Emotional classroom climate from a psychological perspective: An analysis of Grade 3 and Grade 6 participant-produced drawings in the context of geometry lessons

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Classroom climate is a rich and an important research concept due to the early discovery of a relationship between positive classroom climate and academic performance and motivation, engagement, participation, and attitude towards school and teaching. In this paper, I focus on the elements of the psychological dimension of emotional classroom climate and the kind of emotional classroom climate in Grade 3 (N = 25) and Grade 6 (N = 28) school mathematics in the context of geometry lessons by using participant-produced drawings. The students illustrated different elements of the psychological dimension of the emotional classroom climate through physical facial and body features as well as thoughts. Furthermore, the results showed that the emotional classroom climate in both grades was mainly positive, with a negative tendency in Grade 6. The results are discussed not only regarding the research goals, but also regarding their theoretical, practical, and methodological implications.

Keywords: emotional classroom climate, emotions, geometry lessons, participant-produced drawings, primary education

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1 Introduction

In recent decades, the study of emotions has gained greater prominence in educational research (Hascher & Edlinger, 2009). During school years, students experience both positive and negative emotions in various subjects (e.g., Reindl & Hascher, 2013; vom Hofe et al., 2002). Among other things, emotions determine the behavior of those involved in teaching (Evans et al., 2009), willingness to learn and to perform and have a strong influence on the mathematical competence growth (vom Hofe et al., 2002). In mathematics education, the topic of emotions has already its field of research (e.g., Dahlgren Johansson & Sumpter, 2010; Laine et al., 2013, 2015; Reindl & Hascher, 2013). For example, the International Comparative Study PISA 2012 analyzed, among other things, emotional orientation in mathematics (Schiepe-Tiska & Schmidtner, 2012). Germany scored slightly below the OECD average in terms of the emotional orientation of enjoyment in mathematics (Schiepe-Tiska & Schmidtner, 2012). Overall, only 39% of 15-year-old female students reported liking and engaging in

mathematics because they enjoy it (Schiepe-Tiska & Schmidtner, 2012).

Current research on emotions in mathematics education is predominantly limited to secondary, and less to primary level (Reindl & Hascher, 2013). Yet, there is a decline in enthusiasm for learning and school during the first years of education, and everyday school life is increasingly accompanied by negative emotions (Helmke, 1993). Negatively experienced emotions, such as boredom, are the main accompanying symptoms of school experience (Eder, 2002). Additionally, Reindl and Hascher (2013), reported that positive emotions decrease during the elementary school years, with negatively experienced emotions being subject to a slight recovery effect during the transition from primary to secondary school (van Ophuysen, 2008). These results make clear what significance both positive and negative emotions have for the development in primary school age, and the need and the importance of a stronger focus on primary grades (Reindl & Hascher, 2013).

Whereas the reported studies focused on the individual level of affect, Laine et al. (2013, 2015) expanded the previous work by looking at the interindividual level of affect, namely emotions of/ within a group as a part of classroom microculture of the interactions between the teacher and the students in the context of Grade 3 and Grade 5 mathematics lessons. Even though, previous research on emotional classroom climate focused on mathematics education in general, these studies dealt with (Reindl & Hascher, 2013; Schmude, 2005) or reflected mainly different affect aspects within arithmetic (Laine et al., 2013, 2015). For that reason, geometry lessons were chosen as a study context. Specifically, the main goal of the inquiry presented here was to provide insight into Grade 3 and Grade 6 students' perceptions of emotional classroom climate in the context of geometry lessons by using participant-produced drawings.

2 Theoretical perspective

In this section, I first present the construct of classroom climate, with a special focus on the emotional classroom climate. This is followed by the state-of-the-art on emotional classroom climate from an empirical and a methodological perspective. The section ends with two research questions that guided the study.

2.1 Emotional classroom climate

A classroom is a social context for learning, which with time develops a distinct social climate or feel (Ashkanasy, 2003). According to researchers (e.g., Eder, 2002; Evans et al., 2009), the classroom climate refers to a shared subjective representation of important characteristics of the classroom. Based on extensive literature review, Evans et al. (2009) defined three complementing components of classroom climate, namely *academic*, referring to pedagogical and curricular elements of the learning environment; *management*, referring to discipline styles for maintaining order; and *emotional*, referring to affective interactions within the classroom. Here, I focus on the last component which can be described through five components: emotional relationship between teacher and students, emotional awareness, emotion coaching, emotional intrapersonal beliefs, and emotional interpersonal guidelines (Evans et al., 2009). According to Götz et al. (2011), emotional climate refers to both positive and negative emotions of a group as well affective attitudes related to the school, people who are associated with the school, areas of specialization, and subjects taught, among others. Evans et al. (2009) argued for the importance of treating emotional classroom climate as a distinct aspect of classroom climate given emotional classroom climate being "superordinate to other classroom climate domains since it interfaces with the conventional academic and management elements of effective learning environments" (p. 131).

