Accountability affects the use of small group learning in school mathematics

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This study investigates the perspectives of a sample of teachers on the use of cooperative small groups in the teaching and learning of mathematics. We asked teachers (N = 18) in England and Finland about their experiences and ideas of small group learning in mathematics. The research tool used the ordering by each teacher of eight mathematics tasks into a hierarchy from those tasks that are best for small group working to those tasks that are best for individual working as a frame for in-depth interviews. We conclude that the role of small group learning as seen by most of the teachers is for doing mathematics, introducing social skills and discussion rather than learning mathematical knowledge and skills. Furthermore we report on the barriers to using small group learning caused by the accountability structures inherent in the educational systems of both countries.

This study originates from a joint interest in developing the teaching of mathematics in English and Finnish schools. One of us had walked a long path by searching and then researching problem solving, modelling and investigations in school mathematics without and with modern technological tools. The other one had developed and researched alternative approaches to teaching and learning in educational contexts through various teaching and learning methods, especially cooperative learning. These paths crossed in the late 1980s and by the middle of the 1990s we had integrated our concept of mathematics teaching and learning as a dynamic, interaction-intensive school subject. The driving force behind our culturally and also scientifically mixed intention was to understand the nature of the dilemma of teaching mathematics: how do we increase

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Berry, J. & Sahlberg, P. (2006). Accountability affects the use of small group learning in school mathematics. *Nordic Studies in Mathematics Education*, 11 (1), 5-31.

open-ended, cooperative working styles in mathematics lessons in our schools while the traditions and commonly held beliefs about mathematics support isolated thinking and working rather than socially constructed understanding and collective reasoning? Furthermore, the education policies in England and Finland have created very different frameworks for action in terms of how teaching is expected to be arranged. Whereas the Finnish education policy and national curriculum guidelines encourage teachers to seek alternatives to traditional teacher-centred pedagogies, in England the increased accountability and external testing of pupils have narrowed the options of teachers to choose appropriate methodologies for teaching. This has also led to overcrowded curriculum specifications allowing teachers little time to do anything outside of the National Curriculum.

The departure for this research was based on two perspectives. First, we believed that when small groups are used in conjunction with the careful redesigning of mathematical tasks, pupils have more opportunities and reasons to work and learn together. Second, based on informal discussions with several hundred teachers we have established a position that generally teachers do not organise small groups according to the basic principles of cooperative learning that promote higher quality interaction, and hence better achievement. Therefore we wanted to have a better understanding, from a teacher's perspective, of what are the conditions that make small group learning situations in primary (years five and six) and secondary school (years eight to ten) mathematics teaching in Finland and England successful.

Small group learning and mathematics: literature review

A major challenge to the introduction of small group learning in school mathematics is that those entering the teaching profession often do not have the mathematical or pedagogical knowledge necessary to teach in an investigative way. Because of the common view of mathematics as a body of knowledge (number, algebra and geometry) school leavers have learned some content, often using traditional teacher-centred methods that can be carried out more efficiently by information and communication technologies. Our own experience during the past ten years of leading professional development courses for elementary, middle and secondary school teachers has shown that few teachers have acquired the skills of conjecture, exploration and enquiry that are important for developing mathematical thinking. When given a complex problem the notion of *simplify, verify and generalise* does not come naturally. We would argue that most teachers when teaching mathematics will 'do unto them as was done to

them' when they were pupils at school. Klein (2001) confirms this view when investigating constructivist practice in mathematics classrooms.

Some teachers wonder what is the difference between traditional group work and more recently emerged small group learning (or co-operative learning as it is also called). Productive small group learning requires more than just organising large-group instruction around team or pair work activities, and furthermore, not all peer-mediated instruction qualifies as small group learning (Cohen, 1994; Johnson & Johnson, 1994; Sahlberg & Berry, 2003). On the other hand, there is no one definition or set of criteria that makes small group work become authentic cooperative learning. Most teachers and trainers seemingly apply their own constructed versions of cooperative learning that suit their own beliefs and teaching styles and their students' characteristics including their images of mathematics (Picker & Berry, 2000). As Antil and his colleagues (1998) say, "whether these personal adaptations of cooperative learning qualify as the real thing depends on the presence of certain critical features that transform group work arrangements into authentic cooperative learning" (p. 433). The formulation of these critical elements of cooperative learning is not, however, a simple analytical exercise. There are at least four major schools of thought within the umbrella of cooperative learning and they all have their own points of view, characterised by certain theoretical assumptions upon which these methods have been designed (Sharan, 2002; Sahlberg & Berry, 2003).

Since the early 1990s interest in applying cooperative learning arrangements in mathematics has increased. Simultaneously, several significant research results were published and new projects launched. Our synthesis of research on small group learning in school mathematics indicates that there are at least four types of effects on pupils' learning (Sahlberg & Berry, 2002). First, although there is not a widely accepted agreement on the benefits of small group learning in student achievement in school mathematics, it seems that cooperative learning, if conducted carefully and appropriately, will bring about equal academic achievement among all students, compared to more traditional methods of teaching (Slavin, 1990; Davidson & Kroll, 1991; Urion & Davidson, 1992; DePree, 1998). As soon as the scope of expected learning outcomes in mathematics is widened to include interpersonal and social aspects of human development, cooperative learning promises a more positive impact on attitudes, level of confidence, meta-cognitive development of problem solving skills, and higher quality of interaction in general among the group members. Second, some research studies indicate that working in pairs, as a form of small group learning, may be particularly effective in learning mathematics (Fuchs et al., 1998). This may also be the case when pupils study

