EFFECTIVE 'BLENDED' PROFESSIONAL DEVELOPMENT FOR TEACHERS OF MATHEMATICS:

DESIGN AND EVALUATION OF THE "UPOLA"-PROGRAM

Lutz Hellmig

University of Rostock, Germany

The paper describes the implementation and evaluation of UPOLA, a one-year-long blended learning professional development (PD) program for teachers of mathematics. The use of polyvalent tasks in classes as the main issue of UPOLA proved to be appropriate to support changes in classroom practice. Based on a short overview of the concept of polyvalent tasks, a description of the design of the blended professional program is given by considering multiple dimensions of 'blending'. The evaluation of the program shows a shift in participants' perception over the time from rather environmental variables towards the impact of UPOLA for teachers' acting and students' learning. Furthermore, some findings on the implementation of web-based communication and collaboration are presented.

Keywords: Professional Development, Blended Learning, Co-Operation, Evaluation, Polyvalent Tasks

INTRODUCTION

The current practice of teachers' PD in Germany is predominantly a set of single events of limited time, with little impact on teachers' classroom activity and students' learning. Given the current situation in the field of PD of practicing teachers, a lack of effective, job-embedded PD for teachers can be observed (Sowder, 2007). Limited-time events, rarely longer than a single day, are the current practice of teachers' further education in Germany. The impact of most of these lectures, meetings, or workshops is weak, since they do not affect teachers' behavior and students' learning. A detailed analysis of the present state is given by Jäger and Bodensohn (2007).

According to Loucks-Horsley (2003) and Guskey (2000) PD should be an ongoing, intended and systemic process. However, there is no clarity about attributes of effective PD. A comparative study by Guskey (2003) shows that "[…] most of the identified characteristics [are] inconsistent and often contradictory" (Guskey, 2003, p. 4). Overall, implementing peer-cooperation and collaborative activities are frequently named as key features to ensure changes in classroom practice (i.e. Garet, Porter, Desimone, Birman, & Yoon, 2001; McGraw, Arbaugh, Lynch, & Brown, 2003).

Following Jäger and Bodensohn (2007), a successful PD-program has to consider the specific needs of participating teachers. Inside-differentiation in heterogenic classes is one of the most evident general issues for PD of teachers of mathematics (Jäger & Bodensohn, 2007). In the German province of Mecklenburg-Western Pomerania,

where heterogenic classes in grade 5 and 6 have been established since 2006 in opposite to the common trinomial school system, teachers identify a higher need for differentiation especially in their classes.

UPOLA, which means "Teaching by using Polyvalent Tasks" *(in German: "Unterrichten mit POLyvalenten Aufgaben"),* focuses both on offering an appropriate topic (polyvalent tasks) to meet the needs of teachers and on a holistic blended approach for the design of PD. To adjust the ongoing program and to identify its strengths and weaknesses, evaluation on multiple stages was an essential part of the program.

POLYVALENT TASKS – AN ISSUE OF PROFESSIONAL DEVELOPMENT

According to the idea of "Open-Ended Approach" (Becker & Shimada, 1997), Sill and Hellmig (2008) defined the concept of "polyvalent math tasks". A mathematical task is polyvalent, related to a group of students, if (1) every student is probably able to find a solution, and (2) the task has a set of solutions on different levels according to the use of mathematical skills. These attributes distinguish a relative small set of polyvalent tasks from a broad range of general open tasks. Thus, polyvalent tasks are highly appropriate to meet the needs of differentiation.

Asserting the benefits of these tasks requires an apposite style of teaching, which is different from the general practice in Germany. Hellmig *et al*. (2007) suggested a time-ratio of about 50% to 50% for two phases of implementing polyvalent tasks in classroom: First the students are asked to find answers to the task individually, by cooperating in pairs or in small groups. During the second phase students present their solutions. The teacher encourages less successful students to show their ideas first; further other students are asked to present different solutions with a higher degree of complexity. The aim of this phase is to develop a culture of communication about mathematics in classes. The course material (Hellmig *et al*., 2007), provided to every participant in the program, described the characteristics of these tasks, their use in classes, and contained a collection of 70 tasks for grade 5 and 6 students.

