



Impact of Teacher's Actions on Emotional Atmosphere in Mathematics Lessons in Primary School

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Abstract

The aim of this article was to determine the factors in teachers' actions that could explain differences in the emotional atmosphere of primary school classrooms. Based on pupils' drawings about their mathematics lessons, we analyzed both the pupils' and their teachers' actions, including pupils requesting help, sitting alone, and talking about mathematics, as well as the teacher helping, praising and criticizing. We could conclude that the teacher has a central role in the formation of the emotional atmosphere in mathematics lessons. The emotional atmosphere can be built up to be positive when the teacher encourages the pupils to talk about mathematics and their own understanding with each other. The emotional atmosphere is then open and tolerant. The emotional atmosphere can turn to be negative when the pupils are working by themselves and are afraid of criticism and embarrassment.

Keywords Emotional atmosphere · Mathematics lessons · Primary school · Pupils' drawings · teacher's actions

Introduction

Teachers have a central role in advancing social interaction and a positive atmosphere in their classes. In particular, the emotional relationship between the teacher and the pupils, the teacher's awareness of the pupils' feelings and of the reasons for them, the teacher's skill in evaluating the pupils' feelings and responding accordingly, the teacher's conception of the importance of different emotions in the learning process, and the teacher's emotional interpersonal guidelines all affect a classroom's emotional atmosphere (Evans, Harvey, Bucley &

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Yan, 2009). Harrison, Clarke and Ungerer (2007) summarized that a positive teacher-pupil relation advances both pupils' social accommodation and their orientation to school. Positive friendships also seem to increase pupils' school attendance. Several studies have found a close connection between the atmosphere in the classroom and emotional and social experiences (e.g. Frenzel, Pekrun & Goetz, 2007).

In the classroom, interaction occurs between the teacher and the pupils, and between the pupils themselves. In this interaction, the teacher is more central as s/he decides who is allowed to talk and what to talk about. The relations between the teacher and the pupils and between the pupils themselves, as well as the rules and the ways of working in the classroom, have an effect on this interaction and also on its openness (Newman, 2002). In this interaction, learning is important for the development of mathematical thinking, social skills, and positive self-efficacy (Blum-Kulka & Dvir-Gvirsman, 2010). The development of social skills will, for its part, advance the development of a positive emotional atmosphere (Humphrey, Lendrum & Wigelsworth, 2010). On the other hand, experiences that are related to social humiliation, for example, are particularly negative. Such cases are for example when a pupil tries to solve a mathematical problem in front of the class and fails (Ashcraft, Krause & Hopko, 2007) or when the pupil is criticized by the teacher (Uusimäki & Nason, 2004, p. 373).

Longitudinal research by the Finnish National Board of Education found that students' mathematical self-efficacy and enjoyment of mathematics decreased over the course of comprehensive education (Metsämuuronen & Tuohilampi, 2014). Dahlgren and Sumpter (2010) compared Swedish second and fifth graders' conceptions of mathematics and mathematics teaching via drawings with a written questionnaire. Most of the second graders were found to have a positive attitude toward mathematics whereas a larger portion of the fifth graders had a negative attitude. These results are in line with a number of studies reporting similar results worldwide (see Lee, 2009; Sjøberg & Schreiner, 2010): pupils' attitudes toward mathematics deteriorate during basic education.

In a three-year research project carried out by the Department of Teacher Education at the University of Helsinki in 2010–2013, primary school pupils' drawings about mathematics lessons were collected in one of the background studies. As part of an analysis of pupils' drawings, we have earlier looked at the kind of emotional atmosphere that dominated in these third and fifth graders' mathematics lessons (Laine, Näveri, Ahtee, Hannula & Pehkonen, 2013; Laine, Ahtee, Näveri, Pehkonen, Portaankorva-Koivisto & Tuohilampi, 2015). In the third grade classrooms, the emotional atmosphere was mainly positive and in the fifth grade, the atmosphere was more negative, although there were large differences between classrooms. Therefore, we wanted in this research first to find out whether the emotional atmosphere had become more positive in any class and secondly to compare the teachers' behavior in the classes where the emotional atmosphere had become more positive compared to the classes where it had become more negative. Therefore, our aim was to find out what factors in teachers' and pupils' behavior could explain the differences in the emotional atmosphere between different classes in the fifth grade. We hope that this study will add to the information on how pupils' attitudes toward mathematics could remain positive throughout primary school.

Theoretical Background

Here, we deal with two items that are central for the following empirical study: collective emotional atmosphere and drawings as a research method. We examine the changes in the emotional atmosphere in mathematics lessons based on pupils' drawings.

The Collective Emotional Atmosphere in a Classroom

Evans et al. (2009) divided the notion of classroom atmosphere into three complementary components: (1) academic, (2) management, and (3) emotional. In this study, we concentrate on the third component, i.e., emotional atmosphere, which refers to the affective interactions within the classroom.