The emotional classroom climate can be regarded either from a psychological (i.e., level of the classroom individuals) or a social point of view (i.e., level of the classroom community) (Hannula, 2012). The *psychological dimension*, which is in the focus of the paper, refers to the level of an individual and involves affective conditions, namely emotions and emotional reactions (e.g., fear, joy), thoughts (e.g., "This is difficult."), meanings (e.g., "I could do it."), and goals (e.g., "I want to solve this task.") and affective properties, namely attitudes (e.g., "I like math."), beliefs (e.g., "Math is difficult."), values (e.g., "Math is important."), and motivational orientations (e.g., "I want to understand.") (Hannula, 2012; Laine et al., 2013, 2015). The nature of affective conditions and properties can be classified into three categories, namely positive (e.g., positive emotions such as joy, interest; positive attitude such as "I like mathematics."), negative (e.g., negative emotions such as boredom, fear, anger; negative belief such as "Mathematics is hard."), and neutral (e.g., neutral thought such as "This is a square.") (Laine et al., 2013, 2015; Reindl & Hascher, 2013).

2.2 Emotional classroom climate state-of-the-art from a methodological and an empirical perspective

In recent decades, childhood research has experienced a shift from quantitative to qualitative research designs and methods which led to an increased use of participatory, and visual methods and processes in childhood research, such as drawings (Kuzle, 2019), which engage and emphasize children's experiences, perspectives, and understandings making them active agents in the research process (Einarsdóttir, 2007). Furthermore, in contrast to classical data collection methods (e.g., interviews, questionnaires), the use of students' drawings showed significant benefits in qualitative inquiry when working with (young) students (Einarsdóttir, 2007). According to Thomson (2008), and Weber and Mitchell (1995), with visual methods things can be expressed that cannot be easily verbalized, as they require little or no language mediation. This is especially an important aspect when working with young children; it is not easy to get verbally rich answers to questions from young children, since they tend to give monosyllabic answers to questions, they do not consider relevant to them (Hannula, 2007). In addition, they may have difficulties with reading surveys and expressing themselves clearly in writing or within interview contexts due to talking with an often relatively unknown researcher (Hannula, 2007). Furthermore, both methods are – even when using simple scales – particularly time-consuming and accompanied by partially unreliable students' answers (Ahtee et al., 2016; Reindl & Hascher, 2013). As such, these methods have shown not to be always reliable due to participants' young age (e.g., Einarsdóttir, 2007; Pehkonen et al., 2016; Reindl & Hascher, 2013). Kearney and Hyle (2004) found that using participant-produced drawings was more likely to accurately represent participants' experiences, and especially emotions. At the same time, its usage encourages collaborative meaning-making as well as reliable and trustworthy data by establishing a rapport between the researcher and the participant. Such shift in power (im)balance in the researcher-participant relationship with a less researcher-imposed structure has proven to be important when working with primary grade students, especially due to familiarity with the act of drawing, and non-verbal expression (i.e., language mediation, language barrier) at different levels of representation (Ahtee et al., 2016; Glasnović Gracin & Kuzle, 2018). Thus, participant-produced drawings inhibit viewing these with adult eyes (Kearney & Hyle, 2004; Kuzle & Glasnović Gracin, 2020). For that reason, the method is receiving increasing attention in mathematics education research on students' perceptions of classroom climate (Dahlgren Johansson & Sumpter, 2010; Glasnović Gracin & Kuzle, 2018;

Kuzle, 2019; Laine et al., 2013, 2015; Pehkonen et al., 2016).

Laine et al. (2013, 2015) investigated the emotional classroom climate of Finnish Grade 3 (N = 133) and Grade 5 students (N = 136) using students' drawings only. The emotional atmospheres of the classes were classified into five categories (i.e., positive, ambivalent, negative, neutral, unidentifiable) based on the students' and teachers' mode (i.e., facial expressions) as well as on their speech and thought bubbles illustrated in the drawings. In both studies, the emotional classroom climate was mainly positive, with 38% in Grade 3 and 36% in Grade 5. Similar results emerged regarding the ambivalent emotional classroom climate, namely 33% in Grade 3 and 34% in Grade 5. A negative tendency was observed from Grade 3 to Grade 5 with 10% and 14% of drawings, respectively, portraying a negative emotional classroom climate. With respect to using drawings as a research tool, they reported on difficulties interpreting students' drawings only.

Glasnović Gracin and Kuzle (2018) analyzed the emotional climate in school mathematics during geometry lessons using participant-produced drawings (e.g., Kearney & Hyle, 2004). For it, a multiple case study with four high-achieving students from Grades 2 to 5 from the Zagreb area (Croatia) was conducted. The drawings were analyzed based on facial features, and thought and speech bubbles as suggested by Zambo (2006), but expanded by looking also at body language. This was then followed by the holistic evaluation of the emotional climate in each classroom as suggested by Laine et al. (2013, 2015). The results of the study were aligned with those of Laine et al. (2013) with the emotional classroom climate in geometry lessons on the level of the individual being positive (Grade 2 and Grade 3), unidentifiable (Grade 5) or ambivalent (Grade 4), but in no case dominantly negative. Since a multiple case study was conducted, Glasnović Gracin and Kuzle (2018) could not portray a comprehensive picture of the emotional climate in geometry lessons, but rather case-based results. For that reason, the results were neither representative of a large population, nor generalizable.

2.3 Research questions

Based on the above theoretical perspective and empirical results, the following research questions guided the study:

1. What elements of the psychological dimension of the emotional climate were reported in the participant-produced drawings of Grade 3 and Grade 6 students in the context of geometry lessons?
2. What kind of emotional classroom climate can be seen in Grade 3 and Grade 6 students' participant-produced drawings in the context of geometry lessons?

