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Mathematics Teachers' Experiences of Positive Error Climate

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Abstract

The aim of the study is to examine teachers' views on the applicability of a positive error climate in classrooms. In this qualitative case study, the study group consisted of 19 mathematics teachers with more than five years of professional experience and a master's degree, working in different provinces of Turkey. The study lasted 11 weeks and in the first two weeks, the teachers were explained what a positive error climate is and how it should be implemented. Then, the teachers were asked to prepare lesson plans according to the positive error climate framework program. These lesson plans were discussed by other participants and the researchers. The revised plans were implemented in the classrooms for seven weeks. At the end of the study, teachers' opinions about the implementation were obtained through interviews and the data were subjected to content analysis using MAXQDA. When the results were analyzed, teachers evaluated the implementation as effective, fun, providing permanent learning and increasing self-confidence. On the other hand, they stated the negative aspects as insufficient time, difficulties in classroom management and causing mislearning. Most of the participating teachers stated that they would like to use the positive error climate in their future lessons.

Keywords: Positive error climate, MAXQDA, effective and permanent learning.

About the Article

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Introduction

Classroom environments are the main places where learning takes place. The classroom climate in these environments is influenced by attitudes towards learning, social norms perceived in the classroom, learning structures determined by the teacher, and the acceptance of ideas or errors in the classroom (Urdan & Schoenfeld, 2006). Turner and Mayer (1999) point out that for learning to take place in the classroom environment, risks should be taken, difficulties should be pursued and errors should be accepted as a natural element of the teaching process (Urdan & Schoenfeld, 2006). Thus, it is accepted by the class that errors are a part of learning (Ames, 1992). This situation provides the basis for students to perceive errors in the classroom in a positive way and to create positive error climates in the classroom.

Theoretical Framework

How errors are perceived, used and evaluated in the classroom creates the classroom error climate (Steur et al., 2013). To create a classroom with a positive error climate, firstly, students' negative feelings toward errors should be overcome. If a negative reaction is shown toward the student who makes a mistake in the classroom, the student is afraid of making a mistake, prefers to keep silent instead of saying something wrong, and does not want to participate in the lesson due to the fear of making a mistake (Steuer et al., 2013). The second one is that the student's strong achievement goal orientation and positive academic self-concept can be gained and the student can be directed toward self-regulated learning (Steuer et al., 2013; Tulis, 2013). Apart from these two, students should take the risk of making errors for a positive error climate. Taking the risk of making an error is expressed as academic risk-taking behaviour. Students with this behaviour engage in learning activities by considering the importance of the negativity of the error they make (Clifford & Chou, 1991). In classrooms with a positive error climate, teachers accept student errors, do not show a rigid attitude toward errors, act tolerantly and are open to discussion (Oser & Spychiger, 2005).

Heinze (2005), who mentions that being able to say why something is wrong beyond why it is right will support learning, evaluates learning from mistakes as a method. Similarly, Borasi (1994) stated that errors can be used as a springboard in education. In addition, there are many studies indicating that learning from errors positively increases student achievement and motivation (Barbieri & Booth, 2020; Durkin & Rittle-Johnson, 2012; Heinze & Reiss, 2007; Rach et al., 2013; Rittle-Johnson & Star, 2009; Yıldırım, 2019). Considering all of this, the importance of using errors as a teaching tool in education becomes apparent.

When error-based teaching studies are examined, it is seen that video recording studies are predominant (Matteucci et al., 2015; Santagata, 2005; Son, 2013; Tulis, 2013). These studies describe the current situation and offer solutions to the problems identified. Looking at the teacher dimension of the studies, it was observed that although teachers generally accepted the instructional potential of errors, they had concerns about their

use in the classroom environment (Palkki & Hastö, 2018). In the studies, it is seen that teachers who create a positive error climate in classrooms sometimes do this consciously and sometimes unconsciously (Abay & Clores, 2022; Alvidrez, 2019; Matteucci et al., 2015). In these studies, it can be said that a plan that helps to create a fully positive error climate in classrooms cannot be put forward. As a result, there is a need for planned intervention studies that fully reveal the effects of classroom error climate.

Teachers are the ones who will create a positive error climate in classrooms. Their attitude towards errors directs the student's attitude towards errors. In this regard, teachers need to be made aware of the error climate and learn how to implement the error climate in their classrooms in a planned way. The present study fulfills this requirement. The aim of the study is to examine teachers' views on the applicability of a positive error climate in classrooms. In this context, the question "What are teachers' views on the applicability of a positive error climate in the classroom?" guided the research.

Method

The case study method, one of the qualitative approaches, was used in this research. In research conducted with a qualitative approach, the situation or phenomenon investigated is analysed from the perspective of the participants constituting the study group (Ekiz, 2009; Metin, 2014). Specifically, with the case study method, the data obtained from the study group is described in depth, and the situation is divided into themes and presented effectively (Creswell, 2015). In this study, a case study was used because the positive error climate programme was examined in detail before and after the programme. Since the effects of the positive error climate programme on teachers and students were tried to be revealed comprehensively and longitudinally, a "Case Study Based on the Effects of the Programme", one of the six case study types proposed by Datta (1990), was adopted in the current study (Gökçek, 2009).

Participants

The study's participants were 19 secondary school mathematics teachers. When the literature is examined, it is emphasised that teachers should have at least three years of experience to provide effective teaching (e.g., Erdik, 2014; Star & Strickland, 2008). Since this research involved the implementation of a positive error climate in the classroom, it was accepted as a criterion with the common opinion of the researchers that teachers should have at least three years of experience. All teachers selected by criterion sampling had five years or more of professional experience and worked in different provinces of Turkey. These teachers, who were continuing their master's degrees, stated that they had not encountered a concept related to positive error climate before and that they had no idea about the positive error climate framework programme. Therefore, it can be said that the teachers participating in this study can evaluate the training given in the positive error climate programme without prejudice. Due to the

ethics of this research, the participant teachers were coded as A1, A2, A3, ..., A19. Ethics committee approval was obtained from the relevant institution for the present study.

