



Effect of social aspects of the classroom climate on Grades 3–6 students' perceptions of the emotional classroom climate in primary school mathematics lessons

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Abstract. Current research efforts highlight the significance of the social climate in the classroom. This climate influences not only students' academic performance, motivation, engagement, and participation, but also their perception of the emotional classroom climate. However, little attention has been given to the effects of the various social aspects of the classroom climate on students' perceptions of the emotional classroom climate. The present study addressed this gap by investigating aspects of the social classroom climate as possible explanatory factors of a positive, negative or ambivalent students' perception of the emotional classroom climate in Grades 3–6 mathematics lessons. The secondary analysis of participant-produced drawings revealed that in drawings depicting a positive emotional classroom climate, the teacher provided assistance and made the lesson goals clear. Furthermore, the students talked to each other about mathematics. Conversely, in drawings depicting a negative emotional classroom climate, the teacher made behavioral requests, and negative student-student communication was present. Both the working method and the classroom seating arrangement did not seem to affect the perceived emotional classroom climate. The results are discussed in terms of their theoretical, and practical implications.

Key words and phrases: classroom social climate, drawings, emotional classroom climate, primary education, mathematics lessons.

MSC Subject Classification: 97C20.



Introduction

School time plays a decisive role in the socialization of children and young people (Hummrich & Kramer, 2017). For primary school students (Grades 1 to 6), the number of compulsory weekly lessons ranges from 20 to 30 hours, five of which are usually dedicated to mathematics lessons (OECD, 2019). Most of these lessons take place in the classroom, making it a very important social environment for their development. Every classroom and the lessons that take place in it are characterized by a particular climate (Evans et al., 2009). How this climate is perceived within a class is highly subjective; within a class, there are “almost as many different perceptions of climate [...] as there are students”¹ (Grewe, 2007, p. 548). Depending on whether the classroom climate is positive or negative, this can have a variety of effects on students and teacher. For example, a positive classroom climate can increase school satisfaction and students’ enjoyment of lessons, improve classroom discipline, and counteract psychological stress, such as anxiety or overburdening (Evans et al., 2009; Grewe, 2007; Leitz, 2015; Meyer, 2022). The classroom climate can be influenced by various factors (Götz et al., 2008). However, the social relationships within the classroom structure are particularly important (Grewe, 2007). Furthermore, the quality and quantity of the relationships between students, and especially between teacher and students, are a key climate-relevant characteristic (Evans et al., 2009; Götz et al., 2008; Leitz, 2015; Reindl & Gniewosz, 2017).

In the recent decades, various studies focused on the classroom climate in mathematics lessons. Here, children’s drawings were primarily used as a research instrument, as these provide unique insights into the emotional realm, and the students’ perception of the classroom climate (Borthwick, 2011; Einarsdóttir, 2007; Kearney & Hyle, 2004). A predominant focus in this research domain pertains to the emotional aspects of the classroom climate, with a particular emphasis on the utilization of diverse attributes within the drawings (e.g., facial expressions and gestures), providing a comprehensive insight into the students’ perceptions of the emotional classroom climate (Glasnović Gracin & Kuzle, 2018; Kuzle, 2021, 2025; Laine et al., 2013, 2015, 2020). Additionally, various social climate aspects are taken into account, thereby providing a holistic picture of the social classroom climate (Ahtee et al., 2016; Kuzle & Glasnović Gracin, 2019, 2021; Kuzle, 2023).

¹Translated by the author.

This study is part of a broader research project investigating the emotional and social classroom climate in mathematics lessons, with the objective of identifying the social aspects of the classroom climate that exert a notable influence on students' perceptions of the prevailing emotional classroom climate in primary school mathematics lessons. In this regard, the work refers to two studies by Kuzle (2021, 2023), which have previously analyzed the emotional and social climate in Grades 3–6 mathematics lessons. The data from both studies are analyzed secondarily and linked to each other.

Theoretical background

The following section first examines the construct of classroom climate, followed by the social and emotional aspects of the classroom climate. Furthermore, research findings on the impact of the teacher's actions on the collective emotional classroom climate in primary grade mathematics lessons are presented. The section ends with a research question that guided the study.

Classroom climate and its components

The construct of *classroom climate* is complex and hard to delineate, and no uniform definition or model exists to date. Rather, it is a multi-faceted concept described through its fundamental supporting elements (Eder, 2002), which can be reduced to different factors or dimensions in a variety of ways (Evans et al., 2009), mostly involving academic and management dimension of classroom climate. Yet, different dimensions overlap. For example, although feedback on students' work is typically viewed as an instructional or academic component of classroom climate, the way it is delivered can strongly influence students' emotional experiences. It may evoke feelings of disappointment or inadequacy (sadness), or even resentment toward the teacher (frustration and anger) (Pekrun, 2006). Thus, “[e]motion is involved in disciplinary contexts as well as instructional contexts, and so emotional climate can be thought of not as a third component of the classroom ecology but as an aspect of all teacher-child interactions” (Evans et al., 2009, p. 140).