3 Research process

3.1 Research design and subjects

For this study, an explorative cross-sectional qualitative research design (Patton, 2002) using participant-produced drawings (Kearney & Hyle, 2004) was chosen. The research project participants were Grades 3–6 students. In this paper, I report on drawings of 25 Grade 3 and 28 Grade 6 students from different urban schools of two federal states in Germany, namely Berlin and of Brandenburg. Guided by the project experience, Grade 3 students were chosen as students at this age can differ between different types of mathematics lessons, and, thus, can report on their perceptions of the emotional classroom climate in the context of geometry lessons. Lastly, the quality of drawings is already solid to high enough to allow rich insights into the emotional classroom climate. Grade 6 students were similarly chosen for the above-mentioned reasons in addition to being in the last school year of their primary education. Regarding the sampling, from the same school, a maximum of two average students were randomly selected. Typical case sampling as a type of purposive sampling was utilized as a way of collecting rich and in-depth data and to allow for a comparison between other similar samples (Patton, 2002).

3.2 Data collection instruments and procedure

The research data consisted of (a) audio data, (b) document review, and (c) a semi-structured interview. The audio data were comprised of the students' unprompted verbal reports during the drawing process, and prompted verbal reports after the drawing process ((a) and (c)). For the document review (b), each student was given a piece of paper with the following assignment: "Dear _____, I am Anna and new to your class. I would like to get to know your class better. Draw two pictures of your mathematics lessons. The first drawing should show what your arithmetic lessons are like and how you view them. The second drawing should show what your geometry

lessons are like and how you view them. In each drawing, include your teaching group, the teacher, and the pupils. Use speech bubbles and thought bubbles to describe conversation and thoughts. Mark the pupil that represents you in the drawing by writing "ME". Thank you and see you soon! Yours Anna." (Glasnović Gracin & Kuzle, 2018; Kuzle, 2019). Thought and speech bubbles were used to present children's thoughts as an additional visual representation and to facilitate children's description of their thoughts (Wellman et al., 1996). Here, only the second drawing is of relevance. The students took as much time as needed, usually about 10 to 15 minutes for both drawings. After the students had finished drawing, the drawings were used as a catalyst for a semi-structured interview (Kearney & Hyle, 2004). During the interview, both a free description of the drawing on the part of the child were given (e.g., "Describe your picture to me.") and specific questions based on the child's description were posed (e.g., "How does the child 1, 2, etc. feel in the second drawing?", "What is the reason for that?"). This procedure gave each student the opportunity to frame own experiences, and interpret own drawing. This last part lasted about 5 minutes in total. Multiple data sources were used to assess the consistency, and to increase the validity of the results as was suggested by Einarsdóttir (2007) when employing visual research methods.

3.3 Data analysis

As suggested by Patton (2002), multiple stages of the analysis were performed, and contained the following steps: (a) transcribing audio data, (b) analysis of drawings using qualitative content analysis (Patton, 2002), and (c) confirming or adjusting their interpretation by content analysis of the data from the semi-structured interview. Concretely, the author transcribed the audio data (a), and together with another coder coded the drawings independently (b). Here each drawing was analyzed one content category at a time. To examine the emotional classroom climate of each drawing, the individual children drawn were first analyzed, which was followed by the analysis of the illustrated teacher in order to achieve a holistic evaluation of the emotional classroom climate as suggested by Laine et al. (2013, 2015). Concretely, the evaluation was based on both the students' and the teacher's moods as well as on their speech and thought bubbles illustrated in the drawings. According to Koike (1997, cited in Gramel, 2008, p. 36) feelings can be divided into five categories of expression in drawings, namely facial expression, gestures, the facial schema, the representation of situations triggering emotions, and symbols. Here, different facial features, and speech

and thought bubbles were analyzed based on the coding manual developed by Zambo (2006), which was expanded with physical body gestures (i.e., body posture, arm position) as suggested by Koike (1997, cited in Gramel, 2008, p. 36), Glasnović Gracin and Kuzle (2018), and Kuzle (2021), to achieve a more accurate representation than was the case in the earlier research of Laine et al. (2013, 2015). In order to facilitate the interpretation of the children's drawings, the semi-structured interviews were analyzed in the same manner (so-called participant-produced drawings) (c). The data from the semi-structured interviews confirmed the coders' analysis of the drawings or added new information than was revealed in the drawings (e.g., emotions of non-depicted students or the teacher, or students and/or the teacher depicted from behind) or on rare occasions gave a completely different picture of the emotional classroom climate. By combining the two data sources, the consistency of the results was assessed which consequently increased the validity of the results as was reported in similar studies (e.g., Kearney & Hyle, 2004; Kuzle, 2021; Kuzle & Glasnović Gracin, 2020).