The emotional atmosphere within the classroom can be regarded either from the viewpoint of individuals in the class or from the viewpoint of the classroom as a whole (Hannula, 2011). The individual level looks at the individual experiences that occur in the class, whereas the classroom level looks at the class in terms of social interaction, communication, and norms. Furthermore, a distinction can be made between two temporal aspects of "affect": state and trait (Hannula, 2011, 2012; see also McLeod, 1992; Goldin, 2002). State refers to the emotional atmosphere at a specific moment in the class while trait refers to more long-term conditions. These form the matrix shown in Table 1.

At an individual's level, the rapidly appearing and disappearing affective states are different emotions and emotional reactions, thoughts, meanings, and aims (Hannula, 2011, 2012). From this perspective, the state emotional atmosphere is the collection of such individual affective states in the class at any moment. On the other hand, more

Table 1 Dimensions of the emotional atmosphere in a classroom, modified from Hannula (2011)

	Individual level		Classroom level	
	Types	Examples	Types	Examples
Affective condition (state)	Emotions and emotional reactions	Frustration and joy	Social interaction	Lively discussion in the classroom
	Thoughts	This task is fun.	Communication	
	Meanings	I can do it.	Atmosphere in the classroom (momentarily)	Pupils laugh together.
	Goals	I am the quickest.		
Affective property (trait)	Attitudes	I do not like mathematics.	Norms	You cannot laugh at the mistakes.
	Beliefs	Mathematics is easy.	Social structures	Friends who always want to work together
	Values	Mathematics is important.	Atmosphere in the classroom	Safe
	Motivational orientations	I want to please my teacher.		

stable affective traits are related to attitudes, beliefs, values, and motivational orientations (Hannula, 2011, 2012). The trait emotional atmosphere is the collection of such individual affective states in the class. Examples of these individual's level states and traits are presented in Table 1.

The collective concepts in the classroom level are however not just a collection of the beliefs and conceptions of individuals (Cobb & Yackel, 1996). These, like norms, are formed in joint action (Blumer, 1986, see also Partanen, 2011). One student's interpretation of her emotional state and that of others in the classroom also somehow shows her interpretation of the collective experience in the classroom. If these interpretations of all students in the classroom are put together, it could describe the joint action, and in the long run, the collective emotional atmosphere, of the classroom. Examples of these collective concepts are presented in Table 1.

Drawings as a Research Method

Drawings belong to image-based research methods (Thomson, 2008). They offer a different kind of glimpse into human sense-making than written or spoken texts do, because they can express things not easily verbalized. White, Bushin, Carpena-Méndez and Ni Laoire (2010) found that visual methods are effective not simply because of the amount of data produced but also because of the quality of the data providing glimpses and insights into the everyday lives of children. Also, some of the children's viewpoints are better discerned from their drawings than through other data collection methods (Harrison et al., 2007).

Kearney and Hyle (2004) found that participant-produced drawings appear to create a path toward participant feelings and emotions, making them viable tools for researchers who seek access to this type of data, and lead to a more succinct presentation of participant experiences. Altogether, their findings further establish that drawings are an important source of data especially when the drawers' feelings and experiences are examined. According to Picard and Gauthier (2012), the way children express their feelings in their drawings can be verbatim or symbolic. In verbatim expression, feelings may be described with smiling or sad faces. In symbolic expression, feelings are described more abstractly using dimensions, colors or thickness of lines, for example. Children younger than 10 years old use mostly verbatim expressions whereas older children combine verbatim and symbolic expressions in their drawings.

As a research method, drawings are important particularly when children are studied. When written questionnaires are used as a method, children do not necessarily understand the words and statements in the way the researchers intended (Bragg, 2007; Ruffel, Mason & Allen, 1998). Interviews may also be problematic, as it is not easy to elicit linguistically rich responses from young children (Hannula, 2007). Many researchers (e.g. Aronsson & Andersson, 1996; Murphy, Delli & Edwards, 2004; Pehkonen, Ahtee & Laine, 2016; Weber & Mitchell, 1996) have found pupils' drawings to be an abundant source of data. Altogether, pupils' drawings are important in bringing forward the children's point of view. All young children have the competence to engage in research as sophisticated thinkers and communicators and that the inclusion of children's views is pivotal if we are to understand their life worlds (Harcourt & Einarsdottir, 2011).

The Purpose of the Study

Based on our data on emotional atmosphere in the third and fifth grades, we wanted to compare the teaching in classrooms where the emotional atmosphere had become more positive to classrooms where it had become more negative. We wanted to compare the teachers' and pupils' behavior in these classrooms in order to identify factors that could explain why the emotional atmosphere had become more positive when generally it becomes more negative as pupils get older. Thus, our research question was as follows: Which factors in teachers' and pupils' behavior as seen by the pupils in their drawings could explain differences in the emotional atmosphere in the different classrooms in the fifth grade?

