of these changes to the education system are currently justified by the conclusions of wide-ranging educational studies (cf. PISA). In the past years universities developed a host of projects which serve to encourage self-regulated learning among pupils. In both these cases not the protagonists themselves suggest new ideas, rather external authorities are making the suggestions in line with a “top down strategy” (Gräsel & Parchmann, 2004). This very typical method of changing teaching processes is also known as “Research, Development and Diffusion (RDD)” (Krainer, 2003). What characterizes this classic method is that “there is a human and temporal split between the conception and development of particular innovations and their implementation.” (Gräsel & Parchmann, 2004, p.199). Due to this split it is hardly surprising that further training will in most cases not change teaching practices (Kaenders, 2010).

Gräsel (2010) suggests that teachers working collaboratively are a central feature of successful adopted innovations. Teacher collaboration can therefore be used to integrate the training objectives more effectively during teaching. The evaluation of the cross border model experimental programme “Quality Improvements in Schools and School Systems (QuiSS, Qualität in Schulen und Schulsystemen)” showed that good teacher cooperation amongst the body of teaching staff was the strongest predictor for the spreading of model experiment objectives within the school (Jäger, Reese, Prenzel & Drechsel, 2003).

Krainer (2003) further emphasizes that teacher collaboration processes are ideally accompanied by external support from e.g. university researchers to yield optimal results. In his approach of collaborative research the protagonists with different types of expertise examine and develop their own teaching practices together. Teachers are not considered the passive recipients of scientific research but as experts on teaching lessons. As much as the teachers learn from scientists, science itself learns from them as practitioners. This type of mutually beneficial activity and learning can be viewed as a transdisciplinary approach in action.

Collaborative Teaching Development from an Integral Perspective

Collaborative approaches in teacher training widen the perspective from the interaction between a teacher and her/his class to the interactional and systemic view as a prerequisite for long-term implementation. The following paragraphs will analyze teacher training for self-regulation from an integral perspective. We will focus on Wilber's Integral Theory (2001) in which he developed a quadrant model to describe research processes under the viewpoint of the individual / collective dimension and the internal / external dimension. Wilber's model is based on the concept of Habermas (1995) in which different universal concepts are divided according to their subject area and claims for validity into a subjective, objective and a social world. Wilber broadens these reflections and differentiates between four approaches to cognizance which rest on two independent dimensions inside / outside and individual / collective (cf. Table 1).

The external individual approach to scientific knowledge is directed towards representational or propositional truth. The greatest possible concurrence with objective facts is sought. This view is considered the basis for the empirical (natural) sciences (quadrant 2). A great number of training projects in the educational-psychological discipline can be located in this quadrant. Many of them are developed and evaluated to a high methodological standard alongside international and national educational studies, whose primary objective it is to improve the cognitive and motivational skills of pupils. Within this scope the area of self-regulation deserves particular attention.

The internal individual approach is committed to a subjective claim for recognition and strives for truth, dependability and sincerity. Interests and convictions are frequently looked at from a phenomenological point of view and interpreted hermeneutically (quadrant 1). In this quadrant, the empirically proven efficiency of self-regulation is not the central issue. Rather, the question is how relevant a concept is for an individual teacher or pupil in terms of their subjective view of the world and how to relate it to their own actions.

In the outer collective quadrant a complex all-encompassing system is the primary reality. In this systemic view the overall system defines the many functions for its separate components. Zierer (2008) calls this "the requirement to fit in functionally" meaning that the single parts "must be woven into the fabric of the overall system" (p. 576). From this perspective it should be possible to prove through objective and empirical evidence that ongoing support of self-regulation leads to the smooth transition of those in learning into the overall economic structure of their country.

Wilber (2001) defines the inner collective quadrant as situated in a cultural context. An inter-subjective claim for recognition is negotiated among two or more individuals. Justice and mutual understanding are central considerations which do not necessarily lead to an objective linking of systems. Social and cultural behaviour is acted out in rituals and procedures which are recognized by the participants to be right and just. For self-regulation to flourish in this quadrant, it is important that those actively involved are in agreement about the role that self-determination should play in the learning process and how it should be adapted into the everyday reality of the school.

Table 1: Overview of the quadrants in Wilber's integral theory.