Following the rating of the children drawn, the holistic evaluation of the emotional classroom climate in the context of geometry lesson was assessed by combining Zambo's (2006) rating, and Laine et al. (2013, 2015) emotional classroom climate categories. If a child's rating of a category was emotionally positive, a counter (+1) was noted. If the assessment was negative, a negative counter (-1) was noted, and if the assessment was neutral, the symbol 0 was noted (Zambo, 2006). If none of the categories was drawn, it was classified as unidentifiable and received a dash (-) (see Table 1). In that manner, the ratings from +2 to -2 for the entire drawing were possible. After rating each feature, the "counters" were balanced against each other. If the score was 0, the emotional state of the respective child was rated as neutral; if the score was positive, it was rated as positive; and if the score was negative, it was rated as negative. If an individual contained both positive and negative characteristics, it was coded as ambivalent. As can be taken from Table 1, the emotional feeling of child 1 was coded as negative since counters for physical facial features as well as for speech/thought bubble features were assigned each -1. Following the rating of the children drawn, a slight adaptation of Laine et al. (2013, 2015) emotional classroom climate categories were employed for the purposes of the holistic evaluation of the emotional climate as was earlier reported by Kuzle (2021). The emotional categories were as follows: positive (i.e., persons smile, think or behave positively, although some of the expressions can be neutral), ambivalent (i.e., there are both positive and negative facial/body

language expressions or thoughts in the drawing), negative (i.e., persons are sad or angry or think/behave negatively, although some of the expressions can be neutral), neutral (i.e., all facial/body language expressions or other thoughts are neutral), and unidentifiable (i.e., no facial/body language expressions or thoughts are present in the drawing) (Laine et al., 2013, 2015). If identifiable and non-identifiable persons were illustrated, only the non-identifiable ones were identified in the overall image analysis but were scored as neutral.

Table 1. Exemplary coding of the emotional feeling of the drawn child.

Child	Physical and speech/thought bubble features	Feature clues	Explanation	Score
 ”me”	Face features	Mouth	-	-
		Eyes/eyebrows	Closed, down-ward slant	-1
		Face drawn sym-bols	-	-
	Total: Physical face features			-1
	Body features	Arm position	Downward	0
	Speech/thought bubble features	Symbols	-	-
		Signs	-	-
		Words	“I find geometry hard.”	-1
	Total: Speech/thought bubble features			-1
Total: Child 1				-2

Two researchers coded the students’ data separately from one another. The inter-rater reliability was high (90% agreement). Nevertheless, we discussed the differences in coding taking into consideration both students’ products and refined at the same time the coding manual. This decision mainly related to the drawings in which the protagonists were depicted from behind or in an extremely simplified or generic man-ner. Furthermore, there were a few disagreements regarding the nature of individual thought features, such as “good”, “okay” which were then discussed. Also, it was also agreed that the final decision about the nature of a counter assigned to a particular physical feature would be based on the interview data. Such inconsistencies were pri-marily seen in Grade 3 students’ drawings. Due to analyst triangulation, adjustments were subsequently made to our coding, after which the interrater reliability was 100%, and the same time contributed to the verification and validation of the qualitative analysis. Afterwards, descriptive statistics were calculated in order to determine the kind of emotional classroom climate.

4 Results

This section is divided into two parts. In the first part, the focus lies on different elements of the psychological dimension of the emotional classroom climate and their nature in both grades (i.e., similarities, differences), whereas in the second part on the kind of the emotional classroom climate in Grade 3 and Grade 6.

4.1 Psychological dimension of the emotional climate in Grade 3 and Grade 6 participant-produced drawings in the context of geometry lessons: Similarities and differences

Tables 2 and 3 illustrate psychological dimension of the emotional classroom climate on the basis of the physical features (e.g., face, body), and speech and thought bubbles reported in the participant-produced drawings which were assigned one of the three categories (i.e., positive, negative, neutral).

Table 2. Nature of different emotions illustrated in Grade 3 students' drawings in the context of geometry lessons.

Feature and thoughts		**Emotional classroom categories**		
		Positive	**Negative**	**Neutral**
Physical face features	Eyes/ eyebrows	Wide open; upward slant	Closed; downward slant	Typical without expression; no slant no special features
	Mouth	Full, wide smile	Angry; open in a scream; drawn as a jagged line; portrays a frown	Drawn as a straight line
	Symbols	–	Tears; tongue stuck out	–
Physical body features	Arm posture	In the air (open upwards); request to talk	–	In action; open downwards; on/behind the back; on the table
Thoughts	Symbols	Hearts; peace sign	!!!	–
	Signs	Laughing smiley	Smiley with slanted mouth	Smiley w/straight mouth
	Words	"I am in a good mood."; "Yes!"; "AAAAA"; easy; fun; cool; interesting; I like/love geometry; very happy; it feels good	"boring"; "I find geometry difficult.	That's a …

From both tables, similarities and differences can be observed regarding the features and thoughts that were illustrated as well as their nature. Regarding the neutral emotional classroom category, no differences could be observed regardless of the feature and thought. The same applies for physical face feature "eyes/eyebrows" across all three emotional classroom categories. Whereas physical face feature "mouth" was the same for positive and neutral emotional classroom categories, only Grade 3 students' drawings revealed negative features, namely angry mouth, screaming mouth, mouth turned downward. Thus, physical face features reflected different positive (i.e., joy), negative (i.e., anger, sadness) and neutral emotions and emotional reactions. Joy was illustrated for instance with wide open eyes and mouth, sadness with a mouth portrayed as a frown and tears, and anger with mouth portrayed in a scream or with a tongue stuck out. The physical body feature "arm posture" was the same for positive and neutral emotional classroom categories in both grades, but Grade 6 drawings revealed two negative features, namely arms crossed on the body and holding/playing with a smartphone. Both reflect an emotional reaction whereas the former is a sign of discomfort, uneasiness or insecurity, and the latter a sign of boredom or disinterest.