Data Collection Processes

Since the teachers in the study group worked in different cities, the research courses were conducted online. The application lasted 11 weeks. Before starting the study, preliminary interviews were held with the teachers and their attitudes towards errors and their opinions about the use of errors in the classroom were recorded in writing.

During the first two weeks of the process, the field expert explained to the teachers what a positive error climate is, how to create one in the classroom, how to use errors as teaching opportunities, and how the process will proceed. Then, the teachers were divided into five groups consisting of at least three and at most eight people, depending on the grade levels they teach. Teachers were asked to teach their lessons according to the positive error climate framework program at the grade level they selected as a group (Özkaya et al., 2022).

Teachers, together with their groups, created lesson plans for the positive error climate they would create in their classrooms for seven weeks. These plans were presented in a two-hour online classroom and discussed by researchers and other participants. At the end of the discussions, the revised plans were implemented in the classes selected by the groups, and the teachers shared their experiences, plans, and thoughts about the error climate they created in their classes in the online lesson every week. The positive error climate framework program is given in the appendices (A1). An overview of the positive error climate program is presented in Table 1.

Table 1. Overview of the positive error climate programme

Stages of the Programme	Content
Explanation	Introduction of a positive error climate How to create a positive error climate in classrooms? Positive error climate process Presentation of a positive error climate framework
Preliminary preparation	Determination of common student errors over the subjects taught in the class levels entered in the lesson Teachers' observation of the error climate in their own classrooms
Preparation of a lesson plan	Analysing the sources and collecting data to prepare the lesson plan for the identified errors

	Using the positive error climate framework in the classroom, taking into account the students'/teacher's approach to errors and the approach to errors in the teaching context Preparation of the lesson plan in line with the stated objectives
Finalising the lesson plans	Presenting and discussing the prepared lesson plans with other participant teachers and researchers Revising lesson plans in accordance with the feedback provided
Course teaching	Implementation of the plan Taking observational notes on the positive error climate
Summarised	Sharing ideas for a positive error climate Discussion of the effect of errors on student learning Presenting the problems in the process and offering suggestions

Data Collection and Analysis

The data of this study were obtained after the interviews with the teachers before and after the positive error climate programme. In the pre-interview questions, teachers' views on errors, whether they used them in the classroom, their reactions, feedback and help in the face of errors were asked. In the post-interview questions, teachers' positive error climate experiences, whether they would use it in the next process, and positive and negative aspects of positive error climate were asked. Interview questions are given in the appendix (A2). Mathematics teachers' views on implementing a positive error climate in the classroom before and after the positive error climate programme were subjected to content analysis. Creswell (2015) determined the stages of the data analysis process obtained as a result of the case study as follows: i) data organisation, ii) reading, taking short notes, iii) describing the data in codes and themes, iv) classifying the data in codes and themes, v) interpreting the data, vi) presenting and visualising the data. In the current study, the data were analysed by following these six stages. The MAXQDA qualitative data analysis programme was used to analyse the data. Firstly, the data obtained was converted into written form and made suitable for the analysis process.

Reliability and Validity

In this study, in which a qualitative approach was adopted, an 11-week-long positive error climate programme was conducted with mathematics teachers. There was a long-term interaction with the teachers during the research process. The data were collected in depth and analysed by two expert researchers in the current study. Throughout the implementation, the researchers guided the participants about the implementation of the positive error climate, the preparation of lesson plans and the process. The views of the participant teachers were presented in detail and the analyses were deepened by

including direct quotations. In addition, while determining the sample of this study, it was noted that the teachers had at least three years of experience. Accordingly, the study group was selected by purposive sampling. Apart from the validity measures mentioned for the current research, Yıldırım and Şimşek (2016) mention consistency examination for reliability. In this direction, the coding of the data was performed independently by the researchers. Afterwards, the coded data were compared, and the codes with disagreement and consensus were determined. Accordingly, the reliability coefficient was found to be 90%. According to Miles and Huberman (2016), the reliability coefficient should be around 90%. In this case, consistency was achieved.

Findings

While the findings were being prepared, a pre-interview was conducted to learn the participants' views on errors and their reactions, attitudes and behaviours in the face of errors. The participants' responses to the pre-interview questions were content analysed with the MAXQDA. At the end of the pre-interview, the themes of view of error and attitude toward error were formed. The codes, frequency of repetition (f) and some selected expressions from the participant responses under the theme of view of error are given in Table 2.

Table 2. The theme of the view of error

Theme	Code	F	Participant statements
View of the error	Part of the process	18	*Error is not only part of the lesson, but also part of life The aim is to recognise that mistake and not repeat the same error. (A5, 12)*
	Increases awareness	7	*Sometimes I make mistakes on purpose; I wait for a few seconds and when some students realise my mistake and tell me, I say well done, I am waiting for you to find my mistake and all the attention is focused on the mistake. (A4, 16)*
	Provides experience	5	*Making mistakes during the lesson creates an experience for the students. (A15, 16)*
	Assessment purposes	3	*In this way, I decide how much the subject has been learnt and whether it is necessary to repeat the subject or not. (A14, 16)*
	Unsuitable for classroom use	3	*It is not right to use it all the time. Because it causes confusion for the students who know the correct answer clearly. (A6, 16)*

As shown in Table 2, most of the participants stated that errors are a part of the process under *the view of error*. Participant A5 stated that *error is not only a part of the lesson but also a part of life. The aim is to recognise that mistake and not repeat the same error*. In addition, participants stated that errors help gain awareness, help gain experience and can be used for evaluation purposes. Some participants stated that errors could not be used in the lesson. Participant A6 stated that *it is not right to use it all the time. Because it causes confusion for the students who know the correct answer clearly*. As a result of the pre-interview, the categories, codes, frequency of repetition (f) and some selected expressions from the participant responses under the theme of attitude toward error are given in Table 3 below.