with computers or calculators. Third, there is increasing evidence that small groups are especially powerful in mathematical problem solving situations in helping students to develop problem solving strategies and related working habits (Duren & Cherrington, 1992; Kroll et al., 1992; Hart, 1993). The role of higher quality interaction and more constructive activities together with increased time-on-task may well explain why this seems to be the case (Mulryan, 1992; Webb et al., 1995). However, it is important to note that in many cooperative learning situations students need to be trained and guided to perform and think according to the principles of learning together. In particular the promotion of helping behaviour during cooperative learning appears to be one precondition for successful implementation of small group learning methods (Webb & Farivar, 1994; Ashman & Gilles, 1997). Fourth, several research studies suggest that small group learning has a positive effect on pupil's meta-cognitive development, often closely-related to problem solving processes mentioned above (Goos & Galbraith, 1996; Mevarech, 1999; Cooboo & Fortuny, 2000). In these and other studies small group learning was combined with particular meta-cognitive training approaches. Social interaction and peer support seem to be the factors that promote intellectual development in a cooperative learning environment.

A feature of the published research into collaborative small group work in mathematics leads to a dichotomy. Goodman (1995) observes that tasks used in today's classrooms chosen for encouraging collaboration between pupils have become increasingly complex and challenging so that often group work is used only for developing problem solving skills. Generally cooperative learning research studies sought to compare cooperative learning methods and traditional methods and were based on tasks that developed more traditional skills.

Our main point of departure for designing this study was that productive cooperative learning is possible only when the task that the group is working on is designed in such a way that requires a team effort. This means that every team member has something to contribute to solving the task but nobody can do it all alone, or as Cohen (1994) advises that "none of us has all these abilities; each of us has some of these abilities" (p. 128). As simple as it may sound, students need a better reason than teachers' instruction to work and learn together productively. According to many scholars, for example Cohen (1994) and Sharan (1999), when groups do not seem to work well, the reason is often an inappropriate learning task, or curriculum design. This is especially true in school mathematics. Most of the tasks and exercises that are available in textbooks and additional materials are designed for

individuals, not for teams. This implies that these tasks do not necessarily challenge a small group to work together as a team towards a common goal. In other words, the task can be solved by one student alone. First and foremost, the mathematics teacher needs to realise that not all tasks are suitable for cooperative learning purposes because they do not promote interaction within the groups. For example, solving simple equations as such does not require a group to complete the assignment successfully. On the other hand, preparing a plan or investigating the properties of numbers provides fruitful opportunities for real co-operation if students have been trained to do so. Examples of various mathematical tasks are provided in the appendix (see also Stigler & Hiebert, 1999; Sahlberg & Berry, 2003).

When designing mathematical tasks for productive small group learning, a teacher may follow three criteria that the task should fulfil. They are: 1) all members of the group have reasons to participate; 2) the task provides all group members opportunities to talk; and 3) group members need to make choices and decisions. These three conditions of designing tasks that facilitate interactive learning in small groups are discussed in detail in Sahlberg and Berry (2003).

Even if we believe that small group learning has several benefits for students' learning of mathematics, we do not think that all mathematics learning should or even could take place in co-operation with other students. While there should be more student-student interaction in our mathematics lessons, conventional methods of instruction also have their place in teaching. It is recognised fairly widely among mathematics educators in many countries that mathematics teaching and learning has the following six ingredients (Cockcroft, 1982): exposition by the teacher, discussion, appropriate practical work, consolidation and practice of basic skills and routines, problem solving, and investigational work.

The six ingredients of teaching mathematics provide a framework for developing good mathematics lessons. There will be times when exposition by the teacher (i.e., the teacher introducing the topic and 'teaching') followed by individual skill development tasks are important and necessary. If these approaches are mixed with good discussion between 'pupil and pupil' and 'pupil and teacher' then this will encourage active learners involved in the learning process. In this study a classification of mathematics tasks that combines these ingredients of good learning with the features of cooperative learning (Sahlberg & Berry, 2003) provides the focus for the research on the role of cooperative small groups in learning mathematics from a teacher's perspective.

Methodology

The study reported in this paper is primarily qualitative and the sample purposeful since we chose primary and secondary school teachers drawn from the respondents of a preliminary survey from schools in the locality of the two research teams (Plymouth and Helsinki). The preliminary survey, previously reported in Sahlberg and Berry (2002, 2003) involving a questionnaire to teachers that gave us a broad picture of the issues for a more in-depth study. We selected a mixture of teachers from primary and secondary schools in Finland and England to observe any accountability structures affected by school level and country. Eighteen teachers from England and Finland were interviewed from different schools. Nine (four from Finland and five from England) were primary school teachers and nine (four from Finland and five from England) were teaching in secondary school.

In order to investigate the use of small group learning in school mathematics we developed a 'task-based' interview schedule starting with an activity in which a teacher was asked to classify mathematics tasks according to their use in the classroom. For this starter activity we designed a series of eight mathematics tasks that have been used in various class environments from individualised (i.e. pupils working alone) to small group settings (pupils working in groups of two or three). The tasks are described in the appendix. The interviews began by asking the teachers to consider the eight tasks and to rank them according to their suitability for use with pupils working in small groups, i.e. pairs or 3 to 5 pupils in mathematics lessons. They were asked to put the most suitable at one end and the least suitable at the other, placing the others in rank order in between. At least ten minutes was allowed for this.

Following this classification activity each teacher was asked:

– How did you come to choose this order?

Interviewer takes a task chosen as good for small groups and asks:

– If I gave you this task to use at the start of a mathematics lesson then describe how would you actually use this task with pupils?

Interviewer takes a task chosen as good for individual use and asks:

– If I gave you this task to use at the start of a mathematics lesson then describe how would you actually use this task with pupils?