The students of both grades illustrated different emotions and emotional reactions, thoughts, attitudes, and beliefs using symbols, signs, and words. Here, Grade 3 students used these to illustrated positive emotional classroom category (i.e., hearts, peace sign), and Grade 6 students to illustrate negative emotional classroom category (i.e., zzz, dark scribbles). The former reflects positive emotion of affection and optimism, whereas the latter negative emotion of boredom and anger. As mentioned, signs were also used to illustrate positive emotion of joy (i.e., smiley) as well as negative emotion of anger (i.e., child fighting with a sword, crumpled book). Lastly, both groups of students used words to communicate their thoughts, attitudes and beliefs about geometry lessons. Here, Grade 3 students' drawings revealed more positive statements than Grade 6 students' drawings. Similarly, Grade 3 students' drawings revealed fewer negative statements than Grade 6 students' drawings. Positive attitude towards geometry came from two Grade 3 students only ("I like geometry.", "I love geometry."). A negative belief about geometry came also from one Grade 3 student by saying "I find geometry difficult." Most often Grade 3 students used words to convey positive thoughts about geometry lessons (e.g., easy, fun, "Yes!"). On the other hand, Grade 6 students used words to convey negative thoughts about geometry lessons (e.g., "Oh no!", "Not again.", too hard, too difficult, confused, blah blah). In other word, the drawings of Grade 3 students revealed more positive thoughts in the form

of words in their drawings than those of Grade 6 students. Or, Grade 6 students revealed more negative thoughts in the form of words in their drawings than those of Grade 3 students. The interviews revealed that different aspects of affect – both positive and negative – were due to the teacher's teaching practices, the content, and the working method.

Table 3. Nature of different emotions illustrated in Grade 6 students' drawings in the context of geometry lessons.

Feature and thoughts		**Emotional classroom categories**		
		Positive	**Negative**	**Neutral**
Physical face features	Eyes/ eyebrows	Wide open; upward slant	Closed; downward slant	Typical without expression; no slant no special features
	Mouth	Full, wide smile	–	Drawn as a straight line
	Symbols	–	–	–
Physical body features	Arm posture	In the air (open upwards); "Me, me, me" (request to talk); pointing at something	Crossed arms on the body; holding a smartphone	In action; open downwards; on/behind the back; on the table
Thoughts	Symbols	–	Zzz; dark scribbles	–
	Signs	Laughing smiley	Child fighting with a sword; crumpled books	Smiley w/straight mouth
	Words	"Almost done.!; "That's easy.!; "I understand it well."	blah, blah; confused; (too) hard; really complicated, "What is she babbling about?"; "All of them?"; "The faster I finish, the faster I can read."; "Oh no!"; "Not again!"; "What?!"; "Always just writing!"	That's a …

4.2 Emotional classroom climate in Grade 3 and Grade 6 participant-produced drawings in the context of geometry lessons: Similarities and differences

After analyzing the physical features (e.g., face, body), and speech and thought bubbles of drawn children and the teacher in the drawings, they were classified into five categories (i.e., positive, negative, ambivalent, neutral, and unidentifiable) (Laine et

al., 2013, 2015). In Table 4 the results regarding the emotional classroom climate in Grade 3 and Grade 6 drawings in the context of geometry lessons are presented.

Table 4. Absolute and relative frequencies of the reported emotional states in the context of Grade 3 geometry lessons.

	Emotional classroom climate categories				
	Positive	Ambivalent	Negative	Neutral	Unidentifiable
Grade 3 students (*N* = 25)	15 (60%)	6 (24%)	1 (4%)	2 (8%)	1 (4%)
Grade 6 students (*N* = 28)	13 (46%)	12 (43%)	0 (0%)	2 (7%)	1 (4%)

In total, 60% of drawings (n = 15 drawings) of Grade 3 students represented the emotional climate in the context of geometry classroom as positive as opposed to 46% of drawings (n = 13 drawings) of Grade 6 students. Thus, a bit less the half of the Grade 6 students perceived the emotional classroom climate as positive. Nevertheless, the difference of 14% between both grades is not significant. On the other hand, ambivalent emotional classroom climate was reported in 43% of Grade 6 students' participant-produced drawings (n = 12) as opposed to 24% of participant-produced drawings of Grade 3 students (n = 6). Thus, the percentage of drawings portraying ambivalent emotional classroom climate in Grade 6 differed minimally in percentage of those portraying positive classroom climate. The difference between both grades, however, was in this case significant. In both grades, the interviews were somewhat aligned with the data from the drawings but revealed more negative features than the drawings since on occasions the students or the teacher were portrayed from the behind.

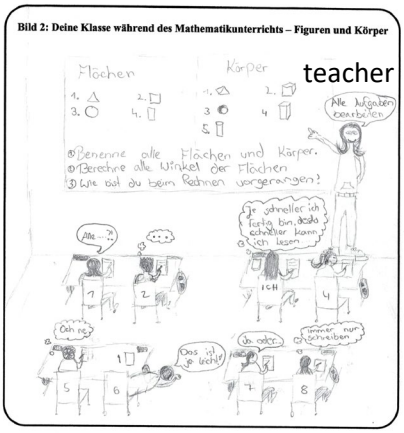

Figure 1. An example of an ambivalent emotional classroom climate from a Grade 6 student.