Based on extensive literature review, Evans et al. (2009) proposed treating emotional climate as a distinct aspect of classroom climate, distinguishing between three complementary components of classroom climate: *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. In their model, the former two are perceived as “a function of the emotional relationship between teacher and students” (p. 141). Treating emotional classroom climate as superordinate to other classroom climate components is not surprising, given that research (e.g., Jennings & Greenberg, 2009) suggested teacher’s social and emotional competence being the key factor in creating positive classroom climate. Such conceptualization of classroom climate, however, allows research on identifying the social aspects of the classroom climate (actions of the teacher) that influence students’ perceptions of the prevailing emotional classroom climate (interactions that involve emotional exchange between teacher and student) in school lessons or explain differences in the perceived emotional classroom climate in different classrooms.

Social aspects of the classroom climate. The conceptualization of the social classroom climate is most often based on the concept of the perceived environment (Eder, 2002; Moos & Moos, 1978; Trickett & Moos, 1973). In essence, it is characterized by the shared, collective perceptions of its members along with several environmental domains, with the objective of capturing its complexity (Moos & Moos, 1978). Accordingly, Kuzle and Glasnović Gracin (2019, 2021) conceptualized classroom social climate as a function of three conceptual categories, namely *Interpersonal relationship*, *Personal growth*, and *Order*, each being described through different dimensions, subdimensions, and scales. The first category *Interpersonal relationship* describes the nature, the intensity of personal relationships, and the mutual influences of the teacher and the students within the classroom, encompassing social, pedagogical and mathematical aspects. It is described through three dimensions: the verbal and non-verbal communication of the teacher, the verbal and non-verbal communication of the students, and organization. Each of the dimensions is described by accompanying subdimensions and scale. The first dimension comprises subdimensions *Teacher’s position in the classroom* (e.g., in front of the blackboard, amongst students), and *Teacher support* (e.g., assistance, positive feedback, negative feedback, mathematics-related question). The second dimension comprises subdimensions *Students’ position in the classroom* (e.g., at the table, next to the teacher, in front of the blackboard), *Participation* (e.g., working on assignments at the table, working on assignments on the blackboard, listening, asking for assistance, non-mathematical comment), and *Affiliation* (e.g., student-student communication, student-student help request, student-student support). Finally, the third dimension comprises subdimensions *Working method* (e.g., teacher-centered instruction, individual work,

group work, working with a partner), and *Classroom seating arrangement* (e.g., traditional classroom arrangement, group tables, mixed arrangement). The second category *Personal growth* is defined by the acquisition of concrete learning opportunities based on the goals and clarity of the lesson objective, and teaching resources. It is described through two dimensions: *Goal orientation* (e.g., goal of the lesson, presence of mathematical content), and *Teaching materials and tools* (e.g., 3D-solids and models, geometric tools, place value board, poster). The third category *Order* pertains to the social norms and maintenance of order in the classroom (e.g., disciplining or asking students to be quiet or to behave) which are established by both the teacher and the students. It is described by one dimension, namely *Keeping order* (i.e., led by the students, led by the teacher).

Emotional aspects of the classroom climate. The emotional classroom climate can be regarded from two distinctive perspectives, namely from the level of the individual (psychological dimension), and from the level of the classroom (social dimension) (Hannula, 2012). The former focuses on the viewpoint of an individual, including different affective conditions (i.e., emotions and emotional reactions, thoughts, meanings, and goals), and affective properties (i.e., attitudes, beliefs, values, and motivational orientations). The latter focuses on the viewpoint of the classroom, including different affective conditions (i.e., social interaction, communication, and the atmosphere in a classroom), and affective properties (i.e., norms, social structures, and the atmosphere in the classroom). Furthermore, a distinction between two temporal aspects of affect, namely state and trait, within both dimensions can be made (Hannula, 2012). Whereas state refers to the emotional climate at a specific moment in the classroom, such as different emotions and emotional reactions, thoughts, meanings and aims, trait refers to more long-term conditions, such as attitudes, beliefs, values, and motivational orientations. Given the teacher's central role in constructing the emotional climate or functioning as the emotional force in day-to-day school lessons (Evans et al., 2009), recurring situations may have an influence on students developing more stable affective traits typical to a certain classroom (Laine et al., 2013).

Empirical findings on the classroom climate in mathematics lessons

For approximately a decade, a distinct field of research in mathematics education has focused on the classroom climate in mathematics lessons from various perspectives, with a particular emphasis on the analysis of children's drawings.

In particular, the research by Ahtee et al. (2016), Kuzle (2021, 2023, 2025), Glasnović Gracin and Kuzle (2018), Kuzle and Glasnović Gracin (2019, 2021) and Laine et al. (2013, 2015, 2020) focused on the emotional and social aspects of the classroom climate within mathematics lessons. It has been demonstrated that various aspects of the classroom climate influence the climate in mathematics lessons and can play a pivotal role in shaping the emotional perception of the classroom climate (Kuzle, 2023; Laine et al., 2020). However, only Laine et al. (2020) investigated the effect of the two climates on each other by analyzing the factors in teachers' actions that could explain differences in the emotional climate in primary school classrooms.