– What do you think are good features for pupils working in small groups?

- What are the main issues in using small group learning in your school from your point of view?
- What pressures do you feel there are against using small group learning in mathematics?
- Give an example of an area of the mathematics curriculum that you might use small group learning in mathematics?

Each question was designed to offer teachers the opportunity to discuss their views on small group learning in the context of teaching mathematics in their classroom with familiar looking tasks. We assumed that this approach would provide responses based on their own practice and not on theoretical or ideal classroom situations.

As we wanted to find out about the use of small group learning in a 'naturalistic' context it was important that the data allowed teachers' issues and the concerns of teachers to emerge from the interviews not from our own preconceptions and expectations. To help facilitate this natural emergence of issues we formed a project team consisting of the two authors (the lead researchers) and two research assistants who conducted the interviews with the teachers using the carefully prepared and piloted interview proforma.

The analysis of the results of the teacher interviews involved identifying emerging categories of responses that linked the roles of tasks and small group working and what role the use of small groups might have in learning and doing mathematics. Through their ranking of the tasks the teachers provide evidence of the role of small groups in their lessons. Through their description of how they would use the tasks either in group working or individual working styles we can gain some insight into their preferences. The emergent categories provide indicators which we use as starting points in the discussion.

Findings

The overall aim of the present research study was to investigate teacher's views on the role of small group learning in their mathematics classrooms. In this section we present the results on teachers' ranking of mathematics tasks and their ideas of and reasons for using small groups in mathematics teaching. The results are given under three subheadings. The first reports on the classification of the mathematics tasks. The second subheading provides data from the interviews leading to the identification of the accountability structures that provide barriers to the use of small group learning in their classroom. The third identifies the

positive features of small group learning in mathematics even though little use of the methods was being made by the sample of teachers.

Task Choice for Small Group Learning

During the interviews teachers were given the eight mathematics tasks described in the appendix. These tasks were designed using the typology of mathematical tasks presented in Sahlberg and Berry (2002, 2003). These tasks represent different categories of that typology varying from typically closed, routine tasks to open-ended, complex tasks. These tasks were printed in cards that teachers could easily read and compare. Teachers had approximately ten minutes to rank order these tasks according to group tasks and individual tasks into a continuum. The interviewer insisted that only one rank order in this case is possible. Figure 1 shows the distribution of primary school teachers thinking about these tasks. The higher the value of each task is, the more suitable it is for cooperative learning. The respective distribution of secondary school teachers' opinions is in Figure 2.

The teachers' responses to the ranking of the eight tasks show an understanding of the role of mathematics tasks that is consistent with the classification typology mentioned earlier. Furthermore there was broad agreement between the teachers in the two countries. In essence there

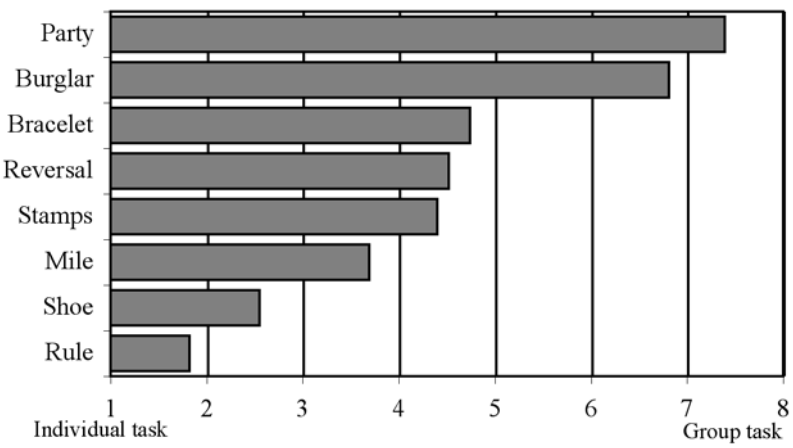

Figure 1. *Mathematical task appropriateness according the primary school teachers ($N_p = 9$) in the interviews.*

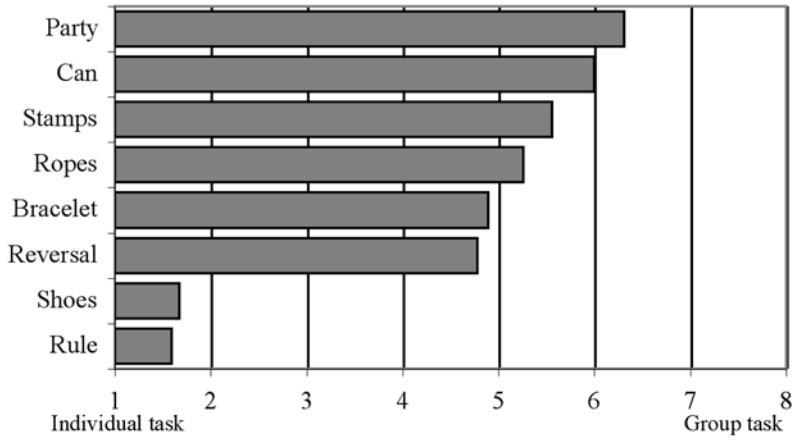

Figure 2. *Mathematical task appropriateness according to the secondary school teachers ($N_s = 9$) in the interviews*

were key phrases identifying the need for collaboration and discussion through to working alone to test basic skills on routine tasks. In general, teachers viewed tasks that were good for small group working as being open ended with many different routes and subtasks. Pupils would benefit from working in a group because through discussion they could identify the different features and each pupil could explore a subtask. There is also the expectation that some pupils would not be able to proceed alone on the more open ended tasks. A secondary school teacher from England said that:

> I started off by thinking of the one that would be most suitable for working with in groups (Drinks Can) so I came up with that one because it is quite a lengthy investigation and there is a lot of maths in it, which most students in Year 10 would find very difficult to do on their own but would benefit from being able to discuss it with others and with a teacher. If they were working in a group it would take quite a lot of discussion to even get going on that one, I would think. So I would want to put them in a situation where they could discuss it and work on it for a length of time.