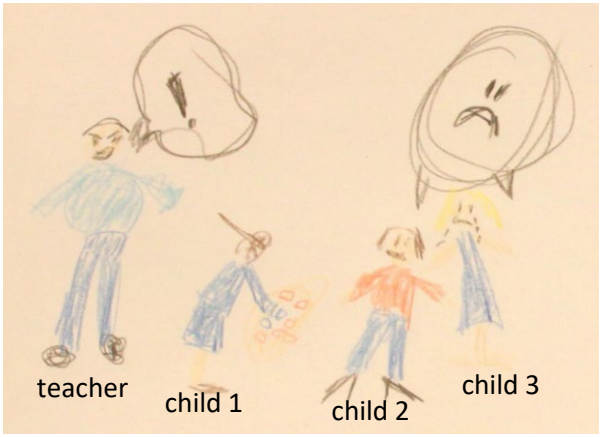

Figure 2. An example of a negative emotional classroom climate from a Grade 3 student.

The drawing shown in Figure 1 is an example of a Grade 6 student drawing that was rated as ambivalent since both positive (e.g., teacher and child 4 smiling, "That's easy."), and negative features (e.g., "Oh no.", "Always just writing.") were illustrated with some neutral ones (e.g., "Do all the tasks."). As opposed to one drawing of Grade 3 student portraying a negative emotional classroom climate, no drawing of Grade 6 student portrayed such climate. The drawing shown in Figure 2 is an example of a drawing that was rated as negative since only negative features (e.g., child 3 crying, child 1' and 3' mouth portrayed as a frown, teacher's mouth open in a scream) with some neutral ones (e.g., arms closed downwards) are illustrated. The interview revealed that the mood was determined by a quarrel between the students which consequently influenced the teacher's mode. In both grades, the percentage of drawings illustrating neutral or unidentifiable emotional classroom climate was similar or the same. With respect to the later, there are no facial or body expressions, and speech and thought bubbles could be identified. Children's names are written down on drawn rectangles, which most likely represent desks. The interviews did not provide any further information.

5 Discussion and conclusions

In this study, participant-produced drawings were used as a data source for researching holistic primary grade students' perceptions of emotional classroom climate during mathematics in the context of geometry lessons. To express different aspects of the psychological dimension of affect (e.g., emotions and emotional reactions, thoughts, attitudes, beliefs) as well as their kind (i.e., positive, negative, neutral), the students used various physical features of the face (i.e., eyes/eyebrows, mouth) and thoughts (i.e., symbols, signs, words), but less physical body features (i.e., arm posture). The analysis of Grade 3 and Grade 6 children's drawings and interviews revealed a positive teaching climate in the context of geometry lessons. However, in Grade 3 such emotional classroom climate predominated (more than 50% of drawings) which was not the case in Grade 6. Furthermore, a striking high percentage of drawings illustrating an ambivalent classroom climate in Grade 6, which was accompanied by a lower percentage of positive ones emerged from the data. Similar results were reported in a study by Dahlgren Johansson and Sumpter (2010) where the majority of Grade 2 students expressed positive attitudes towards mathematics and connected mathematics to a positive feeling, whereas a decrease in positive emotions in Grade 5 compared to Grade 2 was reported. This is also aligned with the results of

Reindl and Hascher (2013) that reported on a negative trend in the course of the primary grade school years regarding the emotional experience, which was also observable when comparing both studies of Laine et al. (2013, 2015). A possible explanation for this finding could be a child's optimism, which is much more pronounced in younger students than in older ones (Hasselhorn, 2005). Since these studies focused on mathematics lessons in general, but mainly used items pertaining to arithmetic or students illustrated arithmetic lessons, it may be that this trend is independent of the mathematics subfield. Grade 3 students' data revealed more positive conditions and properties in geometry lessons than was the case with Grade 6 students. Especially worrying is the nature of different negative emotions, namely boredom, fear and anger, and the way these were illustrated since these have been recognized as negative influencing factors regarding mathematical competence growth (vom Hofe et al., 2002).

The study results confirmed to some extent the results of Laine et al. (2013), when both positive (38%), as well as ambivalent drawings (33%), are considered jointly. These results may be also due to study conditions since the collective emotional atmosphere was researched, which may have contributed to somewhat skewed results. Furthermore, the study looked at mathematics lessons not focusing on specific mathematical content. Taken the experience in the project, students mostly associate mathematics with arithmetic and have more difficulties learning arithmetic content than geometry content. This may have contributed to differences in both studies' results when both categories are treated separately. This assumption is aligned with Krauthausen (2018), and Radatz and Schipper (1983) who state that geometry due to its alternative teaching concepts (e.g., action-oriented instruction, discovery learning) may promote positive mathematics-related affect. Taken that the results did not entirely confirm the results from the earlier research (e.g., Laine et al., 2013), and geometry lessons were chosen as a study context, the next possible step may be to contrast the emotional classroom climate between arithmetic and geometry lessons with a special focus on the specificities of these two mathematics subfields in connection to students' (perceptions of) emotions.