The use of polyvalent tasks in classroom supports the idea of openness, communication and cooperation. To take the mentioned ideas into teachers' practice, the design of the program itself is dedicated to these characteristics.

DESIGN OF THE PROJECT – A BLENDED APPROACH

General considerations

"All learning is blended learning." (Oliver & Trigwell, 2005, p. 20) Designing PD is always a blend of different goals, contents, and methods. Inspired by Cross (2006) the author sees a complementary interaction on several dimensions of PD with the main dimensions (1) instruction/construction, (2) presence/ distance, (3) individual/collaborative learning, (4) content/experience focus, (5) "traditional" media/e-learning. Regarding these dimensions, the project UPOLA was blended

through

- Leading the course by two moderators; one with theoretical background, the other with more practical background.

- Giving content-related input (during meetings) and constructing knowledge by the participants through activity, reflection and discussion.

- Combining individual learning by teaching and reflecting with collaborative learning. This included discussions on didactical issues and about lessons, which were taught by the participants, as well as joint planning of lessons.

- Using a guideline linked to the curriculum during the school year and self-directed teaching, reporting and discussing.

- Meetings "off the job" and phases of experience and reflection "on the job".

- Using traditional channels and web-based environments to communicate.

A factor for transferring the topics of PD into classrooms is engaging more than one teacher per school. Transfer is influenced by organizational support of principals and acceptance by staff members of a school (Guskey, 2000; Krainer, 2002; Loucks-Horsley, 2003; Gräsel, Fussangel, & Parchmann, 2006). Thus, every teacher in grade 5 of the participating schools has been invited to attend the program. We assumed that a vast amount of fruitful peer communication and co-operation during PD could affect the growth of the local professional communities of the participating schools.

Implementation of UPOLA in 2007/2008

After a pilot study in 2006/2007, "UPOLA" was put into practice in 2007/2008. We grouped 44 teachers of grade 5 classes of Mecklenburg-Western Pomerania and Berlin into five courses. These courses were integrated in "Mathematics Done Differently", an initiative for PD of teachers of mathematics. A key feature of the programs in "Mathematics Done Differently" was the moderation by a tandem of a school- and a university-teacher (Rösken & Törner, 2008).

We combined four meetings "off the job" between August 2007 and May 2008 with three phases of PD "on the job"; each segment lasted 8-12 weeks in duration. This combination of presence and distance learning supports co-operative and collaborative work, associated with social interaction and flexible time management, which is important for preventing high drop outs (Lynch & Dembo, 2004; Nash, 2005; Picciano, 2006). A valuable list of factors for blended PD-programs was given by Wideman, Owston, and Sinitskaya (2007). We used the learning-management-system (LMS) "moodle" for online communication.

Meetings

The meetings mostly took place at the participating schools, the workplace of the attendants. We ensured a suitable atmosphere for the meetings, offered refreshments and agreed on an informal style to communicate with each other, even between

participants and facilitators. Typically, a meeting started with a structured group interview as a review on the recent period of work, which often turned into a spirited discussion. The review ended by writing a collective summary. Second, a facilitator linked selected theoretical topics to the issue of polyvalent tasks and encouraged a discussion. Finally, participants selected a concerted task for the next on-the-job-phase and outlined first thoughts on teaching with the chosen task. Each meeting closed with a short written feedback on two open questions. A substantial amount of time of the first two meetings was spent for introducing the LMS "moodle" and the characteristics of asynchronous communication.

Phases of experience and asynchronous communication

During an "on-the-job-phase", the attendants planned and conducted a lesson about the chosen polyvalent task. They were asked (1) to report and reflect upon their own lesson, (2) to comment on the reports of their peers, and (3) to discuss different teaching approaches with polyvalent tasks by using moodle.