Table 3. The theme of attitude toward error

Categories	Code	F	Participant statements
Teacher support for errors	Making realise	5	*When helping the student who makes a mistake, I ask some questions to help him/her realise his/her mistake himself/herself. Are you sure? Is this your last decision? (A16, 16)*
	Peer tutoring	2	*I also use peer tutoring. (A15, 18)*
	Re-explain	8	*I repeat the subject, taking into account the child's cognitive characteristics. (A12, 20)*
	Give tips	9	*I help him/her find the truth by providing various clues. (A15, 18)*
	Say, "Look again".	6	*Firstly, I ask the student to read the question again. I ensure that the question is well understood. (A14, 18)*
	Solve similar questions	6	*I make him solve examples. I give examples for reinforcement. (A14, 20)*
	Say wrong	6	*I point out where he/she made a mistake (A9, 18).*
Feedback on errors	Correcting the error	2	*I correct my students' mistakes, but I do it without making them feel bad. (A1, 14)*
	Say Re-read	9	*Look again, I say. Will he notice? (A2, 14)*
	Making realise	10	*I do not intervene immediately with students who make mistakes. I even postpone telling them so that they realise it themselves. (A2, 12)*
	Say explain	3	*I ask why you think so. (A13, 14)*
	Give clue	4	*I ask short questions to find the truth. (A10, 18)*
Reactions to errors	Tolerant	9	*I am tolerant. Because if the student is afraid of the teacher, he/she does not make any promises that he/she will make a mistake. (A16, 10)*

	Constructive	2	*I am constructive for students who endeavour to understand the lesson. (A18, 10)*
	Patient	3	*I am patient with students who make mistakes, and I try to guide them down the right path with simple corrections. (A12, 10)*
	Angry	2	*I can sometimes get angry when very simple mistakes are made (A13, 10).*
	According to the question	2	*My reaction to errors in easy questions can be too much (A5, 10).*

When Table 3 was analysed, the theme of attitude toward mistakes was divided into three categories: teacher support for errors, feedback on errors and reactions to errors. When the codes of teacher support and feedback in the face of mistakes were analysed, it was understood from the teacher statements that teachers provided feedback and support by enabling students to notice their errors. Participant A16 stated, *while helping a student who makes a mistake; I ask some questions to make him/her realise his/her mistake himself/herself. Are you sure? Is it your last decision, and I do not immediately intervene with the student who makes a mistake? I even postpone what they say so that they realise it themselves*. Again, participant A15, who was directed to the truth by giving clues in the face of mistakes, stated his opinion with the expression, *I help him find the truth by giving various clues*. A2, one of the teachers who suggested rereading the question and looking at it again in the face of the student's mistake, said, *Look again. Let's see if he/she will notice*. It was seen that the teachers showed the behaviours of re-explaining the subject and solving sample questions to support the errors. When the category of reactions to errors was analysed, it was seen that participant teachers generally had positive attitudes, such as being tolerant, constructive and patient. Very few of the teachers stated that they showed anger.

At the end of the application, the opinions of the participant teachers were divided into four categories under the theme of positive error climate: positive error climate experience, its use in the subsequent process, positive aspects and negative aspects, and codes were obtained under each category. The views on positive error climate were divided into 'positive aspects' and 'negative aspects' categories. The code distributions of these categories are given in detail in Figure 1 below, together with their frequencies.

