

DEVELOPING OF MATHEMATICS TEACHERS' COMMUNITY: FIVE GROUPS, FIVE DIFFERENT WAYS

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Developing a mathematics teachers' learning community is one of the in-service teacher training methods in the university. At the beginning of 2006, from the initiative of some teacher training educators, a mathematics teachers' community formed at Tallinn University. The aim of the project was to focus on two of the main problems in school mathematics: teaching percentages and functions. Although all the groups were given the same problem by the tutors, a different approach was used by each group. The article presents an overview of the division of task inside the groups at the end of the first stage of the whole process, and also in what way each group reached its final decision with the matter of how to teach percentages. It turned out that at this stage the workgroups had developed differently.

INTRODUCTION

By Wenger's (1998) theory, working in the *communities of practice* is one of the most common and natural ways of cooperation and it can be seen in every sphere of social life where there is communication between colleagues. The aim of the communication is to solve a certain problem, and in this solving process there occurs constant intercommunication between the group members and the participants learn from each other (Wenger, 1998; Olson & Kirtley, 2001). Communities of practice are mostly informal groups. In a well-formed community of practice people have to know each other well, which implies that the following qualities apply: (Q1) the members of the community know each other's abilities, (Q2) they can be set to work quickly, (Q3) there is a quick flow of information inside the community, (Q4) there is a fluent exchange of information, (Q5) there is a good grounding for finding new strategies, (Q6) the group finds original solutions to problems that have been solved already (Wenger, 1998; see also McGraw, Arbaugh & Lynch, 2001).

The mathematics teachers' learning community, as a part of the in-service teacher training method has, according to a number of researchers (e.g. McGraw, Arbaugh & Lynch, 2001; Goodchild & Jaworski, 2005; Olson & Kirtley, 2005), proved to be successful. The exchange of different opinions and views in the course of discussions gives the participants a chance to view the problems from different angles, and therefore it is instructive for every member (Olson & Kirtley, 2005). Jarowski (2005) points out the importance of disputes and constructive discussions inside the circle, as it is by this process that all conclusive decisions are made. Grossman, Wineburg & Woolworth (2001) also warn that at the initial stage of work the group is liable to

become a *pseudocommunity*, as discussions lack subject matter and the members reach agreement too easily when trying to find solutions.

A mathematics teachers' learning community (referred later as *MMM*-project [1]) was assembled at Tallinn University for the first time in 2006. The *MMM*-project was part of a wider project of enhancing mathematics teaching in Estonia (Hannula, Lepik & Kaljas, 2007). A preparation period of about seven months preceded the assembling of the *MMM*-project, during which mathematics educators at the university acquainted themselves with research on mathematics teachers' communities worldwide (e.g. Olson & Kirtley, 2005; Jaworski, 2005; Goodchild & Jaworski, 2005) and thereby planned the *MMM*-project. The project awoke great interest among mathematics teachers – there were 34 applicants (initially it was planned for 10 teachers), and all of them were invited. I was one of these mathematics teachers. The planning of the *MMM*-project and its initial stages has been described by Hannula *et al.* (2007).

The teachers participating in the *MMM*-project were divided into groups of 6 or 7 members (referred to as G1-G5 in the text) at random. I was a member of G1. At the first two seminars we discussed the problems which resulted from the teaching process of percentages. We worked in the groups only at the seminars, as more rather individual homework was given by the tutors (designing and mediating artifacts). At the third seminar in October 2006 the groups were given a collective task: to make a detailed schedule for 20-25 lessons, about teaching percentages for grades 6-9 (pupils aged 13-16), and producing worksheets for them. The present article focuses on the fourth seminar of the *MMM*-project, which took place seven weeks later where the groups presented their respective views on teaching percentages. Most of the groups (G1, G2, G4 and G5) also gave reasoning in their presentation of how they reached their conclusions, and how they divided the tasks between the group members. In principle, the fourth seminar also marked the end of the first stage of the project, as at the next seminar the groups had to present their completed work of teaching percentages, and then to start discussing a new topic.