In two studies, Laine et al. (2013, 2015) analyzed the collective emotional climate in Grade 3 and Grade 5. In the first study (Laine et al., 2013), the drawings of 133 Grade 3 students from a total of nine classes and five schools were analyzed. Similarly, the second study (Laine et al., 2015) analyzed the drawings of 136 Grade 5 students from eight different classes and five different primary schools. Upon the collection of data from both studies, five classes were taught by the same mathematics teacher (Laine et al., 2013, 2015). This enabled Laine et al. (2020) to investigate factors in the behavior of the teacher and students that could explain differences in the emotional climate of the individual classes (Laine et al., 2019). A subsequent analysis of the drawings revealed six factors in student or teacher behavior that could explain the observed differences in the perceived classroom climate, namely (1) students asking for help, (2) students sitting alone, (3) students talking to each other about mathematics, (4) teacher being located close to students, (5) teacher helping or encouraging students, and (6) teacher praising or criticizing the students (Laine et al., 2020). On the one hand, the results of the study confirmed previous studies (e.g., Hagenauer, 2011; Kuzle, 2021, 2025; Reindl & Hascher, 2013) that indicated a decline in positive emotions from lower into higher grades. On the other hand, in classes that showed a positive development of the emotional atmosphere, it was found that students were more inclined to seek assistance and engage in discourse on mathematical content. Furthermore, the teacher was frequently positioned close to the students within the drawings, and praised and encouraged them more often than in classes that showed the opposite development. In these classes, the students also often sat alone at the table and spoke little or not at all about mathematical content. Furthermore, teachers praised and encouraged significantly less often and were more likely to criticize students in front of the class. Overall, the study

showed that the behavior of teachers and students influences whether a collective classroom climate is perceived as positive or negative.

Research question

The objective of the study was to determine aspects of the social classroom climate that could explain differences in the perceived emotional classroom climate in Grades 3–6 mathematics lessons by addressing the following research question:

To what extent can different aspects of the social classroom climate, as analyzed in participant-produced drawings, explain a positive, negative or ambivalent image of the perceived emotional classroom climate of students in Grades 3–6 mathematics lessons?

Method

Research design and subjects

This study constitutes a supplementary secondary analysis (Medjedović, 2010) of the data that formed the basis for Kuzle's (2021, 2023) exploratory qualitative cross-sectional study. In the secondary analysis, the data concerning the emotional image of mathematics lessons was combined with data concerning the social climate, and considered from a new perspective in order to answer the research question. Thus, for this study, an explorative research design using participant-produced drawings (Kearney & Hyle, 2004) was chosen.

The sample consisted of 114 students (Grades 3–6) from various primary schools from two German federal states, who were selected randomly and without gender bias. As reported in Kuzle (2023), data was collected from a maximum of two students per school. The distribution of the sample according to the individual grades was as follows: 25 students from Grade 3; 33 students from Grade 4; 28 students from Grade 5; and 28 students from Grade 6. The age group of the participants was particularly suitable, as the students had already gained sufficient experience in mathematics lessons, and possessed sufficient drawing skills to provide in-depth insight into the classroom climate (Kuzle, 2021).

Data collection instruments and procedures

The research data were collected in a one-to-one setting between the author and the students at their respective schools in separate rooms (Kuzle, 2021, 2023), and consisted of students' drawings, audio data and a semi-structured interview. Concerning students' drawings, the students received instructions in the form of an Anna letter, which requested that they illustrate two images depicting their mathematical lessons for a fictitious 12-year-old named Anna. For the first drawing, the students were asked to depict their arithmetic lesson, and in the second drawing, to illustrate their geometry lesson. The students were also asked to mark themselves with 'I' in the drawings, and to use thought and speech bubbles to describe conversation and thoughts (Glasnović Gracin & Kuzle, 2018; Kuzle, 2021, 2023, 2025). They needed approx. 10 to 15 minutes each to complete the drawings. The spontaneous comments made during the drawing process were recorded using the audio recordings. After the students had finished drawing, the drawings were used as a catalyst for a semi-structured interview, giving them the opportunity to explain their drawings, the people, thoughts or situations it contained. Data triangulation was used to assess the consistency of the results, and to increase their validity (Kuzle, 2021, 2023).

The data, consisting of drawings of arithmetic ($N = 114$) and geometry lessons ($N = 114$) in Grades 3 to 6, has already been analyzed independently by two experts. The first analysis focused on the emotional classroom climate, and the second on the social classroom climate. As this study is based on these two primary analyses, they are briefly explained below. In the analysis of the social climate, the participant-produced drawings were analyzed using the coding manual developed by Kuzle and Glasnović Gracin (2019, 2021) with regard to various categories, dimensions, subdimensions and scales that provide information about the social climate. The emotional climate was analyzed using the coding manual developed by Glasnović Gracin and Kuzle (2018) and Kuzle (2021, 2024, 2025). After assessing all features within the drawing (i.e., facial features, body posture, and, if applicable, expressions or thoughts in the form of speech or thought bubbles) for both the teacher and the students, a holistic assessment was assigned to one of the five slightly adapted categories of Laine et al. (2013, 2015). These categories comprised: positive (i.e., the majority of persons smile, or 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), negative (i.e., the majority of 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, although some of the expressions can be either positive or negative), and unidentifiable (i.e., no facial/body language expressions or thoughts).