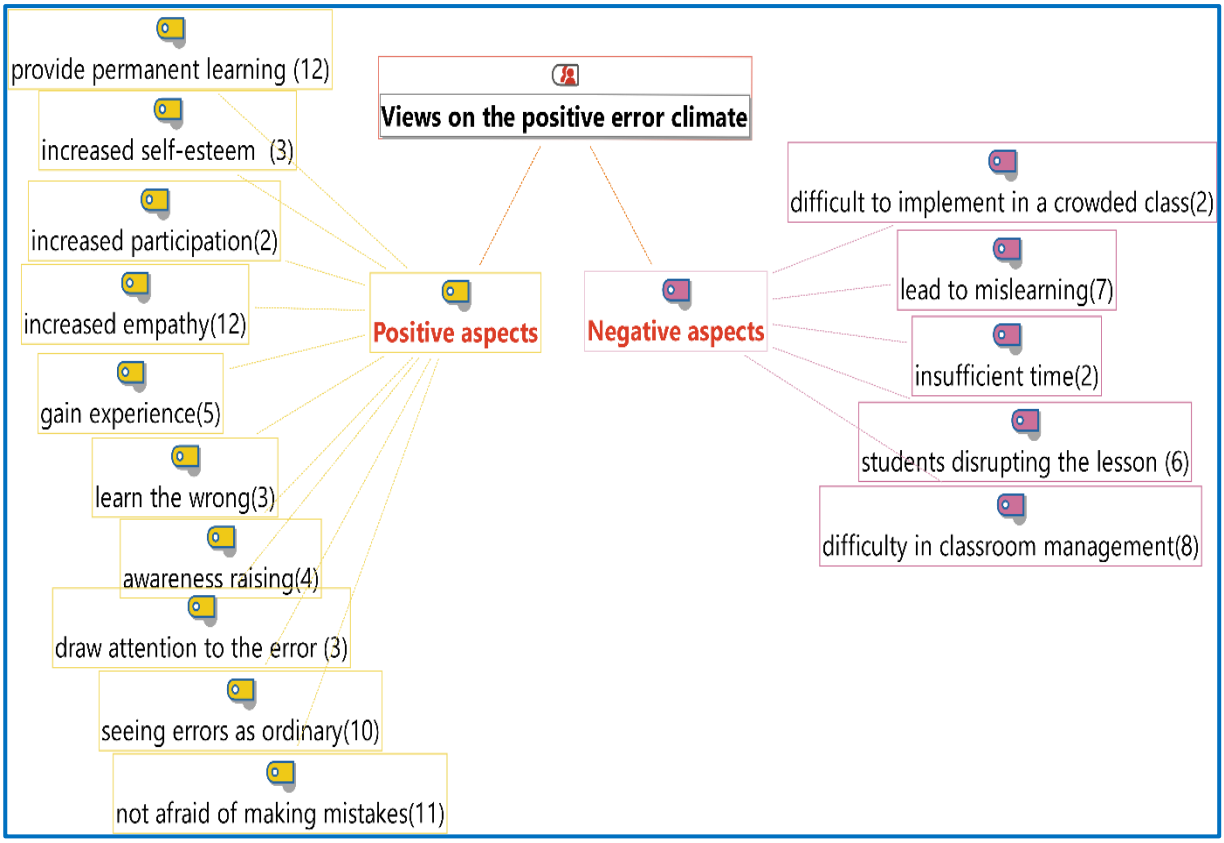

Figure 1. Views on a positive error climate

When Figure 1 was analysed, participants stated positive and negative aspects of a positive error climate in the process. Accordingly, the codes created for the positive aspects were as follows: provide permanent learning, increased self-esteem, increased participation, increased empathy, gain experience, learn the wrong, raise awareness, draw attention to the error, see errors as ordinary, and not be afraid of making mistakes.

Likewise, when the negative aspects were analysed, the codes were as follows: insufficient time; students disrupting the lesson; difficulty in classroom management, leading to mislearning; difficulty implementing in a crowded class. The participants' views about their experiences in the process were collected under the category of 'Positive error climate experience' and the coding and code frequencies of the participant statements are given in Figure 2 below.

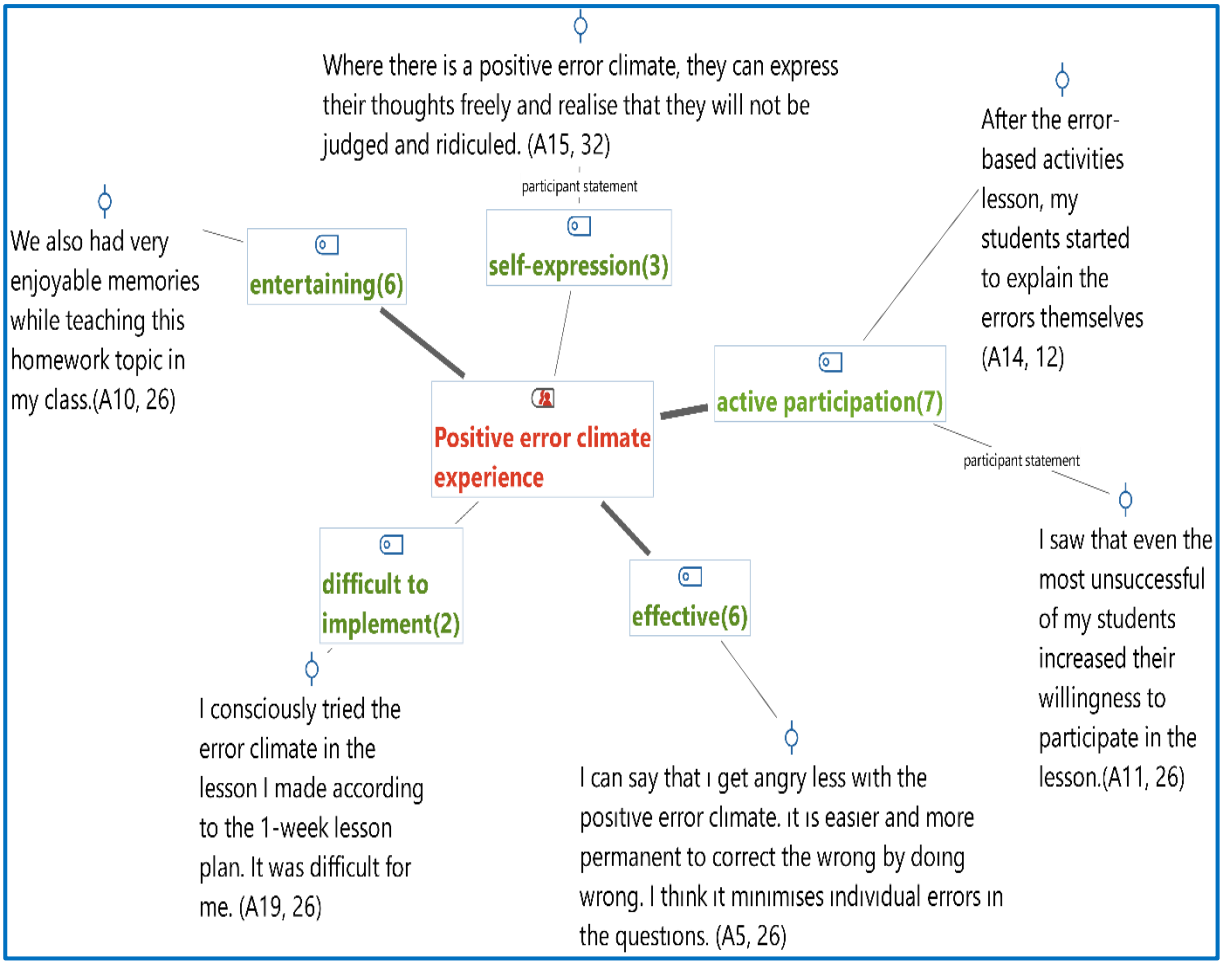

Figure 2. Positive error climate experience

As shown in Figure 2, as a result of the content analysis conducted according to the data obtained from the interview questions of the participants, the codes of entertaining, difficult to implement, active participation, effective and self-expression were obtained. Participant A5 found the positive error climate experience effective and said, *I can say that I get less angry with the positive error climate. It is easier and more permanent to correct wrong by doing wrong. I think it minimised individual errors in the questions*. Participant A10 found the experience entertaining and said, *We also had very pleasant memories while teaching this homework topic in my class*. Participant A19 evaluated the positive error climate experience as difficult and said, *I consciously tried the error climate in the lesson I made according to the 1-week lesson plan. It was difficult for me*. Participant teachers expressed their opinions about using a positive error climate in the following process under the codes of "I think" and "I do not think". The thoughts of the participants about whether or not to use the positive error climate in their classrooms after the process are given in Figure 3, together with the codes, number of repetitions (f) and participant expressions.