The use of participant-produced drawings allowed interpreting the meanings that the students had given to the situations and objects they had presented which would not have been possible using quantitative methods. Thus, the drawings which were triangulated with the interviews (i.e., participant-produced drawings) allowed an in-depth understanding of what each child had drawn, and to more accurately represent

their emotions and perception of the emotional classroom climate. Especially, the interviews gave also an insight into the teachers' mode, and pedagogical skills in geometry lessons. These had either a positive or negative influence on the children's emotional experience in the context of geometry lessons. Given that the teacher is considered as an important factor of the perceived emotions in the classroom, it is a relevant factor in determining the emotional classroom climate (Evans et al., 2009). This provides another interesting research direction, namely to examine the interaction or the influence of psychological dimension (level of the individual) between or on the social dimension (level of the community) of mathematics-related affect levels which is still a rather unexplored area of research.

This study was an exploratory study with a rather small sample, and for that reason cannot be generalizable. Nevertheless, since purposive sampling was used, the results are representative of other similar samples. Futures studies involving a larger data sample and/or using other sampling methods (e.g., maximum variation sampling, probability sampling) could contribute to generalization of the results to a population. The results of this cross-sectional study showed some evidence of increasing negative elements of the psychological dimension of classroom climate from Grade 3 to Grade 6. A longitudinal study from the beginning of school to the transition to secondary school of each individual reference group could be aimed at to investigate the course of the emotional climate in the classroom. Lastly, working with the entire classroom or schools may provide a more holistic insight into the collective or school emotional climate in primary school mathematics.

References

Ahtee, M., Pehkonen, E., Laine, A., Näveri, L., Hannula, M. S., & Tikkanen, P. (2016). Developing a method to determine teachers' and pupils' activities during a mathematics lesson. *Teaching Mathematics and Computer Science, 14*(1), 25–43. https://doi.org/10.5485/tmcs.2016.0414

Ashkanasy, N. M. (2003). Emotions in organizations: a multi-level perspective. In F. Dansereau & F. J. Yammarino (Eds.), *Multi-level issues in organizational behavior and strategy* (Vol. 2, pp. 9–54). Emerald. https://doi.org/10.1016/S1475-9144(03)02002-2

Dahlgren Johansson, A., & Sumpter, L. (2010). Children's conceptions about mathematics and mathematics education. In K. Kislenko (Ed.), *Current state of research on mathematical beliefs XVI. Proceedings of the MAVI-16 Conference* (pp. 77–88). Institute of Mathematics and Natural Sciences, Tallinn University.

Eder, F. (2002). Unterrichtsklima und Unterrichtsqualität [Classroom climate and teaching quality]. *Unterrichtswissenschaft: Zeitschrift für Lernforschung, 30*(3), 213–229.

Einarsdóttir, J. (2007). Research with children: methodological and ethical challenges. *European Early Childhood Education Research Journal, 15*(2), 197–211. https://doi.org/10.1080/13502930701321477

Evans, I. M., Harvey, S. T., Buckley, L., & Yan, E. (2009). Differentiating classroom climate concepts: academic, management, and emotional environments. *Kotuitui: New Zealand Journal of Social Sciences Online, 4*(2), 131–146. https://doi.org/10.1080/1177083x.2009.9522449

Glasnović Gracin, D., & Kuzle, A. (2018). Drawings as external representations of children's mathematical ideas and emotions in geometry lessons. *Center for Educational Policy Studies Journal, 8*(2), 31–53. https://doi.org/10.26529/cepsj.299

Götz, T., Zirngibl, A., & Pekrun, R. (2011). Lern- und Leistungsemotionen von Schülerinnen und Schülern [Learning and achievement emotions of students]. In T. Hascher (Ed.), *Schule positiv erleben Erkenntnisse und Ergebnisse zum Wohlbefinden von Schülerinnen und Schülern* (pp. 49–66). Haupt AG.

Gramel, S. (2008). *Die Darstellung von guten und schlechten Beziehungen auf Kinderzeichnungen: Zeichnerische Differenzierung unterschiedlicher Beziehungsqualitäten* [The representation of good and bad relationships in children's drawings: Drawing differentiation of different relationship qualities]. Verlag Dr. Kovač.

Hannula, M. S. (2007). Finnish research on affect in mathematics: Blended theories, mixed methods and some findings. *ZDM Mathematics Education, 39*(3), 197–203. https://doi.org/10.1007/s11858-007-0022-7

Hannula, M. S. (2012) Exploring new dimensions of mathematics-related affect: embodied and social theories. *Research in Mathematics Education, 14*(2), 137–161. https://doi.org/10.1080/14794802.2012.694281

Hascher, T., & Edlinger, H. (2009). Positive Emotionen und Wohlbefinden in der Schule - ein Überblick über Forschungszugänge und Erkenntnisse [Positive emotions and well-being in the school - a review of research approaches and findings]. *Psychologie in Erziehung und Unterricht, 56*(2), 105–122.

Hasselhorn, M. (2005). Lernen im Altersbereich zwischen 4 und 8 Jahren: individuelle Voraussetzungen, Entwicklung, Diagnostik und Förderung [Learning in the age range between 4 and 8 years: individual preconditions, development, diagnostics and support]. In T. Guldimann & B. Hauser (Eds.), *Bildung 4- bis 8-jähriger Kinder* (pp. 77–88). Waxmann.