Data analysis

The secondary analysis carried out was based on the results of the two primary analyses of the participant-produced drawings described above in order to investigate aspects of the social classroom climate as possible explanatory factors of a positive, negative or ambivalent students' perception of the emotional classroom climate in Grades 3–6 mathematics lessons. In the first step, the drawings of the individual grades were selected in which a positive, negative or ambivalent classroom climate was illustrated. This resulted in eliminating 24 drawings from the sample of 228 drawings in which the emotional climate was either neutral or unidentifiable. Thus, a total of 200 drawings were considered for the secondary analysis. Starting with Grade 3, the corresponding analyses of the dimensions of the social classroom climate were taken into consideration for the purpose of evaluating their presence in drawings reflecting positive classroom climate in mathematics lessons. These were subsequently used to record the absolute frequencies with which the individual subdimensions and scales from the coding manual (Kuzle, 2021, 2023) occurred. The occurrence of the individual scales of the dimensions and subdimensions was determined using descriptive statistics. The frequency of occurrence of the various scales in the drawings with negative and ambivalent classroom climate was determined in the same manner. Subsequently, the same procedure was utilized to analyze Grades 4–6 students' participant-produced drawings. These procedures led to creating a joint summary of absolute frequencies for each aspect of the social classroom climate in connection to emotional image characteristics of the classroom climate (positive, negative, ambivalent). In the last step of data analysis, for all three emotional image characteristics of the classroom climate, relative frequencies were calculated for each scale.

Results

This section outlines the results of the secondary analysis, which is divided into two parts. The first part focuses on drawings depicting a positive, ambivalent

or negative classroom climate in mathematics lessons in Grades 3–6. The second part examines which aspects of the social classroom climate are depicted in the drawings, depending on whether the emotional classroom climate is shown as positive, negative or ambivalent. These results are organized around the three categories of social classroom climate.

Emotional classroom climate in Grades 3–6 mathematics lessons

In the secondary analysis, the occurrence of the different categories, dimensions, subdimensions, and scales on the social classroom climate was recorded using the drawings with a positive, negative or ambivalent image of the emotional classroom climate. A total of 200 drawings of mathematics lessons (geometry and arithmetic lessons) were considered. The positive emotional climate was categorized as positive in 106 drawings, ambivalent in 62 drawings, and negative in 32 drawings (see Table 1). Given the study objective, the results are not layered by different mathematics lessons but presented holistically, meaning that two drawings from a same student are either in the same column or different columns as the classroom climate may have varied in the case of the latter. The dimensions, subdimensions and scales of the social classroom climate that are recognizable within the drawings are shown in Tables 2–10, which are based on the relative frequencies. The peculiarities observed in the data are discussed in the subsequent section.

Emotional classroom climate categories	Grade				Total
	Grade 3	Grade 4	Grade 5	Grade 6	
positive	31	31	24	20	106
ambivalent	11	17	16	18	62
negative	5	8	9	10	32
Total	47	56	49	48	200

Table 1. Distribution of emotional classroom climate by grade level

Aspect of the social classroom climate influencing the emotional classroom climate in mathematics lessons in Grades 3–6

Interpersonal relationship. An examination of the results pertaining to the first category *Interpersonal relationship*, with regard to the dimension *Verbal and*

non-verbal communication of the teacher and its subdimension *Position in the room* (see Table 2), revealed that in drawings characterized by a positive, negative or ambivalent emotional classroom climate, the teacher was predominantly depicted in front of the blackboard, a tendency that was most prevalent in drawings reflecting an ambivalent emotional classroom climate (75.8%). In drawings depicting a positive emotional classroom climate, the teacher amongst students was the second most frequent category (10.4%). Conversely, drawings reflecting a negative emotional classroom climate, showed the teacher very rarely (6.3%) among the pupils. A notable observation is that in the drawings reflecting negative classroom climate, the teacher's position remained unidentifiable in 9.4% of the cases. In the drawings characterized by positive/negative or ambivalent classroom climate, the teacher was depicted at the desk 9.4% and 11.3% of the time, respectively. In a few cases with a positive or ambivalent emotional classroom climate, the teacher was depicted in a different position in the room (2.8% and 1.6%, respectively).

Scale	Emotional classroom climate		
	positive N = 106	negative N = 32	ambivalent N = 62
In front of the blackboard	73.6% (78)	65.6% (21)	75.8% (47)
Amongst students	10.4% (11)	6.3% (2)	8.1% (5)
At the desk	9.4% (10)	9.4% (3)	11.3% (7)
Somewhere in the classroom	2.8% (3)	0% (0)	1.6% (1)
Unidentifiable	0% (0)	9.4% (3)	0% (0)
Unavailable	3.8% (4)	9.4% (3)	3.2% (2)

Table 2. Verbal and non-verbal communication of the teacher: Position in the classroom