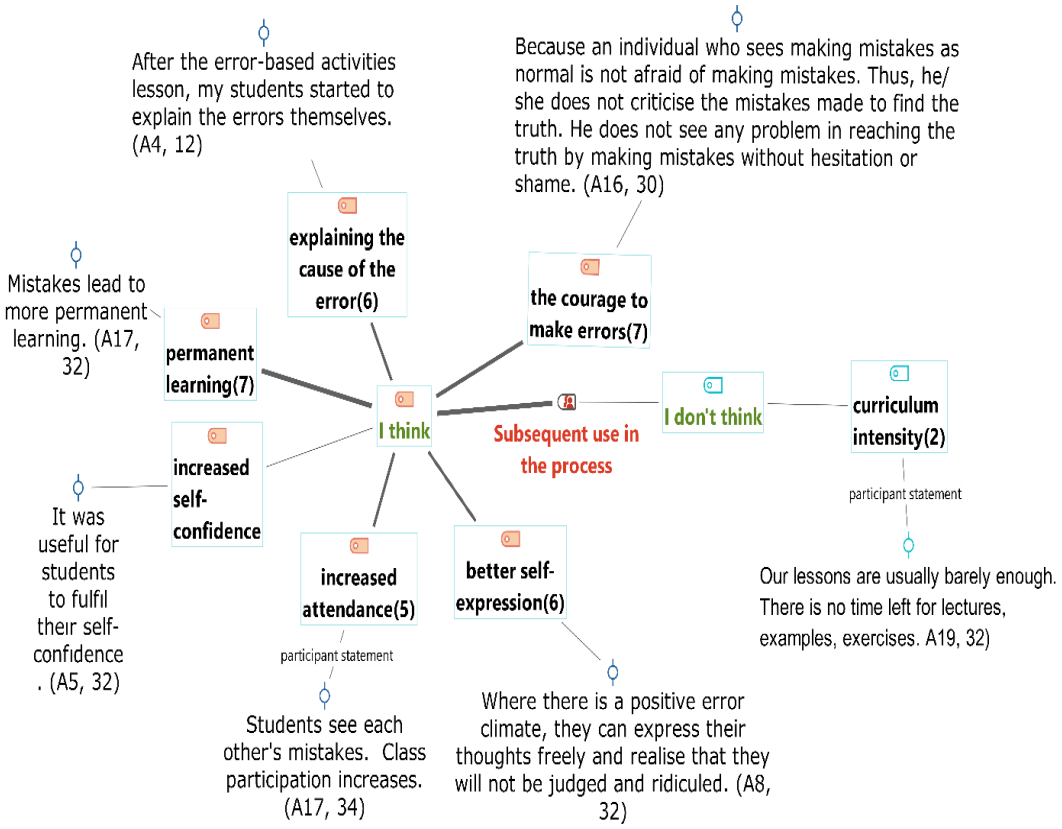

Figure 3. Use of a positive error climate in the subsequent process

At the end of the process, the codes formed under the categories of "I think" and "I do not think" from the statements of the participants about whether they would use the positive error climate in their lessons in the following process are given in Figure 3. When Figure 3 was analyzed, sub-codes were formed from the statements of those who indicated they would use a positive error climate. These sub-codes include: Permanent learning, increased self-confidence, increased attendance, better self-expression, explaining the cause of the error, and the courage to make errors. When the category of I don't think was analysed, it was seen that the code of curriculum intensity was formed. Some of the participants' expressions who thought to use the positive error climate in their lessons in the following process are as follows: Participant A4 *developed reasoning ability by comparing the answer to the wrong question with the correct answer*; Participant A5 found *it useful for students to fulfil their self-confidence*; Participant A17 *students see each other's mistakes and participation in the lesson increases*; Participant A8 *Students can express their thoughts freely where there is a positive error climate, they realise that they will not be judged and ridiculed*. The statement of participant A19, one of the participants who did not think of using the positive error climate in the following process, was as follows: *Our lessons are usually barely enough. There is no time left for lectures, examples, or exercises*. While 17 of the participants said they thought of using

the positive error climate in the next process, two said they did not because of the intensity of the curriculum.

Discussion and Conclusion

The results of this study not only confirmed the findings of the studies on positive error climate in the classroom in the literature, but also took the discussions one step further. This study examined teachers' experiences of classroom practice during the 11-week positive error climate programme designed in this study and demonstrated the impact of positive error climate from teachers' perspectives. Therefore, this study provided a more in-depth look at the positive error climate in the learning process with more teachers.

According to the data of the study, it was determined that the teachers included errors in the lesson process and had a positive attitude towards errors before the positive error climate programme. As a result of the analysis of the interview data conducted with the teachers after the positive error climate programme, teachers experienced that students were better engaged in the lesson. Furthermore, the fact that the teachers wanted to use this practice afterward demonstrates that they believe it should be sustainable. The teachers stated that the use of errors in the classroom caused the students to view errors as a part of learning and to develop a positive attitude towards errors. In addition, it was determined from their views that they were concerned that the positive error climate in the classroom could cause mislearning and make the classroom management process difficult.