	Inside	Outside
Individual	<p>I Intentional Subjective demand for recognition (Genuineness) <i>What does self-regulation mean for my own learning?</i></p>	<p>II Conduct Objective demand for recognition (Truth) <i>How can self-regulation be supported effectively?</i></p>
Collective	<p>III Cultural The inter-subjective claim for recognition (Justice / Cultural fitting in) <i>How can self-regulation be implemented into day to day school life?</i></p>	<p>IV Intentional The inter-objective claim for recognition (Functional fitting in) <i>Are there benefits for the overall economy if self-regulation is encouraged?</i></p>

Self-regulation

Self-regulation is the ability to adapt one's actions to the achievement of medium-term and long-term goals while managing to handle adversity appropriately whether it be from the outside or from within. It is based on the interaction of cognitive, metacognitive and motivational-emotional resources (Artelt, Demmrich & Baumert, 2001). From the integral viewpoint quadrants 1 and 2 (Wilber, 2001) cover those training programmes which consider the thoughts, purposes and the intentions (quadrant 1) as well as the measurable behaviour (quadrant 2) of the individual. Collective perspectives are not explored. The great majority of empirical evaluation studies explore the measures used to support self-regulated learning among pupils in the lower grades of secondary school ("Sekundarstufe 1"). In terms of methodology and validity they can be assigned to quadrant 2 (Zierer, 2008).

The Cologne action model ("Kölner Handlungskreismodell", Aschermann & Armbrüster, 2011) describes self-regulation as a circular process in which the behavioural steps associated with cognitive and motivational-emotional processes are anchored. It is founded in Heckhausen's model of the regulation of action (Heckhausen & Heckhausen, 2008). Heckhausen defines four cognitive phases (setting a goal, planning, implementation, evaluation). Schmitz and Schmidt (2007) as well as Zimmerman (2000) proposed and evaluated similar self-regulation models. These fundamental models of self-determined learning emphasize the importance of emotions for the learning process but do not explicitly root them there. In our model the scope has been widened to include more detailed specifics on the interaction between the processes of regulation and cognitive processes necessary for a successful learning activity. The effectiveness of further training to encourage self-regulation was demonstrated by an empirical evaluation study in a schools context (Armbrüster, 2013).



Fig. 1: Cologne action model (Aschermann & Armbrüster, 2011)

Cognitive Processes

If learning is to be successful, it is important to have a clear and well-defined **objective**. The individuals have to be in a position to take their own decisions and to deal with a subject matter with real enthusiasm. **Planning** involves the definition of partial goals, setting priorities, anticipating possible obstacles and the consideration of alternatives. The **task in hand** demands self-confidence and the ability to apply oneself even when more attractive options or seemingly more urgent activities lure because progress is slow. **Evaluation** includes recording the results of the tasks set, as well as verification whether my own objectives have been achieved. Significantly, this calls for a meta-perspective which allows observing my own learning process in order to achieve realistic self-assessment.

Regulating Processes

In-between each step characteristic mood swings occur which determine the smooth flow of events. The ability to influence one's own emotions is significant for the successful outcome of a learning process. If an evaluation is to be carried out, it is crucial to have the ability to cope with failure or to be able to reassess the overall situation after detailed analysis.

When a new task is set, the mood should ideally be one of enthusiasm and optimism from the outset. When the planning stage arrives, feelings in general turn more sober, especially when obstacles become apparent (**focussing**). Starting and persevering are easier when the general mood is that of confidence (**facilitation**). During evaluation there is stronger attention to detail and the mood gets more serious (**re-centring**). The conclusions generated by evaluation are then transferred into the context of one's own experience. The subsequent change of direction towards a new goal once again demands emotional energizing (**self-referral**).

Although there are relatively stable differences in the personal priorities when it comes to individual cognitive and regulating phases, we contend that all components can be changed through a learning experience.

Objectives of the Study

This study in support of self-regulation in the lower grades of secondary school examines the question how a collaboration group and a training support group made up of teachers differ in the implementation of their further training during their maths lessons. The study also looks into the differences of how the two groups reflect both personally and socially on the concept of self-regulation during school lessons. The main emphasis is on the analysis of the teacher's individual planning for lessons and their views on the importance of self-regulation during learning. In addition, the project measured the learning progress of the pupils. The data is not included in this paper as it is due to be published shortly (Klenzan, in press).