Methodology

The data are based on third and fifth graders' drawings collected at the beginning of the 2010 autumn term and end of the 2013 spring term in Finland (Helsinki area). The pupils performed the drawing task during their mathematics lessons under the supervision of their teachers in the third grade and under the supervision of the researcher in the fifth grade. In the third grade, the pupils were asked to draw the picture to the researchers. All the pupils who were at school that day made the drawing.

The task for the pupils was as follows: "Draw your teaching group, your teacher and the pupils, in a mathematics lesson. Use speaking and thinking bubbles to describe discussion and thinking. And show yourself as 'me' in your drawing." Pupils could freely choose what to draw because they were not asked to draw some particular mathematics lesson. Speaking and thinking bubbles were subsequently used in about two thirds of the drawings.

In the three-year research project, ten teachers and their pupils from the surroundings of Helsinki dealt one open problem each year once a month during the mathematics lessons. Thus, we have altogether 180 video records from the mathematics lessons carried out by the teachers. Also once a month, the teachers met the researchers (including all of the authors) to discuss about the implementation of and experiences with the last experimental problem. These video records have been used in the analyses of the teachers' actions during the open problem mathematics lessons (see e.g. Kojo, Laine & Näveri, 2018; Laine, Näveri, Ahtee, Pehkonen & Hannula, 2017).

We have earlier published our findings on the distribution of collective emotional atmosphere during third grade mathematics lessons in the classes of nine teachers and during fifth grade lessons in the classes of eight teachers, based on a summary of the holistic evaluation of the individual pupils' drawings (Laine et al., 2013; Laine et al., 2015). From this data, we chose those five classes which had had the same teacher from the third to the fifth grade.

The evaluation of classroom emotional atmosphere was based on all pupils' and teacher's visible moods as well as their speech and thought bubbles in the drawings. The pupils' and teacher's moods were determined by the form of the mouth (smiling, neutral, sad/angry, not visible). The nature of the speech and thought bubbles was classified into three subcategories: positive (e.g. "Mathematics is fun"), negative (e.g. "Mathematics is hard"), and neutral (e.g. "Four times four is sixteen"). The classroom emotional atmosphere was therefore composed of five possibilities described in the

pupils' drawings: (1) It is positive when all the drawn pupils and the teacher smile and/or think positively, some can be neutral; (2) It is ambivalent (positive and negative) if at least one contradicting (positive or negative) facial or other expression is found in the drawing; (3) It is negative when all the drawn persons are sad or angry or think negatively, some can be neutral; (4) It is neutral when all facial or other expressions are neutral; and (5) It is unidentifiable when it is impossible to see any facial or other expressions. Examples of the analyses can be found in Laine et al. (2013) and Laine et al. (2015). In this study, we used only three categories, namely Positive (1), Negative (3), and Other, which was combined from the rest of the categories (2, 4, and 5).

From this data, we first looked for the classrooms in which the emotional atmosphere had changed either to more positive or to more negative when the pupils moved from the third to the fifth grade. All the drawings from these classrooms were examined many times in order to find common things that could explain changes in the emotional atmosphere either to a more positive or to a more negative direction. Our research method can be described as phenomenographic because we were looking at a child's conception of a phenomenon, i.e., a pupil's image of how they experienced mathematics lessons. From each drawing, we tried to find meaningful features to describe the meanings behind the image, and then forming larger categories that describe different image groups (Marton, 1986). Pupils construct their image of mathematics lesson based on their earlier experiences that are personal. That is why it is natural that some pupils in a class described the emotional atmosphere as negative, some as positive, and, furthermore, several drawings contained both negative and positive features.

From the pupils' drawings, we collected the features that we found from different classes. For example, in the drawings from the classes in which emotional atmosphere had become more positive in the fifth grade, there were plenty of drawings in which pupils were asking for help, whereas in the drawings from the classes in which emotional atmosphere had become more negative in the fifth grade, there were only a few such drawings. The lists shown in Table 2 contain the things that were found from the pupils' drawings.

We then combined the features that described more positive and more negative classes into bigger entities. We identified the following three explaining factors in the pupils' activities: pupils asking for help, pupils sitting alone, and pupils talking to each other about mathematics. In the teachers' activities, we found three possible explaining factors related to teacher-pupil communication: the teacher was located close to her

Table 2 Features in the drawings found from more positive and more negative classes

Features found from more positive classes	Features found from more negative classes
Pupils are openly asking for help.	A pupil is belittling another pupil.
Pupils are getting help from their classmates.	Pupils are working by themselves.
The teacher is helping/is offering help near the pupils.	Pupils are sitting separately at their desks.
	Pupils are talking about something else.
Pupils are talking about mathematics.	Teacher is criticizing the pupils.
Teacher is praising the pupils.	

pupils, the teacher was helping or encouraging the pupils, and the teacher was praising or criticizing the pupils.