For setting up the LMS we had to consider the skills and the attitudes of the attendants towards information technology. A certain number of teachers felt uneasy and tried to avoid the use of computers; some of the participants had to struggle with technical issues and deficient skills along the entire course. Hence we designed the structure of the moodle-course to be as clear and simple as possible into a general block and three topic-blocks, each for one on-the-job-phase. The main activity of each topic block was a discussion board for reporting everyone's experience in teaching polyvalent tasks and to discuss about didactical issues. Beyond that, we provided additional material such as manuals (i.e. how to write a report) and files of course-related content.

EVALUATION

Success of PD depends both on content and design. Hence, the evaluation followed two main questions: (1) Are polyvalent tasks appropriate to address a broad range of students with different skills and encourage communication about mathematics in class?, (2) How far is this kind of blended learning applicable for teachers' PD and what sort of items can increase the outcome of the program? In this paper, we put our attention to the second question.

Methodology

Guskey (2000) describes a model of evaluating teachers' PD that comprises five stages. We utilized this model, and gathered data for (1) participants' reactions, (2) participants' learning, (3) organizational support and change, (4) participants' use of new knowledge and skills, and (5) student learning outcomes. The author subclassified the second stage into (2a) process, and (2b) results of participants' learning.

Determined by our blended view of professional development, we had to separate

two points of view from each other. On the one hand, we examined five courses in their entirety with certain attributes to find general correlations. On the other hand, we had to regard the participants as individual learners and teachers by case studies.
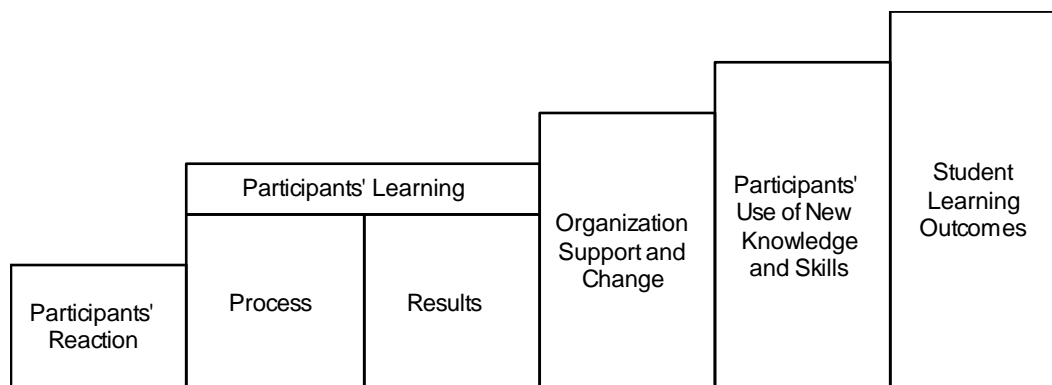
	Participants' Learning		Organization Support and Change	Participants' Use of New Knowledge and Skills	Student Learning Outcomes
Participants' Reaction	Process	Results			

Figure 1: 5 Stages of Evaluation adopted from Guskey (2000)

Use of different means for evaluation was necessary to gain reliable data. The most important means were different questionnaires, interviews with teachers and principals, classroom observations, and monitoring discussion groups by quantitative and qualitative criteria. Finally, a modified method of the Repertory Grid interviewing technique (Collet & Bruder, 2006) was employed to capture the system of participants' personal constructs regarding math tasks before and after the course. Reflective reports and discussions during every face-to-face-session delivered very rich and useful "soft" data to get insights in participants' learning. The variety of tools for evaluation generated two separate sets of data: a set of personalized data, gathered by interviews, online- and face-to-face-discussions, and sampled classroom observations; and a set of anonymous data, collected by surveys and Repertory Grid. On the one hand, it was not possible to avoid getting some personalized data of the participants; on the other hand, protection of privacy is a precondition to get objective and reliable responses by participants. Three examination papers about the influence of polyvalent tasks on grade-5-students with different abilities were written.