According to teachers' attitudes towards errors, although the participant teachers accept the role of errors in teaching and see them as a part of the teaching process, they aim at preventing errors rather than using them. Steuer et al. (2013), who stated that there are eight sub-dimensions of the error climate, stated that one of the dimensions related to the teacher's error orientation is the teacher's help and support after errors. This dimension includes the teacher's patience, explanations and help against errors in the classroom (Oser & Spychiger, 2005). When the category of teacher help in the face of errors is analysed in this study, it is seen that the teachers mostly used these types of help, such as giving hints, telling the students to look again and making them realise their mistakes. Türkdoğan and Baki (2012) stated that the most frequently used feedback techniques in teacher interventions in the classroom are ignoring the mistake or accepting it as correct, telling the answer, saying it is wrong, and feedback techniques. Teachers who think that making mistakes disrupts teaching in the classroom often intervene directly in mistakes (Heinze, 2005; Santagata, 2005).

The fact that a considerable number of teachers in this study preferred to tell the student the error directly is similar to the results of Heinze's (2005) and Santagata's (2005) studies.

In addition to the precautions they offered to prevent errors before implementation, teachers also expressed their emotional reactions to errors. Steuer et al. (2013) mention that teachers have verbal and non-verbal reactions to errors. Errors are inevitable and

natural during teaching. However, students perceive making mistakes as embarrassing, threatening, avoidable and damaging to their self-confidence, and the teacher's reaction to the mistake determines the student's reaction (see Heinze & Reiss, 2007; Rach et al., 2013; Rybowiak et al., 1999; Steuer et al., 2013; Tulis et al., 2016). The teacher's positive attitude toward student errors in the classroom will increase students' motivation and interest in the lesson (Özkaya et al., 2022). Similarly, when the responses of the participants in the category of reactions to errors were analysed, the findings showed that they were tolerant, constructive and patient in the face of student errors. The participants who stated that their reactions would change according to the difficulty of the problem and that they could get angry were a small number in the study group.

When the positive error climate experiences of the participant teachers are analysed, they express the positive error climate as effective, efficient, helpful for self-expression and fun. It has been observed that the same attitude develops in students in studies where teachers are moderate toward errors and see them as learning opportunities and tools (Bray, 2011; Heinze & Reiss, 2007; Tulis, 2013).

Participant teachers mentioned that the most cognitively positive aspects of the process were that students achieved permanent learning and that they could see errors as a part of learning. Sancar (2023), who experimentally investigated the existence of retention after the process of learning from errors, revealed that permanent learning is more common in classroom environments where errors are accepted as normal. In addition, Tulis (2013) emphasised the importance of students being aware that they can see errors as a part of learning. Students should know what they should do as well as what they should not do, which is important in learning.

Studies aiming to use errors effectively in teaching show that the error climate provides positive results for students regarding affective and motivational sense (Heinze&Reiss, 2007; Tulis, 2013). When evaluated in the affective and motivational context, the teachers in this study stated that in the classes where a positive error climate was applied, students were not afraid of making mistakes, expressed themselves better and experienced an increase in their self-confidence. Research on the perceived error climate in the classroom has observed that students are more courageous about making mistakes in a positive error climate (Bray, 2011; Rach et al., 2013; Steuer et al., 2013; Tulis et al., 2016). If the perceived error climate in the classroom is positive, students take the risk of making errors without fear or embarrassment (Heinze & Reiss, 2007; Rach et al., 2013; Steuer et al., 2013; Tulis et al., 2016).

As negative aspects of the process, the participants feared lack of time, difficulty in classroom management, difficulty of implementation in crowded classes, disruption of the lesson flow by some students, and the fear that it may cause mislearning. Likewise, when the answers given by the participants under the themes of view toward errors and attitude toward errors are analysed, it is seen that they mostly see errors as a part of the lesson and that they can be used as a teaching tool. Previous studies have shown that even if teachers have positive beliefs about using errors, they hesitate to use errors in

teaching (Palkki&Hastö, 2018). One of the main hesitations is the concern that the mistakes made will become more common, which was also revealed in the current study. Despite this, studies focusing on learning from mistakes yield positive results (See, Heinze& Reiss, 2007, Rach et al., 2013; Özkaya et al., 2022; Özkaya&Konyalıoğlu, 2019). While research on using errors in the classroom shows the positive aspects of these practices, it shows that the error culture is not sufficiently utilised and teachers do not know how to benefit from errors (Özkaya & Konyalıoğlu, 2019; Santagata, 2005). If it is desired to benefit from errors in teaching, a planned and careful process should be carried out instead of random use (Akpınar & Akdoğan, 2010; Bray, 2011; Özkaya et al., 2022). In this respect, this study will serve as a guide for creating and maintaining a positive error climate in teacher professional development.

Recommendations

In the current study, not observing teachers in the classroom is one of the limitations of the research. In future studies, a model in which the teacher is observed in the classroom can be applied. The current study was conducted with mathematics teachers. Observing the positive error climate effects in different courses can be the subject of future research.

Appendix

A1. Positive Error Climate Framework Program

1. *The teacher expresses her/his tolerance towards mistakes verbally and in behavior.*

The feedback that can be given is as follows:

Verbal feedback

- Answer even if you think you are wrong.
- Errors are ways that are not right, the more wrong ways we eliminate, the better.
- All mistakes are ways that will bring us closer to the truth.
- You are a student, of course you will make mistakes to find the truth, do not hesitate.
- Do not think that I will be angry with you if you make a mistake.
- You are all classmates, let's try to learn a lesson instead of laughing or getting angry at the wrong answers.

Behavioral feedback

- S/he encourages students with low attendance and who are behind the class academically to get up and respond to the lesson.
- S/he encourages the student, who is hesitant and does not want to get up, to participate in the lesson and encourages them to respond.
- S/he asks students to answer even if they are wrong.
- S/he asks the students who make mistakes why they think that way without getting angry.
- Be tolerant towards student mistakes.