This paper seeks answers to the following questions: (1) did any similarities occur in the division of task inside the groups and (2) on what did each group base their approach (the ideas given by the university mathematics educators, scientific articles, or the participants' own experience). According to Jaworski (2005), the approach is only taking shape at the first stage of the learning community's work. Therefore, it would be interesting (3) to analyse whether the groups, as learning communities, had acquired qualities of a solid community of practice at the end of the first stage of the *MMM*-project (Wenger, 1998), or if they were still pseudocommunities (Grossman *et al.*, 2001).

METHODS

In the study I analyze the division of labour inside the groups, the level of development of the groups at the end of the first stage of the *MMM*-project, and on

what were the groups approaches based, apart from each member's own thinking and experience. Unfortunately there isn't much authentic evidence of the division of task inside the groups. The participants were not interviewed about it by the tutors, although the results might have proved interesting, and there are no video recordings of the process of working in the group(s). One of the authentic materials is a video recording of the fourth seminar (hereafter Video), where the representatives (or a representative) of each group tell(s) about the work inside the group and what conclusions they have reached. Parts of this recording have been used as the material to warrant conclusions and as illustrative examples in the present article. At the Estonian mathematics teachers' annual conference (November 2-3, 2007) every group gave its view on how percentages should be taught at school, and each group also had an article about it in the proceedings of the aforesaid conference. These articles were another source that I could use. As the third source I used the teaching materials in each member's folder on the *MMM*-project's home page [2] and also in the folders of the different groups. In the autumn of 2008 I sent an e-mail to the participants of the *MMM*-project in which I asked them to explain the first stage of our project as they recalled it. In this paper I use excerpts of some of their answers to me.

By comparing the above sources it is possible to make some conclusions about the work inside the groups. I searched for certain similarities in the division of task. I also tried to specify the level of development within each group by seeking the qualities of Wenger's (1998) community of practice (see in the introduction, hereafter Q1 to 6). I got data based on each group's approach from their articles (used references), and from the video (the tutors' suggestions to groups).

RESULTS

Division of task

The majority of the groups (G2, G4 and G5) used division of task so that each member of the group had to prepare one subtopic in depth. The unified form and structure was either agreed upon earlier or at the fourth seminar during the group work.

"... We also divided the material by the topics so that each teacher could have one topic to think over more thoroughly ... what it might consist of. And this is exactly what all our members have been doing. And today we tried to unify a little ... what items to put down and where ..." (member of G2, Video).

"... On the basis of it we divided the lessons between us...who is taking what part of these lessons to analyse, and we realised that we had to put down worksheets for the pupils and worksheets (with answers, R. R.) for the teacher, and we agreed on what it should look like. And now we will start writing them, as we do not have anything else today," (member of G4, Video).

"... First we relied on our division of tasks as we had agreed earlier ... we had divided the topics between us as we had previously, and how many lessons might be

reasonable... Then we gave to every member of our group – we chose it ourselves – which topics for whom to analyse in detail. Each teacher ... or a colleague here can choose a topic to his own liking and then we write a program for pupils and for the teacher. We communicate by e-mail; we are trying to put our materials in the internet (*MMM*-project's home page, R. R.),” (member of G5, Video).

G1 compiled their own home page on how to learn and teach percentages, and how to go over the material, which refers to Q6 of Wenger's (1998) community of practice. This group had chosen a slightly different way of dividing tasks, although here also each member was responsible for a certain part of the whole work (Q1). One of its members had knowledge of the program *eXe-Learning*, which he used in making their home pages. There were two experienced teachers in the group with good teaching methods and they prepared the theoretical part. Others prepared exercises and searched for some tests in the web, and my task (as I was the member of G1) was to find visual material and suitable games in the internet.

“Visualization is very important and ... we had one member who specialized on this...” (member of G1, Video).

G1's teamwork can be characterized as very active. In other groups the report was made by one member and all the others were only listeners, whereas in G1 all the members took part in the discussion by reporting (Video).

The division of tasks is not clear in G3. There were two members who gave a report and one of them gave an overview of how he had taught percentages at school (Video). G3's folder on the project's home page is empty; there are some teaching materials in the group members' folders, but they do not follow the principles set for the group work.