Focusing on the use of the LMS, we analysed the number of insights in documents hosted on moodle, and quantitative and qualitative parameters of discussion threads. First, we simply counted the number of postings by every participant, differentiated by opening a thread and giving reactions to a posting. To rate the vitality of the discussion, we defined a scale for grading every thread. Beginning with the lowest degree we distinguished (1) posting by the moderator without a reaction, (2) posting by a participant without a reaction, (3) posting and one answer (one by the moderator) (4) posting and one answer without commitment of the moderator, (5) discussion (at least one posting regarding an answer) between a participant and the moderator, and (6) discussion without participation of the moderator. Furthermore, we viewed the dates of the postings to assess the continuity of participation. An analysis of qualitative variables (i.e. use of new terminology, deepness of reflection) complemented the observation of web-based communication. We compared these

data with additional attributes, such as group-size, schedule of school-year activities and holidays.

Additionally, we could compare online activity of the participants with their contribution to the "off-the-job-meetings", and in some cases by observing classroom-activities concerned with the implementation of the subject.

UPOLA, as a part of "Mathematics Done Differently", was also evaluated externally by the Centre for Educational Research (zepf), University of Koblenz-Landau. Since that external evaluation was designed for one-day-events of PD, the usability of these data and the comparability with our self-evaluated data was limited.

Findings

The description of the findings of the evaluation is grouped according to Guskey's (2000) five stages of evaluation.

On stage 1, participants' reactions, participants appreciated the open and informal atmosphere of the meetings with possibilities to share experience with facilitators and colleagues. They reported about the importance of face-to-face-communication, many felt more comfortable to participate verbally rather than by online-written contributions. Participants attended the meetings regularly; we rated a small drop out (4 of 48) as an indicator of general satisfaction.

On stage 2, participants' learning, we observed that participants shared their individual approach to implement polyvalent tasks in profound discussions. We saw the quality of these discussions as a demonstration of increasing knowledge of participants. Frequently we heard that participants would rather communicate face-to-face than by using a discussion board.

In general, the use of the LMS for asynchronous communication felt short of our expectations. Although we defined a common and clear task for each experience phase, the number of postings by many participants did not match our demands. Most of the discussion-"threads" were only reports without a response by other participants. In some cases, participants received responses, but discussions developed rarely. We can confirm that the group size is an influential factor for the activity and intensity of discussion. Like Caspi, Gorski and Chajut (2003) and Wideman *et al.* (2007) we saw a better performance of courses with ten participants or more. The participants did not contribute postings continuously. First of all, the majority of the postings were written within the last two weeks before the meetings. This is critical regarding to the aim of developing discussions. Furthermore, we placed meetings into the last week before holidays. As a result, stimuli and motivation given during the meetings, faded out immediately due to the holidays.

To keep the attention of participants, daily alerts of ongoing activities had an influence on the activity of participants. Components of the LMS without delivering alerts (downloadable materials as well as some discussion groups) received

measurably less attention or responses from participants. Since reading e-mails was not a daily routine for some participants, facilitators had to contact and motivate some teachers by using additional channels of communication, i.e. by making phone calls.

Participants started to reflect about their lessons just by giving an overview about different approaches of the students to solve polyvalent tasks. By continuing the program many of the attendants included thoughts concerned with planning or reflecting about their lessons.

Evaluating higher levels (stages 3-5 of Guskey's model) of the impact of UPOLA has to regard the conditions of the attendants' workplace in addition to the program. Our research underlines the findings reported by Beaudoin (2002), who reported that a lack of online activity does not implicate a lack of adopting knowledge by participants. Observations of lessons of the UPOLA-project showed that in some cases teachers demonstrated sophisticated skills in teaching with polyvalent tasks, however, they gave no or very few reports to the discussion. Other participants admitted that they did benefit from ideas and experience of others, but hesitated to give themselves a reflection about their own work.