With regard to the subdimension *Teacher support*, the most drawings depicted a positive classroom climate in which the teacher provided assistance to the students (23.6%), followed by drawings with an ambivalent classroom climate (19.4%) (see Table 3). Teacher assistance was only identifiable in 6.3% of drawings characterized by a negative classroom climate. Positive feedback from a teacher could only be recognized in drawings reflecting positive classroom climate (7.5%). However, it is striking that negative feedback also appeared in these

drawings. At 3.8%, negative feedback is actually the most common. No negative feedback was depicted in drawings of negative classroom climate. Teachers quietly observing students' work only occurred in drawings with positive (5.7%) or ambivalent (4.8%) classroom climate. Non-mathematical comments by the teacher were particularly evident in drawings with a negative emotional classroom climate (37.5%). In contrast, only 3.8% of drawings depicting a positive emotional climate and 9.7% of those depicting an ambivalent emotional climate contained non-mathematical comments. Overall, the teacher was most often depicted making mathematics-related statements or asking pupils to solve a mathematics problem (32.1% positive, 43.8% negative, and 40.3% ambivalent). The teacher could only be interpreted as passive in one case with a positive classroom climate (0.9%). The teacher asked mathematics-related questions in 17% of positive drawings, 18.8% of negative ones, and 9.7% of ambivalent ones. There was no support from the teacher in 31.1% of positive drawings, 25.0% of negative ones, and 25.8% of ambivalent ones.

Scale	Emotional classroom climate		
	positive <i>N</i> = 106	negative <i>N</i> = 32	ambivalent <i>N</i> = 62
Assistance	23.6% (25)	6.3% (2)	19.4% (12)
Positive feedback	7.5% (8)	0% (0)	0% (0)
Negative feedback	3.8% (4)	0% (0)	3.2% (2)
Mathematics-related question	17.0% (18)	18.8% (6)	9.7% (6)
Mathematics-related statement	32.1% (34)	43.8% (14)	40.3% (25)
Observation	5.7% (6)	0% (0)	4.8% (3)
Non-mathematical comment	3.8% (4)	37.5% (12)	9.7% (6)
Passive	0.9% (1)	0% (0)	0% (0)
Unavailable / unidentifiable	31.1% (33)	25.0% (8)	25.8% (16)

Table 3. Verbal and non-verbal communication of the teacher: Support by the teacher

Looking at the second dimension, *Verbal and non-verbal communication of the students*, and in particular its subdimension *Position in the classroom*, it is evident that most students sit at their tables and work on their assignments (68.9% in

a positive, 65.6% in a negative, and 64.5% in an ambivalent classroom climate, as shown in Table 4). Within drawings with a negative classroom climate, the position of the students was not clearly identifiable (18.8%), making it the second most common category. Students were only shown in front of the blackboard or in another position in the room in drawings of positive or ambivalent classroom climate.

Scale	Emotional classroom climate		
	positive N = 106	negative N = 32	ambivalent N = 62
Only one student is shown (at the blackboard / at the table)	17.0% (18)	6.3% (2)	9.7% (6)
At the table	68.9% (73)	65.6% (21)	64.5% (40)
Next to the teacher	2.8% (3)	6.3% (2)	4.8% (3)
In front of the blackboard	13.2% (14)	0% (0)	9.7% (6)
Amongst other students	0% (0)	0% (0)	0% (0)
Somewhere in the classroom	5.7% (6)	0% (0)	9.7% (6)
Unidentifiable	4.7% (5)	18.8% (6)	9.7% (6)
Unavailable	3.8% (4)	6.3% (2)	4.8% (3)

Table 4. Verbal and non-verbal communication of the students: Position in the classroom

Regarding the subcategory *Participation*, it is notable that, as shown in Table 5, more than half of the students, depicting in drawings a negative emotional classroom climate, expressed themselves negatively or had non-mathematical thoughts (59.4%). These two scales are also the most frequent in an ambivalent classroom climate at 43.5% and 38.7%, respectively. Though these scales are less pronounced in a positive climate, 22.6% of students made negative comments. Positive statements were most frequently represented in drawings with a positive classroom climate (43.4%). However, 37.5% occurred in drawings illustrating negative classroom climate, and 27.4% in drawings illustrating ambivalent classroom climate. In approximately one-fourth of the drawings, when the atmosphere was positive or ambivalent, students were found to be working on their assignment at the table. In 17.0% of cases with a positive classroom climate, students completed their assignments at the blackboard. This scale was not present

in drawings portraying negative classroom climate. The listening scale was not recognizable in drawings depicting negative classroom climate. However, it appeared in 22.6% of drawings with positive classroom climate, and in 14.5% of drawings with ambivalent classroom climate.

Scale	Emotional classroom climate		
	positive N = 106	negative N = 32	ambivalent N = 62
Working on assignments at the table	25.5% (27)	18.8% (6)	27.4% (17)
Working on assignment on the backboard	17.0% (18)	0% (0)	12.9% (8)
Listening	22.6% (24)	0% (0)	14.5% (9)
Responding	17.9% (19)	18.8% (6)	22.6% (14)
Asking a question	5.7% (6)	0% (0)	12.9% (8)
Asking for assistance	0.9% (1)	6.3% (2)	3.2% (2)
Reviewing	8.5% (9)	12.5% (4)	4.8% (3)
Discussion	15.1% (16)	18.8% (6)	3.2% (2)
Positive expression	43.4% (46)	37.5% (12)	27.4% (17)
Negative expression	22.6% (24)	59.4% (19)	43.5% (27)
Non-mathematical comment	16.0% (17)	59.4% (19)	38.7% (24)
Passive	1.9% (2)	12.5% (4)	19.4% (12)
Unidentifiable	8.5% (9)	0% (0)	12.9% (8)
Unavailable	8.5% (9)	0% (0)	3.2% (2)

Table 5. Verbal and non-verbal communication of the students: Participation

Regarding the subdimension *Affiliation*, most often none of the subscales were present or identifiable in drawings with a negative classroom climate (see Table 6). In these drawings, negative comments towards other students were illustrated in 43.8% of the cases. In most drawings depicting a positive emotional classroom climate, no communication between students was evident (50.9%). Student-student support was only recognizable in drawings reflecting positive classroom climate

(4.9%). In 6.3% of drawings of a negative emotional classroom climate, and 8.1% of drawings of an ambivalent emotional classroom climate, students helping each other could be recognized. However, in the case of a positive emotional climate, this could only be recognized in one drawing (0.9%). Student-student encouragement was not portrayed in any drawing.