Method

This indirect intervention study was undertaken as a project in collaboration between a university and five secondary schools ("Gymnasium"). Ten classes took part and the teachers were assigned to one of three conditions: a collaboration group (N = 6) or a further training group (N = 4). The teachers in the collaboration group all worked at the same school, the teachers of the further training group worked on two different schools nearby. The teachers in the collaboration group and the further training group received identical training on the subject of self-regulation. The teachers in the further training group applied their newly acquired training skills individually to the lessons they were teaching. The collaboration group on the other hand shared these skills with their maths teaching colleagues and applied them to classes (cf. later). These distinctions were put in place deliberately in order to distinguish the effects shown through further training and teaching in collaboration. The teachers implemented the further training that they received into their maths lessons for a total number of 12 weeks. The study is based on a pre-post design. The treatment effects were collated using a post-test shortly after intervention took place. A later survey recorded the longer-term effects. Data readings were taken three times and always based on evaluation-related variables. The period during which the study was undertaken lasted for one school year. The actual evaluation period lasted just over half a year.

The Training Syllabus

The teachers in the further training and collaboration groups participated in two training sessions on the subject of self-regulation lasting half a day each (cf. Table 2). The first training session introduced the teachers to the subject of self-regulation. The theoretical background used was the Cologne action model (see above).

The main objective of the first day was to introduce the teachers to the concept of self-regulation as a basis for motivated learning in school. During the "mental journey" - phase, the teachers were mentally guided through a complex project (organizing an event). Their task was to pay attention to their own reactions, feelings and ideas during this mental journey. In the ensuing discussion they compared their own experiences with those of the learning tasks they

had set their pupils only to discover that they were undergoing a similar learning experience to that of their pupils. The Cologne action model enabled the teachers to talk about the difficulties of motivating pupils without referring solely to the personality traits of the pupils.

Table 2: Day 1 syllabus.

DAY 1	
Phase of the training	Specification
Introduction	First acquaintance, importance of self-regulation in learning contexts
Keynote Speech	Idea and benefit of self-regulation, special relevance for the mathematics instruction
Group discussion	Specification of the phases, creating a school reference
Mental journey	Self-regulation in the teachers life, clarification of functional and dysfunctional behaviour patterns
Workshops	In-depth insight in the field of self-regulation
Discussion and reflection	Questions and feedback, agenda setting for day 2

During the second training session, the teachers were given examples of how to encourage self-regulated learning in the maths lessons. The contents of the syllabus corresponded to the Cologne action model and were divided into the four units, namely defining the objective, planning, the taking of action and evaluation. Priority was given to the link between theory and the practical application in school with a particular emphasis on the practicality of the syllabus and its successful transfer to lessons.

Table 3: Day 2 syllabus.

DAY 2	
Phase of the training	Specification
Introduction	Exchanging experiences and identifying central aspects the teachers wanted to work on
Defining the goal	The purpose of setting a goal is to elicit a motivating effect
Planning	Goals are manageable if split into sub-goals; planning maths lessons
Action	Invested study time and used learning strategies are significant aspects
Evaluating	Feedback is an influencing factor of causal attribution
Discussion	Questions and feedback

The training was devised specifically for the purpose of making it adaptable for teaching in class. Therefore adaptations were not only desirable but necessary and were discussed with the teachers. In a situation where self-regulated learning is encouraged it does not seem practical to make teachers follow a strict regime, as implementation very much depends on the teaching unit in hand and the makeup of the class itself. The teachers who participated were introduced to the possibilities of how to encourage self-determined learning and how to apply it within the context of their maths teaching. It was explained that these were merely suggestions to encourage self-regulated learning. Additional ideas for implementation were expressly encouraged. Three areas of special interest were formulated by the teachers during this training phase:

- How can pupils be supported to give them a realistic picture of their knowledge and competencies in order for them to prepare more independently for written tests?
- Pupils need to revise far more rigorously to attain basic mathematical skills (equations with variables, division of fractions, embedded problems)
- Cooperation in the class while working on a complex problem should be fostered

These aspects are the basis for the collaborative work between the teachers and the research group as well as being the focal point for supervision in the training group.