Different approaches

The university mathematics educators gave all the groups the same task: to make (1) a detailed schedule of 20-25 classes and (2) worksheets to help pupils to understand percentages better. Yet every group had a different approach.

G1 did not give any detailed schedule of classes. Their group website was meant first and foremost for repetition, so that both the teacher and the pupil can go over the sub-themes (Pihlap, Aluoja, Kopli, Koppel, Lepik & Reinup, 2007; Video; *MMM*-project's home page).

“We had one more idea; we wanted to introduce something new, to do it this way as to put the picture and the text side by side, running simultaneously. So that those pupils who do understand the text perhaps do not need it, while others have difficulties with it and so the text keeps running alongside the picture.” (member of G1, Video).

The university mathematics educators gave G1 an idea to add to the homepage a test on the basic knowledge and skills of multiplicative thinking (Video). The group work of G1 on the *MMM*-project's home page and the sketch which they presented at the fourth seminar are very similar.

G2 gave a schedule of classes for teaching in different grades as suggested. The group presumed that the teacher would be using current textbooks and workbooks, and concentrated on making additional worksheets to them. G2 planned to present the most important items of their theory in a *PowerPoint* slideshow (Video). Their work on the *MMM*-project's home page is left unfinished and the group's folder is empty, although there is a lot of different teaching materials (*PowerPoint* slideshows as well) in the members' folders.

In G3 there were two teachers who had been teaching percentages in differing ways for a number of years. This explains why the approach in G3 was influenced by these two teachers.

“For the beginning I must say that it seemed to me that in other groups there have been attempts to teach percentages as it has been suggested; as to our group it is interesting to notice that we happen to have two teachers here (A and H) who have already practiced teaching in the way we advocate now. ... We have tried to have percentages together with fractions, or more precisely: finding a part. ... And now A, who practiced this in his class, is playing his videotape,” (H, member of G3, Video).

The presentation of this group's research work was the longest of all. The report was very interesting in my opinion, and full of subject matter. Yet, as mentioned before, one of the members of the group presented his own personal view of how to teach percentages (Video).

“And therefore I consider it very important that, namely, to begin with, I do not ask the pupils to do any operations, I take simple numbers and you will have to say quickly – three quarters, a half, one quarter or ten percent as well,” (A, member of G3, Video).

The group's article (Ojasoo, Kaasik, Lahi & Pärnamaa, 2007) is based mainly on the same report (Video). The group does not have a collective folder on the *MMM*-project's home page.

G4 based its work on Merrill's taxonomy (Gagne & Merrill, 1990; see Matiisen, Kalda, Kasendi, Tamm & Vahtramäe, 2007). The proportional number of classes was not fixed, and the work was divided into three major subdivisions: (1) immediate understanding (grade 6), (2) arithmetic/basic rules of calculation (grade 7), and (3) “life itself” (grades 8 & 9). On the given theoretical basis this group created entirely novel teaching material – different worksheets for pupils and for teachers (Q5 and Q6). The possibility to use current textbooks and workbooks was excluded (Video).

“As far as I understood we were given such a task ... we cast aside all schoolbooks and we have that batch, and the teacher goes in front of the class with that batch and the pupils will learn how to do percentages.” (member of G4, Video).

In an e-mail a member from G4 brought to mind the period when they had dealt with percentages in the *MMM*-project.

“I had read about and also practiced in my classes the heuristic approach that has been used in schools, and as it sounded interesting to my colleagues they were willing to try it. ... About specialised literature. It is difficult to tell now from which sources exactly. ...

Anyway, some articles written by our mathematics educators are among them.” (member of G4, from e-mail to R. Reinup, Sept.10th 2008).

The results of G4’s work in full are on the *MMM*-project’s home page in the group’s folder.

G5 based its program of teaching percentages on the official program for schools. The group members’ experience in teaching at school was their main starting point. In addition to this they read articles written by different researchers and thereby got an overview of the main problems teachers have when teaching percentages at school in Estonia (see Laanpere, Kattai & Sasi, 2007). The group decided to make some additional worksheets to complement the existing teaching materials. The new teaching materials were to be of help to teachers with little experience (Laanpere *et al.*, 2007; Video).