Results

To determine which factors in the teachers' and pupils' behavior in the third and fifth grade could explain why the emotional atmosphere had changed more positively or more negatively, we first looked for possible classrooms from our old data (Laine et al., 2013; Laine et al., 2015). This is dealt with in the first part of the result. We then compared these classrooms in terms of the features related to positivity and negativity. This is dealt with in the second part. In addition, we made a summary of the teachers' actions as seen from the drawings and the video recordings from the mathematics lessons.

Emotional Atmosphere in the Third and Fifth Grade

We have earlier published the distribution of collective emotional atmosphere during third and fifth grade mathematics lessons (Laine et al., 2013; Laine et al., 2015). From this data, we chose the five classrooms which had had the same teacher from the third to the fifth grade: Daisy, Claire, Fiona, Helen, and Ann. Table 3 shows the percentages of the pupils in whose drawings the emotional atmosphere in these five classrooms has been classified as positive, negative, or other.

In the fifth grade, no pupil in Claire's class had any longer described the atmosphere as negative, and more than half of the pupils (58%) had drawn it as positive. In Fiona's fifth grade class, the number of the pupils who described the atmosphere as positive had increased as well. However, in both Daisy's and Helen's classes, the number of pupils who described the emotional atmosphere more negatively in the fifth grade than in the third grade had increased. In Ann's fifth grade class, the percentage of pupils whose drawings were classified as positive or negative had decreased, whereas the proportion of pupils whose drawings were classified in the category Other had increased. In the next analysis, we therefore concentrated on Claire's and Fiona's classes where the emotional atmosphere had changed to more positive according to the pupils' drawings, and, respectively, on Daisy's and Helen's classes where the atmosphere had changed to more negative. When Claire's and Fiona's classes were compared with Daisy's and

Table 3 The distribution of the emotional atmosphere in the third grade (80 pupils) and fifth grade (91 pupils)

		Claire	Fiona	Daisy	Helen	Ann
3rd grade	Positive	47% (9)	29% (5)	44% (8)	36% (4)	53% (8)
	Negative	11% (2)	0%	0%	9% (1)	20% (4)
	Other	42% (8)	71% (12)	55% (10)	55% (6)	27% (3)
5th grade	Positive	58% (11)	42% (8)	33% (6)	35% (6)	33% (6)
	Negative	0%	5% (1)	11% (2)	24% (4)	17% (3)
	Other	42% (8)	53% (10)	56% (10)	41% (7)	50% (9)

Helen's, a statistically significant difference was found between emotional atmospheres in the fifth grade ($\chi^2 = 5.51$; $df = 1$; $p = 0.019$) but not in the third grade ($\chi^2 = 0.39$; $df = 1$; $p = 0.534$). This means that Claire's and Fiona's pupils described their emotional atmosphere more positive in their drawings in the fifth grade than Daisy's and Helen's pupils.

Explaining Factors

In the pupils' drawings from Claire's, Fiona's, Daisy's, and Helen's third and fifth grade classes, we looked for features that could explain the differences in the emotional atmosphere in the fifth grade. Table 4 shows the number of the pupils whose drawings contained each factor in the three pupil actions: pupils are asking for help from the teacher or from their classmates, pupils are sitting alone at their desks, and pupils are talking to each other about mathematics. Table 4 also includes the number of pupils whose drawings contained the four teacher actions: the teacher is located close to the pupils, the teacher is helping or encouraging the pupils, and the teacher is praising or criticizing the pupils.

When examining the pupils' drawings, most striking in Claire's classes was that more than half of the pupils had drawn something about asking help either generally, like "Could somebody help me?", specifically from the teacher, like "Teacher! I need help.", or from classmates, like "Could you help me?" These requests were responded to positively, as in "I will help you!" or "Of course." The pupils also revealed in their

Table 4 The distribution of the explaining factors. The percentages indicating the magnitude are mainly included to help in making comparisons

	Emotional atmosphere more positive in the fifth grade				Emotional atmosphere more negative in the fifth grade			
	Claire		Fiona		Daisy		Helen	
Grade	3rd	5th	3rd	5th	3rd	5th	3rd	5th
Number of pupils	19	19	17	19	18	18	11	17
Pupils are asking for help	15	10	7	9	1	1	1	3
	79%	53%	41%	47%	6%	6%	9%	18%
Pupils are sitting alone	3	4	1	1	8	15	5	8
	16%	21%	6%	5%	44%	83%	45%	47%
Pupils are talking about mathematics	9	10	4	6	0	0	0	1
	47%	53%	24%	32%	0%	0%	0%	6%
The teacher is close to the pupils	6	8	0	4	1	0	2	3
	32%	42%	0%	21%	6%	0%	19%	18%
The teacher is helping or encouraging	6	7	3	5	0	0	1	2
	32%	37%	18%	26%	0%	0%	9%	12%
The teacher is praising	2	1	2	1	5	3	0	3
	11%	5%	12%	5%	28%	17%	0%	18%
The teacher is criticizing or embarrassing	0	0	0	0	0	1	0	5
	0%	0%	0%	0%	0%	6%	0%	29%