2. *The teacher is tolerant of the student who makes an error or gives an incorrect answer, thanks him/her for the error s/he finds and turns students' attention to that error.*

The feedback that can be given is as follows:

- Why did you think like that?
- Shall we think together?
- Your friend has mentioned a very good mistake, let's be careful about it.
- Thanks for your friend's reply.
- Well done, you have caught a very important point -to class- do you think your friend's answer is correct?
- If it's wrong, let's think about why it's wrong.
- You gave a very good answer. Thank you.

3. *Instead of giving the answer directly, the teacher gives clues to the students. Discusses the given answers in class. Draws students' attention to the given answer.*

The feedback on this issue is as follows.

- S/he does not directly say that the mistake made is wrong. Or s/he does not give the correct answer directly to the student.
- S/he asks questions that will help the student find the right answer.
- S/he draws the attention of the students in the class to the mistake made.
- S/he involves the entire class in the process.
- S/he explains the importance of the mistake made by the student.
- S/he provides corrective feedback to the student.
- S/he discusses the student's mistake in class.
- S/he allows students who gave incorrect answers to express the correct answer in their own words.

4. The teacher encourages the student, who is shy and does not want to attend the lesson. S/he enables them to participate in the lesson and encoureges them to respond.

The feedback that can be given is as follows:

- It does not directly say that the answer given is wrong.
- Asks the students why they gave such an answer.
- Asks the class for the student's answer.
- Makes the students think about their errors.
- S/he thanks the student for the point s/he caught.

5. After the teacher decides that s/he has solved enough examples at the end of the subject, he gives an incorrect statement about the subject or makes an incorrect solution and waits for the students to catch the mistake. Ask students to express both the incorrect statement/solution and the correct statement/solution in their own sentences.

The feedback that can be given is as follows:

- Let's examine the given statement/solution/question.
- Do you think it is true?
- If it's wrong, why is it wrong.
- If true, why is it true?

6. At the end of the subject, the teacher exams the students, the exam is not for scoring. Puts an erroneous example in the exam. At the end of the exam, he/she solves the questions in detail in the class.

A2. Classroom Error Climate Teacher Questionnaire Interview Questions

Dear Colleagues

This questionnaire was developed to understand teacher and student perceptions of student mistakes and errors made in subjects or questions in lessons. The data to be obtained from this study will be used only for scientific purposes. Therefore, it is very important for us that you answer the questions sincerely and accurately in order for the measurement results to be healthy. Thanks for your interest and help.

1. How do you react to student errors in the lesson?

2. Do you see errors as a part of the lesson? Can you explain briefly?

3. What is the first feedback you give when a student makes a mistake? Why do you prefer this feedback method?

4. Do you use mistakes as a teaching tool in the classroom? Do you think it is right to use mistakes as a learning tool? Why is that?

5. How do you help a student who makes a mistake?

6. Can you share your positive error climate experiences?

7. What do you think are the positive aspects of a positive error climate?

8. What do you think are the negative aspects of a positive error climate?

9. Would you consider making use of the positive error climate in your future lessons? Could you share your answer along with the reason?

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Genişletilmiş Türkçe Özet

Hata yapmak öğretim sürecinin doğal bir unsuru olmasına rağmen sınıf ortamlarında genellikle olumsuz ve utanç verici bir durum olarak algılanmaktadır (Heinze & Reiss, 2007). Bu algılar çoğu zaman öğretmenlerin ve öğrencilerin hataları öğrenme fırsatı olarak görmelerine engel olur (Özkaya & Konyalıoğlu, 2019; Palkki & Hastö, 2018). Araştırmalar hata yapmanın öğrenmeyi olumlu etkilediğini ve öğrenme sürecini geliştirdiğini göstermektedir (Borasi, 1989; Rach vd., 2013; Tulis, 2013). Sınıf içinde hataların öğrenme sürecinin ayrılmaz unsurları olarak kullanıldığı ve değerlendirildiği sınıf iklimlerinde, olumlu hata iklimi görülür (Steuer vd., 2013; Tulis, 2013). Olumlu hata ikliminin, öğrenci ve öğretmenler üzerinde duyuşsal ve bilişsel bir çok olumlu etkisi görülmüştür (Alvidrez, 2019; Heinze & Reiss, 2007; Ingram, 2015; Özkaya vd., 2022; Steuer vd., 2013; Tulis vd., 2018). Sınıfta hata kullanımına ilişkin araştırmalar, bu uygulamaların olumlu yönlerini ortaya koyarken, hata kültüründen yeterince yararlanılmadığını ve öğretmenlerin hatalardan nasıl yararlanacaklarını bilmediklerini görülmektedir (Özkaya ve Konyalıoğlu, 2019; Santagata, 2005).

Hata temelli öğretim çalışmaları incelendiğinde video kayıt çalışmalarının ağırlıkta olduğu görülmektedir (Matteucci vd., 2015; Santagata, 2005; Son, 2013; Tulis, 2013). Bu çalışmalar mevcut durumu betimlemekte ve tespit edilen sorunlara çözüm önerileri sunmaktadır. Çalışmaların öğretmen boyutuna bakıldığında, öğretmenlerin genel olarak hataların öğretimsel potansiyelini kabul etmekle birlikte, sınıf ortamında kullanımına ilişkin endişeleri olduğu görülmüştür (Palkki ve Hastö, 2018). Çalışmalarda, sınıflarda olumlu bir hata iklimi oluşturan öğretmenlerin bunu bazen bilinçli bazen de bilinçsiz olarak yaptıkları görülmektedir (Abay ve Clores, 2022; Alvidrez, 2019; Matteucci vd., 2015). Bu çalışmalarda, sınıflarda tam anlamıyla olumlu bir hata iklimi oluşturulmasına yardımcı olacak bir planın ortaya konulamadığı söylenebilir. Öğretimde hatalardan yararlanılmak isteniyorsa hataları rastgele kullanım yerine planlı ve dikkatli bir süreç yürütülmelidir (Akpınar ve Akdoğan, 2010; Bray, 2011; Özkaya vd., 2022). Sınıflarda olumlu hata iklimini oluşturacak olanlar öğretmenlerdir. Onların hatalara karşı tutumu, öğrencinin hatalara karşı tutumunu yönlendirir. Bu bakımdan öğretmenlerin hata iklimi konusunda bilinçlendirilmesi ve hata iklimini sınıflarında planlı bir şekilde nasıl uygulayacaklarını öğrenmeleri gerekmektedir. Bu çalışma bu ihtiyaca hizmet etmektedir.