Another British teacher commented that:

> The ones most suitable to group work are the ones which lead to the question 'what if...' and the need to find a rule. The more open ended are more suitable for group work. Open ended means the problem

> has more that one possible outcome and is suitable for different levels of ability. For example in an investigation which requires a rule to be found then one person may be able to formulate that rule algebraically while another person can just describe what needs to be done in words – they have both shown an understanding of the task.

Ian, an experienced teacher from a British school, looked at his choice of ranking and provided an interesting overview of how he might use each task. He thought that:

> The 'Planning a Party' problem I see working with groups of 4 or 3, there will be something for everyone to do regardless of ability, although it is important for me to choose the groups carefully to make sure that the group can work together [...] The ones at the end, the 'Shoes' and 'Practise the Rules', well they are simply testing if a student can do the work set, there is only one answer and usually only one way to get that answer. There would be no need for any discussions.

This insight suggests a continuum of tasks from those that are good for group work because discussion and collaboration are needed to get started on the task through tasks that could promote some discussion after a period of working alone through to those routine tasks for which discussion is just not helpful.

Teachers viewed tasks that were suitable for working alone as closed and routine tasks with just one answer and one method of approach, providing practise at the mathematics skills and algorithms that they had met before. A Finnish secondary school teacher gave the following reasons which were typical of the teachers' responses in general:

> For those that can be done in groups they will need to talk a lot, listen to other peoples views, draw on others experience, if they were doing such a task on their own they would miss a lot of things as they would only get their own perspective on it. At the other end, these problems are closed questions. There is no need for them to talk to others when doing such problems, it is just doing questions. This (Practise the Rules) is like the exercises at the end of the chapter in that they are specific routine activities. They would need to know how to do the questions so I would use it as revision or review. I would just set them going and see how they did it, who could not do it etc. I guess that for those who finished quickly I could ask them what happens if you change the coefficients?

Teachers' ideas that the 'Practise the Rules' task has one correct answer and one method of approach fails to show an understanding of the

multiple representational view of mathematics in which each equation could be solved algebraically, numerically or graphically. If each member of a three person group was challenged to solve each equation using one of the methods and then a group discussion followed about the route to the solution then we would have the possibility of a rich dialogue about the appropriateness of different approaches to mathematics problems. Many equations can only be solved numerically or graphically. We feel that most of the teachers in our small sample recognise the 'Practise the Rules' task as a routine textbook exercise on algebra. However, a Finnish teacher said that:

> It's very much the student working on their own because it looks just like routine practise. I think if I was introducing equations then that would be different but this looks like a set of routine practise questions.

There is a hint in this comment that such a task could be used with small groups to introduce equations. Moreover, this presents many other teachers' views of small group learning as 'doing mathematics' rather than learning new concepts or rules.

Although there is little evidence from the interviews that the teachers in this study have had experience of the models or theories of cooperative learning, their ranking of tasks and reasons for doing so suggest an intrinsic understanding of what makes a good task for group working. The most commonly presented reasons for the ranking of tasks as good for small group working were the need for discussion and the task should be open-ended with many different routes through the problem. The following quote from a British teacher is typical when describing the choice of the most appropriate task for small group working. She argued that a good small group learning task is:

> [...] open ended task which has a lot of mathematics in it. There is a lot more needing to be thought through, and I think a student would be more likely to get stuck on this and would need to be helped and they would need to talk to people about it. Many students would get stuck on it if they were working on their own and because it is quite a lengthy task I think if they were working on their own they would be likely to get fed up.

However, good reason for choosing a task does not necessarily lead to the pupils actually learning cooperatively. Consider the comment of an experienced Finnish primary school teacher who said that:

> Anything that has need for discussion is a good group task. Or like the 'World Record for the Mile' where they have to go off and find

> out information. If there is an element of finding the same rule given different starting points, it is good because they can all do it individually and then come together as a group and discuss.

This teacher identifies the need for discussion and an element of practical work in the previous problem, however she sees her pupils working at the task as individuals and then coming together to discuss the outcomes. This is also the teacher who would not rank the 'Planning a Party' at all because she could not see any mathematics in it.

The issue of each pupil having a role and being able to take part is taken up by a newly trained British primary teacher who has just joined the teaching profession. Her opinion was that:

> It needs to have several stages to promote organisational skills and teach them how to function as a group i.e. everyone has a task which must all come together. It needs to have a range of tasks to promote inclusion, can't have spectators, everyone must have an integral part to play. This is not just a matter of having 'easy and hard' numbers and give the easy numbers to the weak one and the hard number to the stronger one, this is not a good idea [...] The onus is on myself to make sure that the tasks are then allocated fairly without making it obvious. Kids are very aware if they are 'thick' so you have to make sure they are doing something they are good at.

We asked each teacher to give an example of an area of the mathematics curriculum that they might use small group learning in mathematics. The most common area proposed by both primary and secondary teachers was statistics including data handling and designing questionnaires. Typical of the responses was the following from a Finnish primary school teacher who said that:

> [...] the task where pupils have to collect data they need to work together to get enough good data and then also in the treatment of the data they can discuss what to do and each member of the group can do a bit, we are always doing displays of this type of thing! Obviously measurements are best done in small groups, pairs probably. For example with 'Burglar' task I would set each group a different but related task i.e. measuring heights, weights, arm length, leg length, shoe size of each other in class and then bring them altogether as a whole class investigation. This way is better than having each group measuring the same thing. Many would not see the point if another group was doing it then why should they as well.