speech bubbles when they could not do something or when the task was difficult for them, in expressions like “I have no idea what to do,” “I cannot do it,” or “I didn’t understand.” Also, in these cases, other pupils were offering their help even when it was not specifically asked. For example, in Fig. 1, the teacher is sitting behind her desk but she is ready to go to help the girl sitting at the front and thinking mathematics. The boy sitting at the back has come forward to the girls sitting together. He is asking: “Could one of you help me?” The drawer (ME) and another girl are talking about mathematics. The pupils are sitting on gymnastics balls.

In both Claire’s and Fiona’s classrooms, the pupils were asking for help already in the third grade. In Fiona’s classes as well, the pupils’ drawings featured several instances of the pupils asking for help, whereas in Daisy’s and Helen’s classes, there were only a few such drawings. This difference in asking for help in the fifth grade between Claire’s and Fiona’s classes and Daisy’s and Helen’s classes is significant ($\chi^2 = 8.85$; $df = 1$; $p = 0.003$).

Another almost significant difference ($\chi^2 = 3.88$; $df = 1$; $p = 0.049$) between Claire’s and Fiona’s classes and Daisy’s and Helen’s classes was observed in drawings in which the pupils described how they were sitting in their classrooms (see Table 4). In Daisy’s fifth grade class, almost all pupils drew themselves and their classmates sitting alone at their own desks and separate from each other. In Helen’s fifth grade class, close to half of the drawings depicted the pupils sitting alone at their desks. In Claire’s class, four



Fig. 1 Example of a drawing where the pupils help each other from Claire’s fifth grade class

from the total of 19 drawings depicted the pupils sitting alone, and in Fiona's class, only one from 19. In all these classrooms, the videos recorded during the research project showed the pupils sitting in pairs or groups in the third, fourth, and fifth grades.

Figure 2 is a drawing from Daisy's fifth grade. In the drawing, the teacher, Daisy, has written the tasks on the blackboard: (1) Text-book pp. 50–51 and (2) Hand-out on the teacher's desk. The smiling drawer (ME) is sitting alone at her desk, working on her tasks, and thinking "Now I know. It is 125."

In the fifth grade, the pupils talked more about mathematics in Claire's and Fiona's classes than in Daisy's and Helen's classes (see Table 4). The difference was almost significant ($\chi^2 = 5.99$; $df = 1$; $p = 0.014$). In Claire's and Fiona's classes, there were drawings in which the pupils talked about mathematics with each other in both the third and fifth grade. In Claire's class, a third grader wrote at the back of her drawing "We can talk about mathematics in the mathematics lesson." In Daisy's classes, there were no drawings in which the pupils talked about mathematics together, and only one such drawing was found in Helen's fifth grade class (see Table 4).

An important part of a teacher's actions is how she communicates with her pupils. This was first examined by looking at the teacher's location in the classroom. In Claire's fifth grade class, 42% of the pupils had drawn the teacher positioned among the pupils (see Table 4). In Fiona's fifth grade class, 21% of the pupils did the same, as well as 18% of Helen's fifth graders. In Daisy's fifth grade class, the teacher was drawn either standing or sitting at the front of the class, or she was not at all in the picture.



Fig. 2 Example of a drawing where pupils are sitting alone and doing their mathematics tasks from Daisy's fifth grade class

In the drawings in Claire's fifth grade class, when the teacher was drawn among the pupils, she was shown as helping and encouraging them with words like "Carry on, make it a bit clearer," going to help them, or pupils had gone to her for help. One picture showed the teacher standing in front of the class and asking "Does anyone need help?" Only one picture shows the teacher praising a pupil while standing beside him, saying "Very good Thomas. That is quite correct." In the drawings in Fiona's fifth grade class, the teacher was also drawn among the pupils helping them or going to help them. It seems to be important to the teacher that everybody understands what has been taught. For example, in one drawing in front of the class, she asks "Did you understand?" And almost all the pupils are answering something like "Yes" or "Oh, it went like that." In another drawing, she is praising the pupils "You all solved it very quickly." In neither Claire's nor Fiona's fifth graders' drawings, the teacher said anything negative in any of the drawings (see Table 4). Figure 3 drawn by Fiona's fifth grader shows the teacher helping a pupil who has difficulties understanding a challenging long division exercise. On the blackboard, there is a division exercise and the instructions for how to do it: (1) Divide, (2) Multiply, (3) Subtract, and (4) Drop down. The teacher Fiona is saying "Now we have mathematics. What do you see on the blackboard?" She continues "If you have difficulties I can come to help you." The drawer (ME) is thinking "I shall never learn that." Then, he says aloud "I cannot do that" and shouts "TEACHER! I need help." The teacher helps him "Tim, first ..., then ..., and so on." Tim replies to the teacher "I still did not understand." The girl sitting next to him says "I understood. I can help you." Tim replies to her "Thanks." Tim continues "Aah ... Now I understood. This is quite easy." The girl says "Ok, I won't help then."