Shaping Transdisciplinary Cooperation

Continuous exchange between teachers: During the period of implementation, a continuous exchange between the members of the collaboration group was initiated and supervised. This discussion took place on three levels: the teachers worked together on didactic impulses for encouraging self-regulated learning. Ideas for implementation were floated and experiences were adapted accordingly. These exchanges took place within the context of personal conversations during the breaks or free time in-between lessons.

Transdisciplinary contact: To enable the transdisciplinary exchanges between teachers and researchers, regular meetings were arranged once a week. These meetings lasted about 90 - 120 minutes and took place at the school. The ideas and thoughts of teachers and researchers contributed mutually to the progress of the work. On the one hand these meetings served to clarify the next steps to be taken and allowed room for the exchange of views on the experience gained previously. On the other hand, the meetings strengthened personal contacts. Transdisciplinary perspectives and experiences were brought together and could be used for future implementation. This notion of collaboration across disciplines contradicts the “Research, Development and Diffusion paradigm” (RDD, Krainer, 2003) in which teachers are solely seen as the recipients of research findings.

Support website math-il.de: Cooperation among the group of teachers was further supported through the web platform math-il.de. Participants were able to exchange views flexibly regardless of time and place. The working group consisted of the participating number of six teachers plus university staff from the faculties of Mathematical Didactics and Educational Psychology. The platform served as an additional source for exchange and for uploading ready-made teaching materials.

It is through these impulses that changes in respect of individual approaches and convictions (quadrant 1) as well as of conduct (quadrant 2) were to be achieved. Changes in the school's circumstances (quadrant 3) were also to be documented. A change in terms of the inter-objective claim for recognition (quadrant 4) was not intended.

Observations in Class plus Interviews

During the period of intervention each teacher was observed twice in class for the purpose of recording the self-regulating components during the lesson. All observations were conducted by the same member of the university team. The central observation was how the Cologne action model was implemented in the lesson. The following observation grid to code the relevant aspects that were found in each lesson was devised exclusively for this purpose:

- Type of classroom instruction: teacher centered, working in groups, lecture, pupils working by themselves
- Activities of pupils during the lesson: the amount of time needed to complete the task, discussion of the maths problems, seeking help from the teacher or other pupils
- Possibility of independent self-regulated work in the class (amount of time, intensity)
- The introduction of self-regulation teaching aids
- Looking at how the different phases were implemented

The focus here lay specifically in the observation whether at least one of the four action phases had been implemented and how it was brought about. Further, the general presence of the action model during the lesson was recorded (visual presence and / or the explicit naming of a particular phase). The observations in class were based on fundamental criteria seen as prerequisites for self-regulated learning such as the prevailing teaching method and the perceived independence of the pupils (Hattie, 2009). In the course of three measuring periods, extensive interviews were conducted with the teachers in the collaboration and further training groups. Different members of the research group conducted the semi-structured interviews. They were recorded and subsequently transcribed. The subjects discussed during the interviews were expectations, knowledge, the changes that the teachers themselves perceived regarding their own planning and their teaching, the subjective theories about learning in school and the reactions of the pupils in view of the changes taking place during lessons. We use the method of Mayring (2010) for coding the teacher's statements. This method was chosen to deepen our knowledge of the teacher's thoughts, their feelings, meanings and their interpretation of teaching in their specific situation. The thematic analysis consisted of a two-step procedure. In the paraphrasing phase initial codes were generated by extracting interesting features from the data set. The relevant data for each feature was then given a code. Repetitions and embellishments were omitted. In the generalization phase the relevant themes emerging from the coding were extracted and named. Central topics of the pre and post interviews are summarized in table 4.

Table 4: Main topics of the semi-structured interviews

Pre interview	Post interview	Follow-up interview
– Personal ideas and reasons to participate in the project	– Applying the training materials in a classroom setting - regularity and intensity	– Do you still support self-regulated learning? – What changed?
– Individual objectives in the project	– Which aspects regarding the training were useful in your lessons?	– Continuation of teacher collaboration
– Definition of self-regulation	– Difficulties and obstacles encountered	– How intense was the practical implementation?
– Advance knowledge about self-regulation	– Solutions and alternatives	– How was the implementation structured?
– Assessment knowledge: How do you identify the self-regulation competences of your pupils?	– Prospective utilization of self-regulation in lessons – Did the project lead to cooperation with other teachers?	– Are there any reasons why training should not be undertaken?
–	– Results of the collaboration?	– What are benefits / costs of self-regulated learning?