Problem solving and investigational work were also suggested as good areas for pupils to work together. When prompted by the interviewer

about what he would define as investigational work and whether any of the given tasks would be defined as investigational, one Finnish secondary teacher responded that:

> Yes, I would say that would be 'Number Reversals' and 'Bracelets'. Because they are not related to a particular part of the curriculum and they are not focussing on any one mathematical skill but they are looking for rules and looking for patterns. Children are not being guided as to what mathematics they should be using.

This response reinforces the view that small group work is for collecting data and doing mathematics rather than for learning new mathematical concepts and skills, for example. Several teachers that we have met during this study expressed directly or indirectly the same view.

To summarise the data on the classification of mathematical tasks we would conclude that the teachers tend to use two categories: those tasks that can be described as investigations and those that are projects are good for cooperative learning because they are open ended practical tasks that require discussion, division of labour and an extended period of time to solve. In contrast are the more traditional skill based tasks such as learning the rules and word problems. The primary teachers are consistent in choosing projects, measuring and data collection problems as the most suitable for cooperative learning. Primary school teachers teach across the curriculum and tend to have more training and experience at using tasks that draw upon the skills and knowledge from subjects other than mathematics. At secondary school level the teachers are usually specialised mathematics teachers and see mathematics in a different way than their colleagues in primary school. The development of rules and their belief in mathematics as a body of knowledge to be delivered would tend to restrict the choice of tasks and the style of working. Secondary teachers see teaching and learning in small groups often as a means of doing mathematics rather than learning new knowledge and skills within the curriculum. There appears to be less of an incentive to do investigations, modelling and project work unless it features in the assessment as it does in the UK.

Accountability structures leading to barriers

In terms of spontaneous responses the lack of time was the most significant barrier to using small group learning in the sense that the pressure of external examinations leads to a need to cover the curriculum, i.e. textbooks properly. Other barriers that emerged were: parental pressure

in that small group learning is not seen as doing real mathematics, noise and the lack of teacher time to prepare good tasks for collaboration.

Lack of time

Many teachers spoke about being preoccupied with the curriculum content to be covered in their mathematics lessons. Therefore they have little or no time to use small group learning in their teaching. A teacher who teaches mathematics in an English secondary school said that:

> I think the things that would stop me using it would be the pressures of getting through the curriculum quickly and we do have a lot of pressure particularly in year 9 when they are coming up to SATs and the quickest way is to simply sit them down and teach them.

Time also seems to be in short supply when planning teaching and preparing for lessons. Quite correctly teachers recognise that planning small group learning lessons requires more time and resources than normal lessons. Another secondary mathematics teacher from an English secondary school, said that:

> The time is an issue, not for doing the work but usually in the preparation. I normally do such work when I have a free period previous to the class, I can get resources ready among other things.

The problem of time also appears to be one of the most commonly experienced barriers for teachers in Finland. Although, the curriculum does not set such rigid requirements in terms of covering the content as in England, some teachers mention lack of teaching time as an obstacle for using small group learning. While teaching mathematics in secondary school, one Finnish teacher said that:

> Lack of time is a problem! There are so few lessons and so much to teach. I have to cover all topics in the curriculum and that is why I have only little time for each new theme.

Another Finnish mathematics teacher in secondary school, also admitted that small group learning requires a lot of time from the teacher but then adds that:

> It is up to the teachers to decide how to spend the time available for teaching mathematics, you cannot blame anybody else but yourself for lack of time.

Some teachers also saw that pupils' mathematical knowledge and skills are related to the choice of teaching methods in school. Because in normal classrooms there are a wide range of mathematically able pupils, teachers

tend to use teaching arrangements that they believe are fit for all pupils. Some of the teachers we interviewed were afraid that "lazy pupils do not do anything when assigned to small groups in mathematics". A primary school teacher from Finland said that:

> When pupils work alone they all are forced to do work and the teachers also can better monitor the performance of pupils.

Finally an English secondary school teacher summed up the pressures by reflecting on all the barriers in her school by saying that they are related to:

> [...] timing issues, we need time to do and present the task, we would feel unfulfilled if we just left it without some sort of feedback, report, conclusions to the whole class. It also takes longer than solo work, the students are more involved and so it might take longer than you anticipated.

The shortage of time to plan and implement the curriculum are often seen as real obstacles in making use of pedagogical innovations. Teachers have no objection in principle to using small group learning in mathematics. Many teachers that we interviewed witnessed that their most concerns are somehow related to time. However, this seems to be the barrier among those teachers teaching in secondary schools. Primary school teachers had quite different opinions when we asked them the main pressures that are against using small group learning in teaching mathematics as described in the following paragraphs.

Instructional strategies and policy decision

There was a remarkable difference in primary school teachers' responses to the question of barriers to use small group learning in mathematics in England and Finland. In Finland there is a loosely defined national curriculum framework and total pedagogical freedom in schools to choose the best possible teaching methods in any school subject. In England, the newly introduced National Numeracy Strategy (NNS) stipulates specifically what teachers should teach and also how teaching must be arranged. The NNS in practice leaves very little methodological freedom to teachers when they design their lessons. Therefore, the NNS is mentioned by all five English primary teachers and most of them see it as a barrier for using cooperative learning in mathematics. One of the teachers saw her possibilities as a teacher this way:

> Having to follow the NNS, I can't see how you can do group work in maths as much as other subjects because of the time limitations, you have to start with the mental activity and finish with a plenary

> so fitting it all in is a problem. It was nice when you could spend the whole day doing maths or English or whatever if you wanted!