Araştırmanın amacı öğretmenlerin olumlu hata iklimi ile ilgili deneyimleri ve görüşlerini incelemektir. Bu bağlamda "Olumlu hata ikliminin sınıfta uygulanabilirliğine ilişkin öğretmen görüşleri nelerdir?" sorusu araştırmaya yön vermiştir. Araştırma nitel durum çalışmasıdır ve 19 matematik öğretmeniyle toplam 11 hafta süren bir çalışma neticesinde ortaya çıkmıştır. Bu öğretmenler ölçüt örneklem yöntemiyle seçilmiş, beş yılın üzerinde hizmet süreleri bulunan ve yüksek lisans dersi alan öğretmenlerdir. Öğretmenlerle yapılan çalışmanın ilk iki haftası olumlu hata iklimini tanıtmak olmuştur. Öğretmenler olumlu hata ikliminin ne olduğunu, derslere nasıl uygulanacağını, hatalara nasıl dönüt vereceklerini, olumlu hata iklimi çerçeve programının ne olduğunu bu iki haftalık süreçte alan uzmanı bir araştırmacıdan öğrenmişlerdir. Daha sonra

kendilerinden okuttukları sınıf seviyelerine göre grup oluşturmaları istenmiştir. Her grup olumlu hata iklimi çerçeve programını temel alarak ders planları oluşturmuşlardır. Bu ders planları sınıf ortamında araştırmacılar ve diğer katılımcı öğretmenler tarafından tartışılmıştır. Revize edilen planlar yedi hafta boyunca öğretmenlerin derslerini yürüttükleri sınıflarda uygulanmıştır. Uygulama neticesinde öğretmenlerden olumlu hata iklimiyle ilgili deneyimleri görüşmeler yoluyla elde edilmiştir. Veriler MAXQDA nitel analiz programıyla analiz edilmiştir. Katılımcı öğretmenler, sürecin bilişsel açıdan en olumlu yönlerinin öğrencilerin kalıcı öğrenmeyi gerçekleştirmeleri ve hataları öğrenmenin bir parçası olarak görebilmeleri olduğunu belirtmişlerdir. Hatalardan öğrenme süreci sonrasında kalıcılığın varlığını deneysel olarak araştıran Sancar (2023), hataların normal kabul edildiği sınıf ortamlarında kalıcı öğrenmenin daha yaygın olduğunu ortaya koymuştur. Buna ek olarak Tulis (2013), öğrencilerin hataları öğrenmenin bir parçası olarak görebilmeleri için bunun farkında olmalarının önemini vurgulamıştır. Öğrenciler ne yapmaları gerektiği kadar ne yapmamaları gerektiğini de bilmelidirler ki bu da öğrenmede önemlidir.

Bu çalışmanın sonuçları, literatürde sınıfta olumlu hata iklimi üzerine yapılan çalışmaların bulgularını doğrulamakla kalmamış, aynı zamanda tartışmaları bir adım öteye taşımıştır. Bu çalışmada tasarlanan 11 haftalık olumlu hata iklimi programı sırasında öğretmenlerin sınıf içi uygulama deneyimleri incelenmiş ve olumlu hata ikliminin etkisi öğretmenlerin bakış açısından ortaya konmuştur. Dolayısıyla bu çalışma, öğrenme sürecindeki olumlu hata iklimine daha fazla öğretmenle daha derinlemesine bakılmasını sağlamıştır.

Çalışmanın verilerine göre, öğretmenlerin araştırma öncesinde hataları ders sürecine dahil ettikleri ve hatalara karşı olumlu bir tutum içinde oldukları belirlenmiştir. Olumlu hata iklimi programı sonrasında ise öğretmenlerle yapılan görüşme verilerinin analizi sonucunda, öğretmenlerin öğrencilerin derse daha iyi katıldıklarını deneyimledikleri görülmüştür. Ayrıca öğretmenlerin bu uygulamayı daha sonra da kullanmak istemeleri, bu uygulamanın sürdürülebilir olması gerektiğine inandıklarını göstermektedir. Öğretmenler, sınıfta hataların kullanılmasının öğrencilerin hataları öğrenmenin bir parçası olarak görmelerine ve hatalara karşı olumlu bir tutum geliştirmelerine neden olduğunu belirtmişlerdir.

Öğretmenler süreci eğlenceli, etkili, kalıcı öğrenmeye yardımcı bir süreç olarak değerlendirmişlerdir. Buna karşın sürecin olumsuz yönlerini ise sürenin yetersiz olması, sınıf yönetiminin zor olması ve yanlış öğrenmeye neden olması olarak belirtmişlerdir. Görüşmeler sonunda 19 öğretmenden 17 tanesi olumlu hata iklimini sonraki süreçte derslerinde kullanmak istediklerini belirtmiştir. Matematik öğretmenleriyle yapılan bu araştırma planlı bir olumlu hata ikliminin etkililiğini ortaya çıkarmıştır. Diğer derslerde de benzer uygulamalar gelecekteki araştırmaların konusu olabilir.

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