Results

We will present the results in the order of Wilber's Integral Modell (2001). First, we will focus on how the teachers analyzed the project from a subjective perspective (focus on quadrant 1). This is followed by a description of how the syllabus of the further training was applied during lessons by both groups as perceived by the classroom observers (focus on quadrant 2) and the type of activities developed by the collaboration group (focus on quadrant 3). Although inter-objective changes were not taken into account here, the results are mentioned for the purposes of a complete representation (quadrant 4).

Quadrant 1: How Important is Self-regulation for my Teaching / for the Apprehension of my Pupils?

The focus of the interviews was the question whether implementation of self-regulated learning had taken place and from the teacher's point of view in what way implementation had differed in the collaboration group and the further training group. This qualitative procedure fits quadrant 1 because the individual perspective is particularly clear here. Post interviews were

conducted with nine teachers, six from the collaborative group and three from the training group (one teacher could not be interviewed due to parental leave).

In table 5 the results of the post-interview are summarized. For each category derived by the qualitative interpretation method the number of teachers who made statements relating to one of the categories below and the sum of all statements are shown.

Table 5: Overview of categories extracted from post-interviews and frequency of statements.

Category	Number of entries (teachers / statements)	
	Collaborative group (N = 6)	Training group (N = 3)
Implementation process	5/21	2/2
Self-reflection of teachers	5/8	2/2
Learning progress for pupils	4/9	2/2
Reflection of specific phases in the Cologne action model	6/9	3/3
Collaboration	6/12	1/2
Positive impact on teaching and learning	6/7	2/1
Difficulties encountered	6/6	3/3
Development of new maths tasks	5/6	2/4
Structure of the lessons	3/3	1/2
Future use of self-regulated learning	6/7	2/2
Costs of implementation (e.g. time, conflicts)	4/6	2/2
Website math-il.de	6/9	-/-

Eight teachers stated that they had implemented the action model either implicitly or explicitly in class. Of those eight teachers six belonged to the collaboration group while two belonged to the further training group. All eight teachers stated that they intended to continue using the action model.

The teachers of the collaborative group elaborated in detail on the process of implementation. They focused often on the learning processes of the pupils and used the action model in a differentiated manner to describe the positive changes in the lessons. Teachers of both groups reported some difficulties; these were in all interviews mostly attributed to the time the pupils needed to adjust to a new format of lessons. Teachers of the collaborative group talked more often about changes in their own perception of the learning process than the teachers in the training group. Analysis of the post-interviews shows that all six teachers in the collaboration

group experienced cooperation as most satisfactory and effective. The discussions with their colleagues were very much appreciated and led to a broader understanding of learning practices. Only one teacher stated that he or she found cooperation too time-consuming. It was also stated that cooperation added to an improved feeling of social cohesion among the teaching staff and to much improved personal satisfaction in the day to day business of the school. Two teachers pointed out that the positive effects of cooperation had led to getting to know a new colleague (female teacher in the post-interview of the cooperation group: “All six colleagues cooperated at regular intervals, consulted each other, devised work sheets, developed written tests. This is something I had never experienced before, especially that all the teachers worked together.”)

The website math-il.de was not considered a practical support tool. The reason being was that personal contact and the exchange of views were felt to be more convenient and more satisfactory. The exchange of teaching materials and permanent access were mentioned positively.

Reflections on the action phases for the pupils were a frequent theme during the interviews:

What I noticed more the second time round and that is important to me is how much we miss looking back and reflecting on the objectives, planning, acting and evaluation during the lessons. Especially in this mode we have become aware of how much the teacher is involved. Perhaps that is how it should be to ensure that the lesson can be maintained in its structure as prescribed by the curriculum. In my view it could be an advantage for many pupils if they thought more about how they could be more pro-active. (Teacher post-interview, collaboration group).

By contrasting two quotes from teachers from the collaboration group and the further training group on the subject of evaluation and objectives, the conceptual differences on teacher level become obvious:

Teacher (male) cooperation group: How did Cologne action model help?