The effects of external policies, such as testing, will add to the pressures of what happens in the classroom as reported by an English mathematics teacher:

> I think that the NNS will stop a lot of teachers doing group work – they will not see how it can fit into the structured lesson but as I said before it is not just maths skills so you can take it onto other lessons. We are all pressured by SATs, who isn't and I guess that group work does not fit into preparing the children well for the tests. But if you do a bit of everything then the children should come out OK.

It seems that some teachers are starting to think that one of the main purposes of teaching is to prepare pupils to manage tests. For example, another teacher from England thought that teaching mathematics is shifting towards teaching for testing. He says that:

> We don't do as much as we used to due to time restraints of NNS – just trying to get through the material sometimes is a struggle time wise. Like the 'Party' problem I said that it needed 2 lessons but honestly we could not justify that with the amount we need to cover now, it would get relegated to an activity week type thing which I feel really sad about. The more able students would benefit from such activities, the normal stuff is a bit boring for them, this type of activity would stretch them but fitting it in with the whole class when we have to stick to the NNS is difficult. If there was problem solving in the strategy with time allocated for long investigations that would be good. Also exams, I am ashamed to say that we do end up teaching for the tests because that is how the school is judged.

Strategic constraints and curriculum regulations are playing an increasingly central role in deciding on what methods of teaching are used in mathematics lessons in schools although they do not directly promote or limit the use of any particular method. Furthermore, the strengthening role of external assessment and testing is putting pressures upon teachers who are looking for alternative ways of teaching mathematics. But where small group learning is implemented successfully there are apparently no barriers as one secondary school mathematics teacher from England reports:

> There are no pressures in my school – I have proved that group work and investigations have dramatically improved the results in the examinations – and that keeps everyone happy!

As a summary, teachers see several external obstacles that prevent them from implementing small group learning and probably other educational innovations as well in their lessons. Teachers clearly point towards a shortage of time when looking for barriers to using small group learning in mathematics. But the externally mandated accountability strategies like the NNS in England obviously set some real restrictions to using some particular approaches in teaching mathematics. This indicates that present educational policies that regulate teachers' methodological options may be counterproductive in the longer-term development of higher quality teaching and learning in schools (Hargreaves & Fink, 2006).

Positive features of small group learning

In their responses most of the teachers emphasized the barriers caused by the accountability structures than the advantages afforded by the use of small group learning. However, the teacher interviews do provide some insight into the benefits of using small group learning in school mathematics. They were asked: "What do you think are good features for pupils working in small groups?" The responses can be categorised under four headings.

Learning social skills

Most of the teachers commented that when working in small groups pupils learn the social skills of working together, teamwork, learning from each other, communication and discussion, and organisational skills.

Learning mathematics

There were only a few comments identifying that small group work might help in the learning of mathematics. One teacher said that learning to speak mathematics aloud helps pupils to understand the mathematical concepts. Another teacher thought that small group work encourages critical thinking and one teacher said that mechanical drilling skills were suitable for work in small groups but she did not elaborate on this point. An important thought from one teacher is that:

> When pupils learn in small groups they will see that it is not just the teacher who knows the answer but the pupils can find out things from each other.

Increased involvement

Several teachers commented that one benefit from small group working is that more pupils participate in a task than when working alone and

that different learning can be included. A further benefit identified by one Finnish teacher was sustained attention and involvement in the task could be expected because:

> When explaining what you have done and received support from your peers then the comfortable feeling with each other helps you to concentrate longer and together achieve better results than when working alone.

Change in routines

Small group working allows a change in routine for the teacher as well as for the pupil. One teacher commented that when her pupils are working in a small group then she can move around the class and talk to each pupil or group of pupils; and another teacher said that "it gives me a break!".

The following comment from a primary school teacher from England summarises the overall impression that we gained from the teacher interviews:

> A lot of the time it is probably not maths stuff but things like social skills, children at this age need to be taught how to work together, discussing and listening, how to deal with a dominant member of the group, that sort of thing. Problems that get them talking together help in all sorts of ways. Also their organisational skills are being developed. With group work you normally expect a group output, poster, presentation or report, they learn how to do it together so that they get it done. Children of this age are good at telling you if someone is messing around or not doing the work!

In their responses most of the teachers emphasise the generic skills of group working rather than learning new mathematics. The data from the interviews does not give strong evidence that teachers would believe that small group working is beneficial for learning mathematics concepts and skills. Furthermore, there is no evidence from the census questionnaire or from the teacher interviews that teachers in Finland or England have different views on the benefits of small group learning to student achievement in mathematics.

Concluding discussion

Cooperative learning has become a widely recognised alternative to more traditional teaching and learning practices that still dominate many primary school classrooms and most of the secondary schools worldwide. Despite its increasing popularity among teachers and school

improvement experts, the prevalence of small group learning is not what is often assumed. For example, Antil and her colleagues (1998) along with Sahlberg and Berry (2003) have concluded that only a few teachers practise cooperative learning in their classrooms as it is presented in the professional literature. This article focuses on the school and curriculum structures that encourage or discourage the use of small group learning in mathematics. Two major conclusions from the interview data were:

1 The role of cooperative learning as seen by most of the teachers is to do mathematics, in other words working on problem-solving situations, introducing social skills and conducting group discussions; few teachers in our sample proposed it as a way to learn new mathematical knowledge and skills. In their classification of the eight mathematics tasks the teachers realised that tasks chosen for the mathematics lessons determine the teaching and learning styles, and they classify tasks consistently for cooperative and individual working contexts.