Scale	Emotional classroom climate		
	positive N = 106	negative N = 32	ambivalent N = 62
No communication with other students	50.9% (54)	18.8% (6)	38.7% (24)
Student-student communication	2.8% (3)	0% (0)	4.8% (3)
Student-student encouragement	0% (0)	0% (0)	0% (0)
Student-student help request	0.9% (1)	6.3% (2)	8.1% (5)
Student-student support	4.7% (5)	0% (0)	0% (0)
Negative comments towards other students	9.4% (10)	43.8% (14)	29.0% (18)
Unidentifiable / unavailable	37.7% (40)	43.8% (14)	38.7% (24)

Table 6. Verbal and non-verbal communication of the students: Affiliation

Examining the results for the dimension *Organization* revealed that work is most often depicted head-on, as was the room's layout (see Tables 7–8), which was independent of the emotional classroom climate. Other seating arrangements, such as U-shaped or mixed arrangement, were rarely represented; however, in both subscales, they were most often found in drawings with a negative classroom climate with 3.1% and 12.5%, respectively. Group tables were only illustrated in drawings with a positive (9.4%) or ambivalent classroom climate (11.3%). Partner or group work was rarely represented in the drawings, and if so, then only within the ambivalent or positive emotional classroom climate. The second most common type of work was neither depicted nor identifiable in the drawings. Individual work was depicted in 12.3% of drawings with a positive emotional classroom climate, 12.5% with a negative emotional classroom climate, and 14.5% with an ambivalent emotional classroom climate.

Scale	Emotional classroom climate		
	positive N = 106	negative N = 32	ambivalent N = 62
Teacher-centered instruction	60.4% (64)	53.1% (17)	53.2% (33)
Individual work	12.3% (13)	12.5% (4)	14.5% (9)
Group work	0.9% (1)	0% (0)	0% (0)
Working with a partner	1.9% (2)	0% (0)	3.2% (2)
Work / discussion while working in a circle / half-circle	4.7% (5)	3.1% (1)	8.1% (5)
Unidentifiable / Unavailable	19.8% (21)	31.3% (10)	21.0% (13)

Table 7. Organisation: Working method

Scale	Emotional classroom climate		
	positive N = 106	negative N = 32	ambivalent N = 62
Frontal arrangement	56.6% (60)	46.9% (15)	46.8% (29)
U-shaped arrangement	0.9% (1)	3.1% (1)	1.6% (1)
Mixed arrangement	6.6% (7)	12.5% (4)	6.5% (4)
Circle / Half-circle arrangement	1.9% (2)	0% (0)	0% (0)
Group tables	9.4% (10)	0% (0)	11.3% (7)
Unidentifiable	15.1% (16)	12.5% (4)	12.9% (8)
Unavailable	9.4% (10)	25.0% (8)	21.0% (13)

Table 8. Organization: Classroom seating arrangement

Personal growth. In the second category *Personal growth* and its subdimension *Goal orientation*, the goal of the lesson was clear in almost all drawings. This was most frequent in drawings with a positive emotional classroom climate (92.5%; see Table 9). No mathematical content was recognizable most often in drawings with a negative emotional classroom climate (21.9%). Regardless of the emotional image characteristics of the classroom climate, about half of the drawings show the teacher making the mathematical content clear. Of the students,

52.8% work on an assignment in a positive emotional climate, 31.3% in a negative emotional climate, and 38.7% in a neutral emotional climate.

Scale	Emotional classroom climate		
	positive N = 106	negative N = 32	ambivalent N = 62
The goal of the lesson is clear.	92.5% (98)	78.1% (25)	85.5% (53)
No mathematical content.	7.5% (8)	21.9% (7)	14.5% (9)
The teacher identifies / shows the mathematical content.	51.9% (55)	53.1% (17)	50.0% (31)
The students work on their assignment.	52.8% (56)	31.3% (10)	38.7% (24)

Table 9. Personal growth: Goal orientation

Order. The third category *Order* showed that 89.6% of the drawings with positive emotional classroom climate and 85.5% of the drawings with ambivalent emotional classroom climate did not contain any behavioral prompts (see Table 10). In contrast, 37.5% of drawings depicting a negative emotional classroom climate contained behavioral requests from teachers, while 6.3% contained behavioral requests from the students. This was consistent with the finding that 56.3% of drawings depicting a negative classroom climate did not contain any behavioral requests. Only a few drawings reflecting ambivalent or positive emotional classroom showed recognizable behavioral requests from teachers or students.