The drawings in Daisy's fifth grade class differed from the others: in them, the teacher was never shown among the pupils. In three drawings, the teacher, sitting



Fig. 3 Example of a drawing where the teacher is helping the pupil to understand long division from Fiona's fifth grade class

behind her desk, is praising her pupils “Pupils, very good.” However, one drawing shows the teacher pointing the female drawer and saying “Once again someone has not done the homework” and three other pupils are saying or thinking “She can’t do anything.” Thus in Daisy’s fifth graders’ drawings, the teacher is often praising the pupils collectively but in one drawing the teacher criticizes one pupil in front of the others. The teacher was depicted among her pupils three times in Helen’s fifth graders’ drawings. She praises the pupils when they are solving their tasks. “Nice work,” she says, and also checks that the pupils have understood the point. However, three drawings from the fifth grade depict her having problems with the class. For example, in one drawing, the pupils are behaving improperly and the teacher is shouting “Quiet!”, and she is also shown embarrassing a pupil (see Fig. 4). The teacher has written on the blackboard the tasks the pupils must do for the next lesson (pages: 103, 104, 105, do tasks 1–8 for tomorrow). The teacher stands on the right-hand side in front of the pupils. Four pupils are sitting by themselves at their desks and three pupils are on the floor. A pupil sitting at the back shouts “Teacher! I need help.” The teacher answers to him “AGAIN?” so that everybody can hear it. A second sitting pupil comments on this by saying out loud “SCHOOL NERD.” The teacher asks the third sitting pupil “And by the way, why are you Tom doing nothing?” Tom is thinking to himself “Damn school!” but answers “Because I do not understand.” The teacher asks the drawer (ME) “And you, Anton, what are you dreaming about?” Anton is dreaming of how a meteorite is hitting the school building and then there would be no more school! But his answer is “Nothing.” A pupil lying on the floor is fed up and says “Not so much!!” A pupil on his knees is praying “Mercy, not so much homework.” A standing pupil is shaking his fist and seems to be swearing. The teacher is shouting at these three pupils “NOW RETURN TO YOUR DESKS.”



Fig. 4 Example of a drawing where the teacher is shouting and embarrassing a pupil from Helen’s fifth grade class

Summary of the Teachers' Actions as Seen from the Drawings and from the Video Recordings of the Mathematic Lessons

Next, we give a short summary of the typical actions between each teacher and her pupils described in the pupils' drawings. In order to check that these descriptions correspond to the actual happenings during the lessons, we went through the videos recorded during the lessons (see "[Methodology](#)"). From these recordings, we looked for episodes that describe the typical actions of the four teachers. The episodes chosen here are from our earlier studies in which the video recordings were used (Kojo et al., 2018; Laine et al., 2017; Laine, Näveri, Kankaanpää, Ahtee & Pehkonen, 2014; Laine, Ahtee, Näveri, Pehkonen & Hannula, 2018).

According to the drawings, it is typical in Claire's class that the pupils are asking help both from the teacher and from each other. The pupils are sitting in groups and they are discussing about mathematics. The teacher is close to the pupils and she is helping them. These things can also be seen in the video recordings of the lessons (see also Laine et al., 2018). In Claire's mathematics lessons, the pupils and the teacher seem to be on one hand quite relaxed and on the other hand quite active. Some pupils are walking around asking questions about how to solve the task or commenting it to their mates. Also, the teacher is circling around from one group to another. She seems to have an emphatic relation with the pupils. For example, the next episode shows how the pupils are working when Claire has delivered the task sheets to the pupils.

Claire: "Solve the numbers that replace the question marks."

Some pupils: "I have already solved both of them. Easy."

Claire: "Go to the blackboard and write your initials when you have solved the task."

Some pupils are marking their initials on the blackboard.

One pupil: "I understood the first task. Can I now go and mark my initials?"

Another pupil is explaining the system to his classmate and more and more are going the blackboard to write their initials. Some pupils go and discuss the task with the teacher. They explain and the teacher notes the solution correct by nodding her head. Also, some of the pupils are discussing together about their solutions. The teacher goes and guides personally those pupils, who are asking help by raising their hand.