In the beginning the pupils had to work out what they wanted to do and what their objective would be. They were also encouraged to reflect retrospectively before entering the next circle and steering towards the new goal. They had to reflect on their conclusions and decide whether they had reached their objectives. Then they had to think about how they would need to change direction if they wanted to be more successful the next time round. I liked that.

Teacher (female) further training group:

I found that the list was helpful for evaluation. That is something I do not normally do. They only write things down in their rulebook. However, a list which enables them to check their progress and is good for revision. I find that defining an objective is difficult as it is prescribed anyway. It is not possible to apply that in reality.

While the female teacher in the further training group acknowledges the importance of evaluation for the learning process, she perceives the objectives as prescriptive and not open to change by either her pupils or herself. In comparison, the male teacher from the collaboration group links evaluation and the definition of objectives with each other and thus describes the cyclical character of the action model as a central element.

Follow-up interviews examined whether a transfer had occurred after intervention and if so to what extent. Nine teachers agreed to participate in the follow-up. Three teachers of the collaboration group ($N = 6$) and one of the training group ($N = 3$) stated that self-regulated learning would continue to be encouraged along the lines of the action model after intervention. Teachers and pupils found the opportunity to take stock of the lesson by encouraging the pupils to evaluate (evaluation and self-referral) their own progress during lessons useful. The pupils welcomed the chance to set their own goals. Once the project had come to an end all teachers noted that the intensity of self-regulated learning had diminished.

Despite the positive feedback of the post-interviews the collaborative processes were not perpetuated after the intervention. Merely two of the five teachers in the collaboration group stated that they were still practicing some form of collaboration. The failure to continue with this type of cooperation was put down to lack of time and occasion. It was also stated on more than one occasion that without set tasks and tangible objectives collaboration among the teaching staff does not take place (female teacher in follow-up interview collaboration group: “None of the form teachers in the whole grade would cooperate if the impetus had not been given through an external project like this”).

Overall, the teachers in both groups implemented self-regulated learning during the project time and noticed mainly positive effects on the learning behavior of their pupils. Particularly the phases of goal setting and self-reflection were recognized as useful for the development of a more self-determined teaching style. The teachers considered the problems encountered as manageable.

Quadrant 2: How is the Training Syllabus Implemented in Teaching?

In addition to the subjective impressions of the implementation process, the classroom observations served as a means to get a clearer picture of what happened during lessons.

Twenty lessons were observed and coded and it should be pointed out that this sample is rather small in order to come to a general conclusion. Without doubt the observations did make an impression and complemented the teachers' own perceptions.

The focus here lay specifically in the observation whether at least one of the four action phases had been implemented and how it was brought about. Further, the general presence of the action model during the lesson was recorded (visual presence and / or the explicit naming of a particular phase). The observations in class were based on fundamental criteria seen as prerequisites for self-regulated learning such as the prevailing teaching method and the perceived independence of the pupils (Hattie, 2009).

Type of classroom instruction: Quite a number of maths lessons were observed which were characterized by an open practice of setting tasks as well as a high proportion of active learning time. However, the dominant method of teaching in the collaboration group was from the front of the class. This may be due to the low number of lessons observed but it is very typical for teaching in secondary school in Germany. The teachers did a lot of the talking while the pupils took on a mostly receptive role while learning. This means that there are few opportunities for self-regulation. The teaching of the further training group was mostly centered on the teacher too. It too was characterized by teaching in front of class and teachers who did a lot of the talking. The pupils received substantial direction and the teachers frequently asked the pupils questions, which meant that they had little opportunity to practice self-regulated learning. There were only a few lessons which had a more open feel and a larger proportion of active learning time.

Emphasis on the self-regulation model: There was a poster of the action model displayed in almost all classrooms. It was therefore present during most classroom observations. The model itself and specific phases were mentioned regularly in the collaboration group. The indirect implementation of individual phases occurred frequently. The implementation was evident throughout in check-lists, the free choice of set tasks and in the application of teaching materials devised by the teacher. In the further training group, the action model was also displayed as a poster; individual phases were not explicitly mentioned during lessons.

In sum, there were two noticeable differences between the two groups: teachers in the collaboration group dropped far more metacommunicative hints on the action model and the current phase in which they situated the activities of their pupils than the teachers in the further training group. They also dared to deviate from the teacher centred teaching method so typical for Germany far more often and consistently, thus giving the pupils more freedom to work on the tasks set either individually or in partnership.