Scale	Emotional classroom climate		
	positive N = 106	negative N = 32	ambivalent N = 62
Led by the students	1.9% (2)	6.3% (2)	3.2% (2)
Led by the teacher	8.5% (9)	37.5% (12)	11.3% (7)
Unavailable	89.6% (95)	56.3% (18)	85.5% (53)

Table 10. Keeping order

Discussion and conclusion

This section begins with a discussion of the results of the secondary analysis, which are embedded in the theoretical framework. Additionally, the limitations of the study are discussed, and implications for theory and practice are presented.

Aspects of the social classroom climate as explanatory factors of a positive, negative or ambivalent image of the emotional classroom climate in mathematics lessons in Grades 3–6

The secondary analysis presented here aimed to explain the characteristics of the emotional classroom climate in primary grade mathematics lessons from the perspective of Grades 3–6 students, according to the conceptualization of social classroom climate of Kuzle and Glasnović Gracin (2019, 2021). Overall, the results show that several aspects of the social classroom climate, particularly the behavior of teachers and students, seem to have influenced whether the climate was perceived as positive, negative, or ambivalent.

The teacher, in particular, can influence the emotional classroom climate (Evans et al., 2009). The study results also supported this: teachers were found to provide assistance more frequently overall when the drawings suggested a positive emotional classroom climate. Whereas almost every fourth drawing (23.6%) reflecting positive emotional classroom climate depicted this teacher action, this was only the case in 6.3% of drawings ($n = 2$) reflecting negative emotional classroom climate. These results align with those of Laine et al. (2020), who also found that teachers are more likely to provide assistance in classroom reflecting positive classroom climate. The study results also show that teachers tend less to express themselves mathematically, especially when the emotional classroom climate is negative, which was reported in more than half of these drawings (59.4%). In most cases, these statements consisted of behavioral requests and are consistent with the results relating to the domain *Order*. Furthermore, behavioral requests were mainly made by the teacher in almost every third drawing reflecting negative emotional classroom climate (37.5%), but slightly more often by the students as well. These results support that, in a classroom with a negative emotional climate, lessons are more likely to be interrupted by disruptions, and there is less classroom discipline and poorer student behavior (Evans et al., 2009; Meyer, 2022). These results are confirmed by the fact that, in a positive classroom climate, 89.6% of behavioral requests were not present, indicating clearer rules and

classroom discipline (Kuzle, 2023), compared to results pertaining to negative classroom climate where this was the case in 56.3% of drawings.

Regarding the results pertaining to the teacher feedback depicted in the drawings, it was shown that positive feedback rarely occurred. When it did, it was in response to a positive drawing of the emotional classroom climate. However, negative feedback only occurred when the emotional classroom climate was positive or ambivalent, though such teacher action also occurred very rarely. According to Evans et al. (2009), feedback tends not to have a significant emotional impact when the relationship between student and teacher is positive and respectful, which could explain the results regarding teacher feedback. Nevertheless, feedback can impact students' emotional feelings (Evans et al., 2009; Pekrun et al., 2002).

It was also noticeable that the goal orientation of lessons somewhat differed depending on the characteristics of the emotional classroom climate. When the emotional classroom climate was positive, the lesson's goal tended to be clear (92.5%), and mathematical content was included in almost every second drawing (51.9%). The students also tended to work more frequently on the assigned tasks (52.8%) when the emotional classroom climate was positive, compared to trends in negative and ambivalent emotional classroom climate (31.3% and, 38.7%, respectively). These study trends support that a positive classroom climate influences students' willingness to learn and perform (Eder, 2002; Leitz, 2015; Meyer, 2022), and increases their willingness to make an effort (Leitz, 2015). Additionally, a clear lesson structure positively affects students' learning behavior (Anderman & Midgley, 1997). The comparatively higher proportion of students who pay attention to the teacher indicates an increased willingness to learn and make an effort in a positive emotional classroom climate. Conversely, the decreased proportion of students demonstrating mathematical thought in negative learning environments may indicate a lack of effort, motivation, or interest in the lesson. Pekrun et al. (2002) found that negative emotions, such as anger, fear, and boredom, are associated with thoughts irrelevant to the task at hand. They also found that, albeit slightly, when the emotional classroom climate is negative, there are more cases in which students do not seem to understand the mathematical content and ask for help, or in which students help each other.

According to Hannula (2012), students' attitudes are one dimension of the emotional classroom climate. This could be seen, above all, in students' comments. Drawings depicting negative and ambivalent emotional classroom climate

contained more negative statements (59.4% and 43.5%, respectively) than drawings depicting positive emotional classroom climate (22.6%). Positive statements were more prevalent in drawings of positive emotional classrooms (43.4%), though these were also illustrated in drawings portraying negative and ambivalent emotional classroom climate (37.5% and 27.4%, respectively). These trends suggest that the classroom climate influences lesson enjoyment (Evans et al., 2009), and that students may be less motivated and may participate less in negative learning environments. Communication is another dimension of the emotional classroom climate (Hannula, 2012) which can also influence the characteristics of the emotional classroom climate. The study results confirm this, as negative student-student communication was particularly observed in negative emotional classroom climates (43.8%). Relationships between students appeared to be more negative when the classroom climate was poor. This confirms that the quality of relationships between students determines the climate (Götz et al., 2008). Similarly, the slightly more frequent occurrence of support can be interpreted as an indication of better relationships among students when the emotional classroom climate is positive, with such behavior being neither present in drawings depicting ambivalent nor in those depicting negative classroom climate.