“We presume that we will use current schoolbooks and teaching materials as well. And when we are making those worksheets we will surely refer to the sources. ... Then each member in our group did some searching and found the teaching materials which have proved helpful in his work. Indeed, we have a number of different worksheets,...tests in our computers, games, and now we can see that they all prove useful.” (Member of G5, Video)

The work produced by G5 is on the *MMM*-project’s home page. However, it can be noticed that most of the teaching materials come from only one teacher.

Community or pseudocommunity

It is a rather difficult task to detect whether any learning community characteristic features can be found in any group (see also McGraw *et al.*, 2001). As I did not have any focused video recordings of the groups when working together at the seminars, there are no direct sources of what the work inside the group was like. It can be decided only indirectly whether we consider a group a learning community or a pseudocommunity, although videos, division of task inside the group, written materials, and above all the teaching materials in the groups’ folders on the *MMM*-project’s home page can be of help. This sort of complex analysis allows drawing some conclusions of the developing degree of the groups.

I have some difficulties when judging the work of G1 because I was the member of this group. There is not much material in the members’ folders on the *MMM*-project home page, but I know that all the members of the group sent their materials by e-mail to the member who created the groups’ home page, on which rather intensive correspondence took place, especially during the last week before the fourth seminar. The address of G1’s home page was sent to all the group members so that everyone could suggest any alterations to be made. Also, at the presentation all the group members were very active (Video). So the qualities of Q2, Q3 and Q4 appeared, and earlier we have referred to Q1 and Q6 in connection to G1. Due to the intensive interaction and the fact that all group members contributed, G1 can be considered to be a community of practice in the sense of Wenger (1998).

All the members of G2 worked hard, collecting teaching materials in their folders on the *MMM*-project home page (the biggest amount of materials compared with the other groups), however their processes did not converge towards a shared conclusion, and the group's folder is empty. On the video it can be seen that at the presentation at the fourth seminar the members of the group remain rather passive. Because of the passivity in producing their own material and in interaction, G2 can be considered to be in the developing phase as a group at the end of the first stage of the project. A weak developing degree of working communities at their first stage is also mentioned by Jaworski (2005).

G3 contained a very influential person and my understanding is that the other members in the group accepted his views about teaching percentages, without adding any or very little of their own. The analysis of the group members' folders on the *MMM*-project's home page affirms the assumption – their content was not in accordance with the group's explicated common aim as it was presented in a seminar meeting (*MMM*-project's home page; Video). Onward, when analysing the materials on the *MMM*-project's home page, it can be noticed that all the materials in the G5 folder mainly originated from only one group member, although at the initial phase all was planned differently (Video). In the work of G3 and G5 the qualities of a community of practice (in sense of Wenger, 1998) do not appear. Grossman *et al.* (2001) refer to the basic quality of a pseudocommunity is that the members of it “act as if they are already a community that shares values and common beliefs”. In my opinion these groups (G3 and G5) are not pseudocommunities in this sense exactly. In both cases there is some inherent discordance between the group's public report and the group's actual work on the *MMM*-project's home page. Yet, one might call them pseudocommunities as most of the work seems to be done by a single (or a couple of) member(s) and other members remained rather passive.

In my opinion G4 compiled a very interesting, complete and novel collection of teaching materials (Q6). According to the recollections the work process was very intensive (Q3, Q4).

“Common understanding developed among us on the grounds of everyday activities and experiences. We all had tried something new and we all could point out the benefits or weak facets of our experiments. As far as I know we all tried to put into practice most parts of other members' experiments in our schools. ... I have a sad story to tell, I cannot be blamed for having a small ego, and as a vice-principal (at a school, R. R.) I have acquired an ability to force my views upon others and I tend to do it in every situation. Therefore, I claim that I influenced other members of the group – but it's no use crying over spilt milk.” (member of G4, from e-mail to R. Reinup, Sept. 10th 2008).