When comparing implementation between the two groups of teachers another difference is obvious: the teachers in the further training group were willing to include the elements for encouraging self-regulation, which they had been introduced to, in their own lessons with minimal changes. They laid the main focus on a single action phase as discussed during training. In contrast, the teachers in the collaboration group developed a more complex target. Pupils were expected to complete the action model fully and independently in the space of a double lesson.

Quadrant 3: How can we Implement Self-regulation in Class Together?

Before the project kicked off some of the teachers in the collaboration group were skeptical about the planned cooperation. They were particularly worried that processes affording cooperation would be very time consuming. During intervention an overall invigorating mood developed. The protagonists acted in harmony with each other. One of the female teachers described her experiences thus: "You tend to be more stimulated. I noticed that the whole thing was specially designed so that all of us develop this together. We were not forced to use anything that was prescribed. Nor did I have the feeling that I needed to know all the answers. I was simply able to contribute what I could, based on my current level of expertise."

The action model was introduced into the collaboration classes in close coordination with a colleague whose teaching subject was not related but who had experience in the area of encouraging self-regulation and had also taken part in the two training sessions.

All teachers attended the weekly meetings of the project more or less without exception. Initially the meetings served to discuss the application of the training contents. Later on the discussion shifted to exchanges about the methods that had been implemented and their possible adaptations. Individual teachers developed their own teaching materials for the purpose of implementing the action model. They would make these materials available to their colleagues on math-il.de (teacher post-interview, collaboration group: "We had to work together more closely. It was very helpful to exchange views regularly on how certain set tasks had worked out, even if it was only in passing on the corridor. We would discuss what had worked out and what had not, how perhaps to phrase questions differently or so. That was good and more intense than I had expected.").

One teacher even had the idea to ask his pupils to select their own exercises from an assignment pool and to solve them on their own. The exercises were graded into five levels of difficulty. The work in progress from defining the objective (which exercise will I work on?) to marking was to be recorded in writing. This illustrates how standardized assignments can be developed into an individual process. In preparation of a written test one of the teachers developed a work sheet which is divided into the four cognitive self-regulating phases. On this work sheet the pupils can record what their objective for solving this written test is (defining objective) and how they plan to go ahead (planning). On the back of the work sheet the pupils are able to document how many days they spent revising for the test for the action phase. The evaluation phase is divided into three parts: (1) evaluating the individual preparation before the written test, (2) evaluation of the pupil's own performance during the lesson following the written test and (3) evaluation after returning the test.

The test was developed in partnership by the teachers in the collaboration group. During the weekly meetings the learning objectives and the quality for measuring performance of the exercises were discussed thoroughly and in great detail. The teachers marked the tests collectively too. This was a new experience for the teachers who normally mark the tests in isolation.

In addition the teachers developed so-called "warm-up exercises" which were introduced routinely at the beginning of each maths lesson. These exercises served to support pupils in their self-assessment similar to those exercises for defining objectives. The exercises gave the pupils the opportunity to formulate their personal objectives based on their current status of knowledge. The warm-ups displayed the date of the training course, the predicted number of correct answers and real number of correct answers as well as the self-assessed level of confidence while solving the problems (level 1 = very confident to level 6 = very uncertain). This enabled pupils to follow their own learning progress. The exercises were intended for revision and for consolidating basic abilities and were therefore not very difficult. The time allowed was roughly five minutes. While considering the purpose and scope of the warm-ups, the teachers discussed at length their personal views on the importance of specific aspects of learning and pursuing mathematics. Often these discussions resulted in self-reflection. The teachers in the collaboration group used

the action model as a meta-language to express their own learning process when disagreements occurred.

During the eight-week period of intervention over 30 documents were uploaded on the website math-il.de (in particular work sheets, articles, presentations, one written test). Teachers used the blog for immediate exchanges. The teachers did not use the internet platform much at the beginning. Towards the end of the intervention period this instrument was being used more often.

Teachers in the collaboration group even approached the school's management with suggestions for changes in the system. These changes were implemented in the following term. For the teachers in the collaboration group the most important objective was to have one hour of free time free of lessons in order to make it easier for them to get together and discuss.

Quadrant 4: Is Self-regulation Useful to Cope in a Knowledge Based Society?