According to the drawings, Fiona's pupils are asking help from the teacher; they sit in groups and talk about mathematics. Based on the video recordings and the related studies, Fiona is circling around the class, and she often sits down to help the pupils who have difficulties to get started. She asks lots of questions and challenges the pupils to invent more solutions. She puts lot of her efforts to motivate the pupils, to get them interested in the problems. Altogether, she gives the pupils lots of positive comments and shows an emphatic feeling for them so that a pleasant atmosphere is transmitted (see also Kojo et al., 2018). For example, the next episode shows how Fiona tries to inspire, activate, and get the pupils to work together.

Fiona: "I'll give you now some time to think and solve this problem. Get help from your mates. It is alright to discuss with your mates. And then when you

know how these aritmagons can be solved, call out with loud voice: Hi! I invented! Now I have one good idea in my mind, I know, how this thing goes.”

According to the drawings, Daisy’s pupils do not ask help, usually they are sitting alone and they are not talking about mathematics. In most drawings, the teacher is not present at all. Based on the video recordings and the related studies, the pupils are sitting in pairs but they are each mainly working by themselves. It is almost total silence in the classroom and no pupils are moving around. The teacher is circling around and looking at what the pupils are doing. The teacher pays often attention to the pupils’ mistakes and corrects the indefinite concepts the pupils are using. A strict discipline and concentration on getting the task done are conveyed from the recordings. The following comments picked up from the recordings describe Daisy’s way to communicate with her pupils (see also Laine et al., 2014):

“Now we have to hurry with this.”

“Go to your seat so that we can start.”

“I don’t want to it say hundred times.”

“You have to rub it off. Do not leave anything that cannot be read.”

“Hi, go to your seat. You have your own snail.”

“This is not correct. It has to move from that place somewhere there.”

According to the drawings, Helen’s pupils do not ask help, usually they are sitting alone, and they are not talking about mathematics. The teacher is not present at all in the drawings. Only Helen’s pupils’ drawings contain situations in which the teacher is criticizing or embarrassing the pupils. Based on the video recordings, the pupils are sitting in pairs but they are each mainly working by themselves. None of the pupils are talking or moving in the quiet classroom. The teacher is circling around from one pupil to another and checking the pupil’s output from behind. However, the recordings do not contain episodes in which the teacher is openly embarrassing or criticizing the pupils. She is not either praising them for good work. A strict discipline and concentration on the task are conveyed from the recordings. She gives short advices and asks with low voice short questions from one pupil at a time (see also Laine et al., 2017). However, in some lessons, she ignored some pupils completely even if they had raised their hand to ask help. The following comments picked up from the video recordings describe Helen’s way to communicate with the pupils:

“Think for yourself.”

“I won’t give any more advice.”

“In the task it is neither said you have to draw nor you are not allowed to draw. You yourself have to decide how to work.”

Discussion

A Finnish longitudinal study found that pupils’ attitude toward mathematics decreased over the course of comprehensive education (Metsämuuronen & Tuohilampi, 2014).

This is alarming because these attitudes influence how they later respond to mathematics in their studies. For instance, among students in primary teacher education, only about one third have studied advanced mathematics in upper secondary school (Kaasila, Hannula, Laine & Pehkonen, 2008). Therefore, it is important to determine the factors that may change such attitude starting already at the primary school. We approached this many-sided problem by looking at pupils' drawings to see first how the classroom emotional atmosphere had changed from the third (Laine et al., 2013) to the fifth grade (Laine et al., 2015), and then we concentrated on the four classrooms in which the emotional atmosphere had changed in opposite directions (see Table 3).

Our collection of pupils' drawings about mathematics lessons were gathered from two classrooms in which the emotional atmosphere was more positive in the fifth grade than in the third grade and, respectively, from two classrooms in which the emotional atmosphere was more negative in the fifth grade. The difference in emotional atmosphere between these classrooms in the fifth grade was almost significant. According to the drawings, in the classrooms in which the emotional atmosphere was more positive in the fifth grade (Claire and Fiona), the pupils drew themselves asking for more help than in classrooms where the emotional atmosphere was more negative in the fifth grade (Daisy and Helen). Likewise, in the positive classrooms, the pupils drew themselves discussing mathematics with each other more often than in the negative classrooms. On the other hand, in the classrooms in which the emotional atmosphere was more negative in the fifth grade, the pupils drew themselves more frequently sitting alone at their desks than in the positive classrooms. We checked that these features were also seen in the video recordings.