2 The accountability structures, especially increasing external testing and related rigid curriculum standards that are prevalent in school education emerge strongly as reasons for not implementing small group learning in the mathematics lessons of most of the teachers in the sample.

The role of small group learning as seen by most of the teachers is to do mathematics in problem solving situations or to introduce social skills emphasised in the curriculum. Teamwork is a common classroom structure for promoting pupil-pupil discussion as part of teaching and learning. However, small group learning is only rarely seen as a way to learn new mathematical knowledge and skills. The evidence from our research supports these observations. There is an important link here between the role of small group learning and the mathematical tasks used. Previous research reviews show that there is only a weakly significant gain in learning academic subject matter in favour of small groups compared with traditional arrangements (Davidson & Kroll, 1991; Sahlberg & Berry, 2002). However problem solving and other meta-cognitive skills and learning strategies together with a range of social skills are improved as recent research on effects of small group learning on learning mathematics shows. Where these studies describe the type of task used then we see that they are tasks designed for doing and using mathematics and not for introducing mathematical knowledge and skills. Positive results of cooperative learning in mathematics as reported in the literature focus on learning rather than doing of mathematics.

Mathematics provides a window for looking at the world, a framework for solving problems and a way of thinking. However, the mathematics curriculum that teachers and pupils work from is often presented as a set of rules and algorithms to be learned and tested in formal examination settings. This leads to a dilemma for teachers. It is necessary to ensure that pupils perform well in tests and it seems inevitable that 'teaching to the test' leads to a drill and skill approach to teaching in our classrooms. With this conceptual framework for teaching and learning it is perhaps understandable that teachers will not use small group learning as an alternative way of developing the mathematical knowledge and skill base of their pupils. When it comes to using and doing mathematics then it is easier to provide a team-working environment. We would agree that there are occasions for learning and doing mathematics alone and there are occasions for doing and learning mathematics together. However, the results reported here show that this is not what is happening in our classrooms. The strong message from teachers seems to be that 'first learn mathematics alone and then do mathematics together'.

We conducted this study in two different educational policy contexts. England has centralised its education planning system since the introduction of the first National Curriculum in 1988 although local education authorities and schools are the main administrative entities of that system. The National Curriculum on the one hand, and the National Numeracy Strategy and the Framework for Mathematics Teaching on the other hand establish rather rigid operational signposts for teachers in planning their teaching and especially in choosing their teaching methods. Finland has had a rather different direction since the beginning of 1990's (see Aho et al., 2006). The new education legislation of 1999 and the 1994 National Framework Curriculum for the Comprehensive School provided municipalities, schools and teachers with a new kind of authority to make decisions concerning organising schooling including planning of teaching. Whereas England has moved towards externally controlled local accountability in the form of national testing, the Finnish comprehensive school system is practically free from external tests. Teachers in England and in Finland are hence working in different education policy environments and affected by very different accountability structures that also reflect on their attitudes and views of small group learning and other alternative pedagogic arrangements in school.

In comparing the interview data from the Finnish and English teachers we did observe differences particularly at the primary level. The pressure of a structured instructional model of teaching and external assessment of pupils' achievement is having dramatic consequences according to some teachers. External assessment can also provide a barrier to the

use of small group working methods because teachers and pupils believe that tasks that focus on test items need to be rehearsed individually. In England there is external assessment (standard tests, SATs) for pupils aged 7, 11 and 14 years as well as national school leaving examinations at 16 years and matriculation examinations at 17 and 18 years. Pupils in England are overtested and the results of SATs are not designed as formative assessments to guide pupil progression but are abused to produce school league tables and measures of teacher performance. Inevitably the pressure of such external assessments and related high-stake accountability structures lead to a 'teach to the test' and 'learn by heart' mentalities, that only weakly encourage engaging in any alternative teaching or studying arrangements.

In this study we realised that too rigid and methodologically specific education policies and related national strategies, such as the NNS in England, lead to fragmented and non-innovative teaching that do not enhance risk-taking, creativity and learning of knowledge and skills that are needed in our modern knowledge world. Several teachers refer to nationally set restrictions, regulations and testing when they explain their reasons for using some specific practices, or not utilising small group learning, for example. Similarly, too vague and loosely defined national curriculum frameworks and lack of clearly determined expectations of learning outcomes may lead to easy solutions in mathematics lessons. Teachers may teach mathematics as it was taught to them without being blamed. We recommend that policy-makers and curriculum developers make better use of available research on teaching mathematics in general and using small group learning as part of regular school mathematics in particular. It is paramount that whatever the education policies and national strategies aim at that they do not directly or indirectly refrain teachers from making wise decisions and applying evidence-based pedagogical practises in their classrooms in improving their students' learning and interest in mathematics.

This research study has examined the role of small group learning in mathematics looking through the eyes of a small sample of teachers and the accountability structures have emerged as barriers to using such methods in their classrooms. We are not recommending the total abolition of the systemic devices and structures that provide measures of accountability of schools, teachers and pupils. However, it is clear from our work with the teachers interviewed and those who have attended our workshops on improving learning in mathematics that small group learning is often marginalised because of the accountability structures prevalent in today's education systems.

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Acknowledgements
We are pleased to express our thanks to those teachers and pupils who took part in this study and to our colleagues for interviewing the teachers.

Appendix

Mathematical tasks used in the interviews.
Primary school mathematics tasks.