Helmke, A. (1993). Die Entwicklung der Lernfreude vom Kindergarten bis zur 5. Klassenstufe [Developing learning-eagerness from kindergarten through 5th grade]. *Zeitschrift für Pädagogische Psychologie, 7*, 77–86.

Kearney, K. S., & Hyle, A. (2004). Drawing about emotions: the use of participant-produced drawings in qualitative inquiry. *Qualitative Research, 4*(3), 361–382. https://doi.org/10.1177/1468794104047234

Krauthausen, G. (2018). *Einführung in die Mathematikdidaktik – Grundschule* [Introduction to mathematics didactics – Elementary school]. Springer Spektrum. https://doi.org/10.1007/978-3-662-54692-5

Kuzle, A., & Glasnović Gracin, D. (2020). Making sense of geometry education through the lens of fundamental ideas: An analysis of children's drawing. *The Mathematics Educator, 29*(1), 7–52.

Kuzle, A. (2019). What can we learn from students' drawings? Visual research in mathematics education. In Z. Kolar-Begović, R. Kolar- Šuper, & Lj. Jukić Matić (Eds.), *Towards new perspectives on mathematics education* (pp. 7–34). Element.

Kuzle, A. (2021). Drawing out emotions in primary grade geometry: An analysis of participant-produced drawings of Grade 3-6 students. *LUMAT: International Journal on Math, Science and Technology Education, 9*(1), 844–872. https://doi.org/10.31129/LUMAT.9.1.1620

Laine, A., Ahtee, M., Näveri, L., Pehkonen, E., Koivisto, P. P., & Tuohilampi, L. (2015). Collective emotional atmosphere in mathematics lessons based on Finnish fifth graders' drawings.

LUMAT: International Journal on Math, Science and Technology Education, *3*(1), 87–100. https://doi.org/10.31129/lumat.v3i1.1053

Laine, A., Näveri, L., Ahtee, M., Hannula, M. S., & Pehkonen, E. (2013). Emotional atmosphere in third-graders' mathematics classroom – an analysis of pupils' drawings. *Nordic Studies in Mathematics Education*, *17*(3-4), 101–116.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Sage.

Pehkonen, E., Ahtee, M., & Laine, A. (2016). Pupils' drawings as a research tool in mathematical problem-solving lessons. In P. Felmer, E. Pehkonen, & J. Kilpatrick (Eds.), *Posing and solving mathematical problems. Advances and new perspectives* (pp. 167–188). Springer. https://doi.org/10.1007/978-3-319-28023-3

Radatz, H., & Schipper, W. (1983). *Handbuch für den Mathematikunterricht an Grundschulen* [Handbook for teaching mathematics in elementary schools]. Schroedel.

Reindl, S., & Hascher, T. (2013). Emotionen im Mathematikunterricht in der Grundschule [Emotions in the teaching of mathematics in the primary school]. *Unterrichtswissenschaft, 41*(3), 268–288.

Schiepe-Tiska, A., & Schmidtner, S. (2012). Mathematikbezogene emotionale und motivationale Orientierungen, Einstellungen und Verhaltensweisen von Jugendlichen in PISA 2012 [Mathematics-related emotional and motivational orientations, attitudes, and behaviors of adolescents in PISA 2012]. In M. Prenzel, C. Sälzer, E. Klieme, & O. Köller (Eds.), *PISA 2012. Fortschritte und Herausforderungen in Deutschland* (pp. 99–122). Waxmann.

Schmude, C. (2005). *Differenzielle Entwicklungsverläufe der Lernfreude im Grundschulalter* [Differential developmental trajectories of learning-eagerness in primary school age]. Humboldt-Universität zu Berlin. https://doi.org/10.18452/9291

Thomson, P. (2008). Children and young people: Voices in visual research. In P. Thomson (Ed.), *Doing visual research with children and young people* (pp. 1–20). Routledge. https://doi.org/10.4324/9780203870525

van Ophuysen, S. (2008). Zur Veränderung der Schulfreude von Klasse 4 bis 7 [On the change in school enjoyment from Grades 4 to 7]. *Zeitschrift für Pädagogische Psychologie, 22*(34), 293–306. https://doi.org/10.1024/1010-0652.22.34.293

vom Hofe, R., Pekrun, R., Kleine, M., & Götz, T. (2002). Projekt zur Analyse der Leistungsentwicklung in Mathematik (PALMA). Konstruktion des Regensburger Mathematikleistungstests für 5.–10. Klassen [Project on the analysis of the performance development in mathematics (PALMA). Construction of the Regensburg mathematics achievement test for Grades 5-10]. In M. Prenzel & J. Doll (Eds.), *Bildungsqualität von Schule: Schulische und außerschulische Bedingungen mathematischer, naturwissenschaftlicher und überfachlicher Kompetenzen* (pp. 83–100). Beltz Verlag.

Weber, S. J., & Mitchell, C. (1995). *'That's funny, you don't look like a teacher': Interrogating images, identity, and popular culture*. The Falmer Press.

Wellman, H. M., Hollander, M., & Schult, C. A. (1996). Young children's understanding of thought bubbles and of thoughts. *Child Development*, *67*(3), 768–788. https://doi.org/10.2307/1131860

Zambo, D. (2006). Using thought-bubble pictures to assess students' feelings about reading. *The Reading Teacher, 59*(8), *798–803*. https://doi.org/10.1598/rt.59.8.7