On the other hand, regardless of the emotional image characteristics of the classroom climate, the study results show that mathematics lessons in Grades 3–6 are predominantly frontal. The teacher stood in front of the blackboard while the students worked on assignments at their desks in a frontally arranged classroom. These findings are consistent with research that shows frontal teaching is predominant in various educational systems (Aschersleben, 1999; Götz et al., 2005; Kuzle, 2023). Still, slight differences in classroom organization and working methods may somewhat explain differences in the emotional classroom climate. Interestingly, more open teaching methods and corresponding classroom arrangements (e.g., group and partner work, group tables, or (half-)circle) were slightly more likely to be shown when the emotional classroom climate was positive or ambivalent. One possible explanation is that frontal teaching is more effective than open teaching methods for disciplinary measures and is less susceptible to disruption due to teacher-centeredness (Aschersleben, 1999; Gudjons, 2021). Conversely, if the emotional climate in the classroom is positive, more open classroom settings are presumably more likely to succeed. Individual work was also shown in roughly equal proportions. This may suggest that these characteristics of the social climate are not decisive factors of emotional classroom climate. However,

the differences would have to be greater for a conclusive statement to be made in this regard.

Limitations of the study and future research directions

Based on the secondary analysis carried out, there are some implications for future research. First, the analysis revealed the similarities and differences between Grades 3–6 regarding the social aspects, depending on how the emotional classroom climate was categorized. However, to obtain a holistic picture of the social aspects influencing students' emotions in mathematics, it would be conceivable to compare mathematics with other elementary school subjects. This would clarify whether social aspects in mathematics lessons differ from those in other subjects depending on the emotional classroom climate, allowing for more specific statements in this regard. Second, one could investigate the relationship between the emotional classroom climate and the social aspects that determine it, and students' performance in mathematics. This would allow for further analysis of whether a negative emotional classroom climate and associated social aspects promote poor performance in mathematics. Thirdly, children's drawings can only be used to interpret an individual class's climate because they only reflect one child's perspective. Therefore, the classroom climate depicted is strongly influenced by the characteristics and previous experiences of the child who drew it, and no objective statements can be made about the holistic classroom climate (Eder, 2018). A more complete picture of the emotional and social classroom climate in mathematics lessons could be obtained by considering not only one student's perspective, but also those of the other students and the teacher.

Examining the distribution of drawings according to emotional classroom climate revealed that few drawings were classified as negative compared to those classified as positive. Due to the large amount of data, results regarding social aspects associated with a positive emotional classroom climate are more meaningful than results regarding drawings depicting a negative emotional classroom. More data on negative emotional classroom climate could yield more explicit results. Furthermore, the study results revealed several interesting trends which could be further investigated in a study with a larger data set for significant differences. This would also allow layering of data based on a mathematics lesson allowing an insight into possible similarities, and – more interestingly – into differences in aspects of the social classroom climate that positively or negatively influence the emotional classroom climate. Furthermore, the results on the social and emotional aspects of the classroom climate were derived from two drawings

per student. Though such approach has its benefits, it also carries a risk of data skew, since two drawings of one student are more similar than two drawings of two different students. Thus, drawings are not entirely non-independent, and some correlations, bias and/or limits in social/emotional expression may exist. Consequently, a different methodological approach would also be worthwhile in future research. Lastly, since boys and girls still differ in their interest in mathematics and their perception of their mathematical abilities (Hellmich & Jahnke-Klein, 2008), it would be interesting to examine the emotional and social climate in mathematics lessons from a gender-specific perspective and investigate if there are differences.

Practical implications

Regarding educational practice, the secondary analysis revealed that social factors influence the emotional perception of the classroom environment, prompting teachers to address these aspects. The results imply that teachers can foster a positive classroom climate by being helpful, and by providing goal-oriented lessons with clear rules that are less interrupted by disruptions. Good student-student-relationships also promote a positive classroom climate. Conversely, working methods and room layout are less important.

The results also suggest that the opportunities offered in mathematics lessons are not yet being utilized to their fullest potential. For instance, geometry lessons can provide enjoyment through various hands-on geometric activities, as well as through discovery learning. These lessons can also ensure a more positive attitude toward mathematics overall and enable children with learning difficulties in arithmetic to experience success (Franke & Reinhold, 2016; Radatz & Rickmeyer, 1991). Teachers can also develop a more positive attitude toward mathematics through geometric content (Radatz & Rickmeyer, 1991). Therefore, it is important to better train future teachers in this respect.

A positive classroom climate is important for student academic development, motivation to learn and achieve, and willingness to make an effort. A positive and conducive classroom climate can have a positive effect on lessons. Students are happier in a positive learning environment, experience less school anxiety, and enjoy lessons more (Grewe, 2017; Leitz, 2015; Meyer, 2022). Therefore, a positive classroom climate can create a better learning environment and lead to a better attitude toward mathematics.

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(Received July, 2025)