Practice the Rules

Find the missing number in the following:

45 − 38 = ____
178 + ___ = 231
14 × ___ = 154
258 ÷ 3 = ___
39 + 68 − ___ = 17

Burglar

A burglar visits a house which is being decorated and leaves a handprint in some wet paint. The police explain to the home owners how they can generate a life-size image of the burglar from the handprint. Each part of a person's body is proportional to their handspan. For example, height 8 ½ handspans, arm 3 handspans and nose 1 little finger. The police have taken a copy of the burglar's hand print from which the size of the burglar can be constructed. From this copy of the hand print, draw a picture of the burglar.

Planning a party

It's your birthday. Your parents agree that you can have a party or disco to celebrate. You can have the event at home or you can book a hall so that more of your friends can come. Plan your event. Make sure that you arrange for enough food and drink. Be careful to include everything in your estimate of the cost. Decide how you are going to report your work. You may do a poster, a written report, a diary or something else.

Number reversals

Choose a two-digit number. Reverse the number to give a new number. Find the difference between the two numbers. Repeat for other numbers. Is the difference always the same? What do you notice about your answers?

Can you find a rule?

Bracelets

Choose a number between 1 and 18.
Apply the following rule: multiply the number of units by 2 and add the number of tens. This gives a new number. For example, if you begin with the number 15 then the new number is 5 × 2 + 1 = 11.

What happens if you apply the rule to your new number?
Investigate what happens if you continue to apply the rule.

World record for the mile

The table shows the world record for the mile for some of the years between 1913 and 1985.

Time	Athlete	Date
4:14.4	John Paul Jones	31.5.1913
4:10.4	Paavo Nurmi	23.8.1923
4:07.6	Jack Lovelock	15.7.1933
4:02.6	Arne Andersson	1.7.1943
3:58.0	John Landy	21.6.1954
3:53.6	Michel Jazy	9.6.1965
3:51.0	Filbert Bayi	17.5.1975
3:46.3	Steve Cram	27.7.1985

Using the data estimate when it is likely that the mile could be run in 3 minutes 40 seconds. Find the most up to date records and check your answer.

Book of Stamps

In 1985 a book of stamps cost £1. First class stamps cost 17 p and second class stamps costs 13 p.

Which do you think was the most useful?

What are the prices of stamps and a book of stamps today?

How many different ways could a book have been made up?

Shopping for shoes

Sara wanted to buy new shoes. The initial price was £48.50 and there was a 30% sale in that store. They gave an additional 20% discount on shoes.

How much money did Sara need for her shoes?

What percentage was the actual reduction?

Appendix

Mathematical tasks used in the interviews.
Secondary school mathematics tasks.

Practice the Rules

Solve the following equations:

$3x + 2 = 7$
$2x - 3 = 15$
$x + 4 = 5x - 9$
$x^2 + 3x + 2 = 0$
$x^2 - 5x + 6 = 0$

Ropes and Knots

Take a rope and measure the distance between its ends. Tie an overhand knot in the rope and measure the distance between its ends now. The rope has shortened.

Find a relationship between the length of the rope and the diameter of the rope.

Planning a party

It's your birthday. Your parents agree that you can have a party or disco to celebrate. You can have the event at home or you can book a hall so that more of your friends can come. Plan your event. Make sure that you arrange for enough food and drink. Be careful to include everything in your estimate of the cost. Decide how you are going to report your work. You may do a poster, a written report, a diary or something else.

Number reversals

Choose a two-digit number. Reverse the number to give a new number. Find the difference between the two numbers. Repeat for other numbers. Is the difference always the same? What do you notice about your answers?

Can you find a rule?

Bracelets

Choose a number between 1 and 18.
Apply the following rule: multiply the number of units by 2 and add the number of tens. This gives a new number. For example, if you begin with the number 15 then the new number is $5 \times 2 + 1 = 11$.

What happens if you apply the rule to your new number?
Investigate what happens if you continue to apply the rule.

Drinks can

A simple model of a drink can is a cylinder of radius r with circular ends. If its volume is 330 ml. find an expression for h, the height of the can, and hence an expression for A, the total surface area of the can.
Find the dimensions of the can that has the smallest surface area for this volume. Comment your answer.

Book of Stamps

In 1985 a book of stamps cost £1. First class stamps cost 17 p and second class stamps costs 13 p.

Which do you think was the most useful?

What are the prices of stamps and a book of stamps today?

How many different ways could a book have been made up?

Shopping for shoes

Sara wanted to buy new shoes. The initial price was £48.50 and there was a 30% sale in that store. They gave an additional 20% discount on shoes.

How much money did Sara need for her shoes?

What percentage was the actual reduction?

Notes

1 The views are those of the author alone and do not necessarily represent those of the World Bank or any of its affiliated institutions.

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Sammanfattning

I den föreliggande studien undersöktes en grupp lärares uppfattningar om användning av elevsamarbete i smågrupper vid undervisning i matematik. Vi frågade 18 lärare i England och Finland om deras erfarenheter och idéer gällande lärande av matematik i smågrupper. Lärarna fick i uppgift att ordna åtta matematikuppgifter hierarkiskt, från de uppgifter som lämpar sig bäst för arbete i smågrupper till uppgifter som lämpar sig bäst för individuellt arbete. Undersökningsinstrumentet utnyttjade de ordnade uppgifterna som ett ramverk för djupintervjuer. Vår konklusion är att användningen av smågruppsinlärning, enligt de flesta lärarna, bäst lämpar sig för att lösa matematiska uppgifter, introducera sociala färdigheter och diskussion framom att lära sig matematiska kunskaper och färdigheter. Vi belyser också svårigheter, då det gäller användningen av smågruppsinlärning, som sammanhänger med underliggande strukturer i de båda ländernas undervisningssystem.