The outer / collective perspective according to Wilber (2001) had no central part in this study. The long-term effects of improved self-regulation may only be demonstrated through education panels given a wide-ranging scope or through changes in society at large. The great commitment that the teachers showed in this study indicates that these "experts for learning" are convinced of the necessity and effectiveness of this approach and ultimately used it in their own teaching. The exceptionally intense and wide research activity in Germany on the subject of self-regulation is closely related to society's efforts to take into account individual skills and interests and including them in the learning processes in schools for the purposes of lifelong learning. We will know in a few years' time whether or not this approach has succeeded.

Discussion

The aim of this study was to show how the contents of motivational psychological further training can be applied to the teaching of mathematics in the lower school grades of a secondary school. The central theme was to encourage self-regulation according to the Cologne action model. After receiving two training sessions the members of the collaboration group went about implementation by cooperating with each other and started to make changes to their lessons in which the pupils were directed towards more intensive self-regulation. The members of the further training group applied these contents individually and with no exchange of views amongst the group.

Our data suggest differences between the two groups on a number of levels. During the discussions and behavioural observations it became clear that the members of the collaboration group had opted for a much more complex approach to impart the concept of self-regulation amongst their pupils. The teachers in this group intended to design their lessons in a way that pupils were able to complete a full cycle of set tasks by solving a more complex mathematical problem on their own within the scope of the double lesson. They recognized the importance of the connection between evaluation and the subsequent step of defining the new objective. For this purpose, they devised their own exercises and lesson routines. During meetings with the university cooperation partners, it was pointed out that completing a full cycle of tasks could

present a complex challenge for pupils and that they might feel that too much is expected of them. The teachers in the collaboration group agreed with this assessment but decided that they would continue to pursue their didactically ambitious goal. They argued that they hoped the long-term effects would be beneficial because lessons would open up more and that this would fire up the pupil's enthusiasm and interest in the subject matter.

This approach was indeed shared by the members of the university on the grounds of creating a level playing field in the area of academic research and development. The interviews recorded after the implementation phase showed that the teachers in this group had a much deeper understanding of the basic psychological and mathematical didactical concepts. Their pupils had a greater understanding of the cyclicity of action phases and the importance of evaluation followed by the definition of objectives for the purposes of a successful learning experience. The teachers in the collaboration group also used the concepts, which they had acquired to describe and reflect on their own learning process. Here too we see a transfer of a complex nature.

Our study is in line with a growing number of research projects focused on the implementation of teaching strategies aimed at how to foster strategic and self-regulated learning (Gräsel, 2010; Krainer, 2003; Maag Merki et al., 2010; van Beek, de Jong, Minnaert & Wubbels, 2014). Our results indicate that the implementation of a new teaching perspective is enhanced by the possibility to discuss ideas and topics with teaching colleagues and research partners. The results of the interviews also suggest that this wider communication strengthens the development of a sophisticated concept of self-regulated learning that may encourage teachers to gradually introduce more self-regulated activities in their teaching.

In the training sessions we emphasized teacher initiatives which specifically aim to engage students in self-regulated learning. The teachers implemented these new strategies only partially in the lessons observed and maintained external regulating activities (lecturing, questioning, explaining) as well. This might be down to the fact that the process of learning to regulate requires sharing cognitive experiences by means of metacognitive comments and discussing the processes (Flavell, 1987). This interpretation is supported by the frequent reflection on the problem solving processes in class by the teachers as well as their incisive comments during the interviews with the collaborative group.

Some limitations of the study have to be taken into account: the sample of teachers was quite small. Further, only one observer monitored the classroom interactions so that the reliability of these data cannot be assessed. We consider this study therefore as a pilot study. The results should be thoroughly tested by means of a larger number of teachers and classes. The perspective of the pupils should then be taken into account as well. The collaboration period lasted less than half a school year and was too short to ensure that long-term and stable collaborative practices in the school could be established. This result is in line with the results of Kaenders (2010) who reported much longer periods of collaborative interaction between school teachers and university members.

It is a complex and highly demanding task to teach pupils to become more autonomous and self-regulated in their learning. Our study indicates that when teachers collaborate with each

other as well as with university partners, a deeper understanding of these complex processes is gained allowing for the flexible application of new concepts in different teaching situations.

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