Finding relationships between teachers' PD and students' outcome is crucial, but challenging. Polyvalent tasks are usually not suitable for grading students by giving marks. Effects of polyvalent tasks were anticipated and observed in terms of motivating students, especially of students with lower skills, to think mathematically and to communicate about mathematics. Attendants reported that polyvalent tasks gave them the possibility to observe and assess their students in a broader variety of classroom settings. At this point, evaluation of the design of the program is closely linked to the evaluation of content.

Overall, an obvious change in teachers' perception of the PD program was observable. By classifying the comments of attendants on feedback-sheets (often so-called "happiness-sheets") it has become clear that teachers shifted their attention about the meetings from assessing the atmosphere or appreciating refreshment (after the first meeting) to higher-order categories such as content, quality of cooperation, or transferability. Although we encouraged teachers with the last feedback-sheet to report explicitly on their adapted 'knowledge', they focused more than before on their use of knowledge in classroom. In many cases, a possible impact on students' outcome was considered. Figure 2 shows the development of teachers' thinking towards students' learning over time, and indicates a solid impact of the program, according to Guskey's model of evaluation.
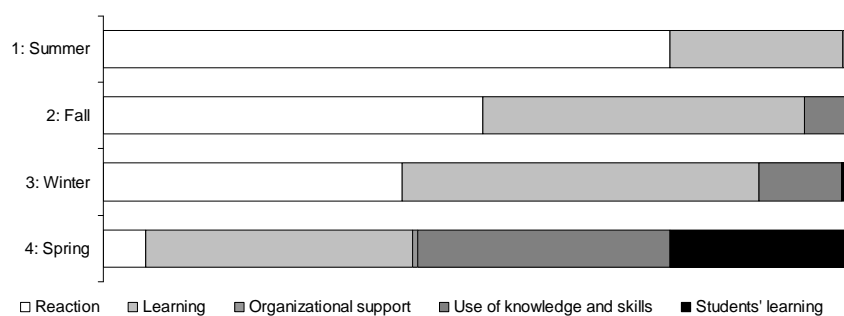
Figure 2: Ratio of participants' responses after each meeting, on Guskey's (2000) five levels of evaluation

In general, data of the internal evaluation was confirmed by the results of the external evaluation by the zepf, Landau.

CONCLUSION

Constructing and developing lasting knowledge, skills and beliefs through teachers' PD must be seen as a process, which needs sufficient time and possibilities to gain experience situated at the workplace and to share ideas and experience in a collaborating group. Using a blended-learning setting – four face-to-face-meetings connected with three experience phases "on the job" – can be one way to meet the needs of participating teachers and to change classroom practice sustainably. We did not merely use a LMS-course to offer instructional and supporting material, but rather the teachers were asked to report and to discuss their lessons using discussion groups in the same moodle-course.

We identified a high acceptance of the topic and of the main structure of UPOLA. Teachers reported the importance of collaboration and discussion among teachers for their situated learning, and their own work. Still, the participants met our expectations about the use of a learning management system only partially.

Different types of weaknesses in terms of remote communication and co-operation have been observed. First of all, teachers were challenged by the faint culture of reflection and discussion about their own work, particularly in a written form. In some cases we identified a lack of motivation for continuous distance learning; teachers had not been aware of the benefits of informal, situated learning and ongoing cooperation. Insufficient technical skills and little experience and confidence, related to asynchronous communication with information technology, hindered the development of a vital and deep discussion. It was indicated that some attributes of the course-design, number of participants per group, dates of face-to-face-meetings, clear tasks for teachers' reports are key for the quality of web-based cooperation. Groups with a certain minimum of participants have to be built to ensure a vital discussion; however, exceeding a maximum of attendants could be a hindrance for developing social relationships.

Further suggestions for planning subsequent projects are to synchronize the course-structure with the schedule of teachers' workload during one school year, to avoid face-to-face-meetings that are immediately followed by holidays, and to design a plain and clear structure of the e-learning-platform, which requires no more than elementary technical skills. In addition, sufficient time and support has to be given to develop technical skills of every participant, including a prior phase for signing in and discovering the LMS through the participants themselves.

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