Although this one member was concerned with having too much influence, the material produced did not originate from a single group member. Moreover, the material was produced in collaboration, not simply collected together. Therefore we can consider this group to have developed into a community of practice (Wenger, 1998).

SUMMARY

Every group of a learning community consists of different people and that's why every different group develops its individual face. One of the main aims with the communities is to gain a new quality through the cooperation of different members with different experiences (Wenger, 1998). In the first phase of the *MMM*-project the groups had to make new proposals and give their solutions to some problems that might help to improve the quality of teaching percentages at Estonian schools. The task set by the tutors was the same for every group, yet every group had a different approach.

There were certain similarities as to the division of task: each group member was responsible for one specific sphere (G1, G2, G4 and G5). The most typical division of task was the thematic approach (G2, G4 and G5). In group G1, taking into account each members' abilities, the participants divided tasks according to the contents of the task. This is a more sophisticated approach.

The group members relied on their own experiences when finding solutions to the tasks given to them, although in some groups (G3 and G5) it can be seen that the whole group relied on the experience of a couple of its members. During the whole project the tutors commented on the work inside the groups. G1 received a concrete suggestion from the tutors and the group took it into account. From references of the articles written by the groups it can be seen that G4 & G5 gained ideas from the literature.

There were no concrete proofs of how the communities developed. In my opinion G1 and G4 were the most highly developed groups. In G1 the group members understood each other's abilities well (the tasks were given to the most able members), and there was a quick flow of information (e-mails, supporting each other at the presentation); they found suitable strategies and original solutions (they made their own home page). The work in G4 can be characterised as a fluent exchange of experiences (most of it was put into practice by various members). They found suitable strategies (the work was based on Merrill's taxonomy) and they found an original solution (a set of worksheets). In the work of both groups G1 and G4 appeared to contain most of the qualities of communities of practice (Wenger, 1998), so I think that these groups can be called communities of practice. In the other groups the progress is somewhat questionable at the end of the first stage. G2 could not give a unified original solution, although there were a lot of teaching materials in the group members' folders. Generally, only two members of G3 put their views and experiences together and one of them presented it (based on the analysis of the Video). In G5 there was some cooperation formally, but the main author of the whole report is a single member of the group (based on the analysis of the group's folder on the *MMM*-project's home page).

The project with Estonian mathematics teachers confirmed Jaworski's (2005) presumption that in the first phase of the work the community is still developing.

“The reports we heard gave us lots of ideas to think over but they all did not have enough time to mature, and to put them into practice when teaching percentages at school. I am quite sure that the result here is rather a reflection of some former experiences than anything new, created in the course of the *MMM*-project.” (member of G4, from e-mail to R. Reinup, Sept. 10th 2008).

Some of the groups in the *MMM*-project developed more than the others, but participation (either actively or passively in the community’s work) was instructive for all its members.

“In my opinion, cooperation was the major driving force. An idea emerged, then someone made it clearer and someone else explained something. We all brought some worksheets; I was discussing my plans on my worksheet, but ideas began to spring up and everyone contributed – some gave more, some gave less. I am convinced that this sort of cooperation gave us lots of ideas and added willingness to achieve better results with pupils at school.” (member of G1, from e-mail to R. Reinup, Sept. 6th 2008).

Every idea needs time to mature. When comparing the teachers’ views during the whole *MMM*-project (from the beginning to the final phase), it can be noticed that during the project the participants developed a much more positive attitude in the subject (Kaljas, Kislenko, Hannula & Lepik, in press).

All five groups also presented their concepts and ideas worked out during the *MMM*-project at the Estonian mathematics teachers’ annual conference, which is one of the biggest mathematics teachers forums in Estonia. The large amount of teaching materials on the *MMM*-project’s home page is available to all mathematics teachers all over Estonia. Today the *MMM*-project has ended. The researchers can make conclusions and also start planning other projects of a similar kind in the future.

NOTES

1. In Estonian Meile Meeldib Matemaatika (*MMM*) – We Like the Mathematics
2. <http://zope.eenet.ee/mmmprojekt>

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