Interaction between the pupils seems to be of crucial importance. An open and tolerant atmosphere is projected from the drawings of classrooms with a positive emotional atmosphere. The pupils are talking about mathematics and advising each other. Therefore, the atmosphere in the classroom is such that learning is appreciated and it allows the pupils to show their own incomprehension or lack of knowledge by freely asking (Ryan, Gheen & Midgley, 1998, pp. 533–534). In an open atmosphere, the pupils are used to telling and arguing about their own views (Newstead, 1998, pp. 12–13, p. 16). On the other hand, in the two negatively developed classrooms, the pupils seem to feel alone when working with mathematics. In the classrooms that emphasized pupils' working silently by themselves, the pupils were not used to describing and justifying their thinking. In these classrooms, explanations and comments were often given publicly to the whole class and not privately in a small group. A typical anguishing situation of social humiliation (see Ashcraft et al., 2007) was described in a drawing in which the drawer herself was leaving the blackboard. She had solved the problem incorrectly. The teacher neither commented nor encouraged the pupil in any way but said "You can go." One of the drawer's classmates was thinking "Fortunately I am not there."

The teacher has a central role in constructing the emotional atmosphere during mathematics lessons (Evans et al., 2009; Harrison et al., 2007). In particular, the emotional relationship between the teacher and the pupils, the teacher's awareness of pupils' feelings and the reasons for them, the teacher's skill in evaluating and responding to pupils' feelings, the teacher's conception of the importance of different emotions in learning, and the teacher's emotional interpersonal guidelines all affect the emotional atmosphere (Evans et al., 2009). The positively developed classrooms

produced no drawings in which the teacher criticized or embarrassed the pupils. Conversely, in the negatively developed classrooms, such drawings were evident, in one classroom, there were even five such drawings. In her thesis, *Storied relationships: students recall their teachers*, Uitto (2011) noted that students recalled how particular moments became significant in their relationships with the teacher.

The emphasis on the importance of involving also young pupils' voices and perspectives to gain understanding of their learning and experiences has increased in the last two decades (see Harcourt & Einarsdottir, 2011). Often also, social context and social relations have been overlooked (Komulainen, 2007). The findings support the notion that even young children are competent thinkers and communicators about issues which require deep reflection (Mortari, 2011).

From the drawings, we were looking at features like were the pupils sitting alone, were they talking with their classmates, or was the teacher close to the pupils or was she standing near the blackboard. We were not interested in any specific lesson but in the general atmosphere during mathematics lessons. Therefore, the quality of the drawings was not important like were the persons drawn as stick figures, did a drawing contain many details, or was it dashed very quickly. The fifth graders used also lots of speech and thought bubbles in their drawings.

When the reliability of this study is examined, one must particularly consider why the pupils in the same class drew quite different pictures of the emotional atmosphere. This is probably because pupils' affective conditions and properties affect how they interpret different situations during mathematics lessons (Hannula, 2011). For example, a pupil good in mathematics likes to solve the problems also by him/herself whereas a pupil not so good in mathematics would feel frustrated without getting help. Therefore, it would be interesting to look at whether the emotional atmosphere is also the same in the lessons of other subjects; in other words, does the emotional atmosphere described here especially pertain to the situation during mathematics lessons or does it also describe the situation in classrooms in general.

The reliability of this study has been given consideration in many ways. The pupils drew their pictures for the researchers and not for their teacher. However, in the third grade, the teachers collected the drawings but the fifth graders could draw without paying attention to the teacher's reaction because the researcher supervised the drawing situation. We analyzed together all the drawings, discussing and negotiating each. We tried to be as open as possible when analyzing pupils' drawings as required in the phenomenographic research method. Most (more than 95%) of the drawings were fairly unambiguous, and it was easy and univocal to pick out things for analysis, like pupils asking for help, pupils talking about mathematics, and pupils sitting alone. However, there were difficulties with some of the drawings that contained a large amount of information. Such pictures included the drawings in Figs. 3 and 4 because one had to think carefully when sorting out the speech and thought bubbles to discern the story the drawer meant to communicate.

It is possible to doubt to what extent the drawings can be used to represent general situation in the classrooms. We think that here a pupil's description does not generally portray a particular lesson. Instead, it is based on a collection of memories and thoughts, which are topmost in the pupil's mind. In addition, pupils' drawing forms a collection of pupils' interpretations. They form together the joint interpretation of the emotional atmosphere of the classroom (cf. Cobb & Yackel, 1996; Partanen 2011).

In order to check that the drawings are giving “true” description of what is going on during the mathematics lessons, we went through all the video recordings from the lessons of these four teachers. The close link between the drawings and the actual situation in the classroom further confirms that drawings are a good research method for gathering pupils’ ideas (see Dahlgren & Sumpter, 2010; Pehkonen et al., 2016).

It seems that open and confidential interaction between the teacher and his/her pupils as well as between the pupils themselves is necessary for a positive emotional atmosphere in the classroom. Therefore, it would be worth studying how such an atmosphere, including the kind of interaction evident in the drawings analyzed in this study, could be created. What means do teachers use to achieve a good teacher-pupil relationship as well as a confidential relationship between pupils? Furthermore, it would be interesting to study how the emotional atmosphere in the classroom affects the pupils’ learning.

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