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Research

Developing Students' Positive Affective Entry Characteristics towards Mathematics: An Action Research Study

Muhittin Çalışkan[1] **Hüseyin Serçe**[2] **Hatice Uysal**[3] **Tianlan Wei**[4]

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Abstract:

Past research has indicated the vital role of affective factors in mathematics learning. This action research study aimed to develop and evaluate the effectiveness of an action plan, which was implemented to foster students' positive affective entry characteristics towards mathematics specifically by fixing the deficiencies in prior learning and promoting the allocation of time to study. Thirteen students attending a secondary school participated in the study over a 12-week period. We collected both quantitative and qualitative data through the Affective Entry Characteristics Scale for Mathematics, the Attitude Observation Form towards Mathematics, the research diary, and indirect observation of use traces on student assignments. First of all, the analysis of these data sources confirmed that there was a substantial improvement in the students' affective entry characteristics, indicating the effectiveness of our implementation. On the other hand, the qualitative data analysis of the diary and student assignments revealed that this effect was not long-lasting for students who lived in a disadvantaged family/home environment. In other words, remedying the deficiencies in prior learning and promoting the allocation of time to study alone were not sufficient for these students. As a result, we came to the conclusion in the study that non-modifiable variables (such as family home environment) are as important as or even more important than modifiable ones in the development of positive affective entry characteristics towards mathematics.

Keywords: Affective entry characteristics towards mathematics, Prior learning, Allocating time to study, Mathematics achievement, Action research

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[1] Prof. Dr., Necmettin Erbakan University, Faculty of Education, Konya, Turkey. mcaliskan@erbakan.edu.tr,
Orcid ID: 0000-0002-2341-0710
[2] Asst. Prof. Dr, Selçuk University, Faculty of Education, Konya, Turkey. hserce@selcuk.edu.tr,
Orcid ID: 0000-0001-7132-2910
[3] Teacher, Turkish Ministry of National Education, Konya, Turkey. h.uysalll@hotmail.com,
Orcid ID: 0000-0003-3935-5899
[4] Assoc. Prof. Dr., Mississippi State University, Educational Psychology Faculty, the U.S.A. ewei@colled.msstate.edu,
Orcid ID: 0000-0002-8270-5287

INTRODUCTION

Mathematics is a fundamental subject that students need to master in order to achieve their academic and professional goals (Chiu & Klassen, 2010). Naturally, it has great importance among school subjects (Li & Li, 2008; Wang, 2006). For this reason, mathematics achievement has always been the focus of research endeavors. Research has shown that both cognitive and affective factors need to be investigated to understand how to improve learning in mathematics (Leder & Forgasz, 2002). Thus, examination of affective as well as cognitive factors has become an important issue (Lebens et al., 2011). For instance, there is a large body of research that indicates how affective factors impact on student achievement in mathematics (Carpenter & Clayton, 2014; Chiu & Klassen, 2010; Cvencek et al., 2015; Edirmanasinghe, 2020; Ehmke et al., 2010; Ganley & Vasilyeva, 2011; Gunderson et al., 2012; Lee & Anderson, 2015; Pantziara & Philippou, 2015; Peters, 2013; Samuelsson, 2021). It is also stressed that affective factors are an important predictor of mathematics achievement (Grootenboer & Hemmings, 2007; Liston & O'Donoghue, 2009; Marsh et al., 2005). Although there is widespread knowledge about the relationship between affective factors and learning mathematics, more research is needed on how to develop these factors (Samuelsson, 2021). Therefore, as the action research team in this study, we set out to investigate how we could improve students' affective entry characteristics towards mathematics.

Theoretical Framework

Affective characteristics play a major role in students' decisions about how proficient they need to be in mathematics and how they approach mathematical studies (Reyes, 1984). In addition, students with positive affective entry characteristics tend to be more attentive, persistent, and successful in their learning processes (Anderson & Bourke, 2000). Therefore, affective characteristics are an important factor in learning mathematics (Maass & Schlöglmann, 2009), which is reasserted periodically in the literature (Evans & Tsatsaroni, 1996).

One theory that can help promote students' learning mathematics is Bloom's mastery learning (Bloom, 1998). In addition to cognitive prerequisites, affective entry characteristics play an important role in Bloom's model as they influence achievement and speed of learning (Seel, 2012). According to Bloom (1998), affective entry characteristics, which are a combination of student interest, attitude, and academic self-concept towards a course or the learning units of that course, account for 25% of the variation in learning level.

Research reveals that positive affective characteristics are directly associated with better learning outcomes (Çalışkan, 2014; Edirmanasinghe, 2020; Samuelsson, 2021). A learning environment that develops students' affective entry characteristics towards mathematics can be characterized by a) ensuring student achievement first (Ganley &

Lubienski, 2016; Ma & Xu, 2004), to this end b) fixing the deficiencies in prior learning (Bloom, 1998; Hailikari et al., 2008) and c) supporting students to devote time to studying (Kitsantas et al., 2011).

In order to develop positive affective entry characteristics towards mathematics, students firstly need a sense of achievement. Past achievement significantly predicts the future attitude (Ma & Xu, 2004). Mathematics achievement is a consistent predictor of later self-confidence and interest (Ganley & Lubienski, 2016). On the other hand, deficiencies in prior learning must be fixed beforehand to enable student achievement. Studies conducted at different teaching levels and in different subject areas have shown that prior learning has a positive effect on achievement (Thompson & Zamboanga, 2004). Prior learning is also a strong predictor of mathematics achievement (Hailikari et al., 2007, 2008). Ninety-five percent of the studies reported that prior learning had a positive and facilitating effect on learning (Dochy et al., 1999). However, remedying the deficiencies in prior learning alone is not sufficient for achievement. Students must also dedicate time to studying. Achievement necessitates student engagement with the learning unit. (Butler & Winne, 1995). Therefore, the time allocated to study is an important variable that has a positive effect on mathematics achievement (Kitsantas et al., 2011; Özer & Anıl, 2011). Accordingly, students can achieve success in mathematics only when (a) their deficiencies in prior learning are addressed at the beginning of a new learning unit; and (b) they allocate sufficient time to study. The achievement in turn may result in positive affective entry characteristics. Finally, positive affective entry characteristics can motivate the students to devote time to studying in subsequent learning units. This cyclic process may repeat itself in such an order that each variable affects the other positively as students proceed to each new unit of the mathematics course (Çalışkan, 2014).

Purpose of the Study

Quantitative studies have certainly contributed to our understanding of affective entry characteristics in mathematics. Nevertheless, qualitative inquiries should not be neglected in this regard. Qualitative data can provide a richer description of the nature and development of affective entry characteristics in learning mathematics. Therefore, there is a need for interpretative qualitative research to improve our understanding of the process of promoting or developing affective entry characteristics. As a result, as the action research team in this study, we aimed to investigate how we could improve students' affective entry characteristics towards mathematics by specifically fixing the deficiencies in prior learning and promoting the allocation of time to study. Accordingly, we implemented an action plan based on the theoretical explanations above and evaluated its effectiveness.

METHOD

Research Design

We adopted the *technical/scientific/collaborative* mode of action research for the present study. The goal of this mode is to test or evaluate the implementation of an action plan based on a pre-specified theoretical framework. This goal is achieved by the close collaboration between a practitioner and a researcher. Accordingly, the researcher identifies a problem and develops a theoretical plan while the practitioner implements it. Furthermore, the researcher guides the practitioner to facilitate the implementation and deal with the problems that might arise throughout the process (Berg, 2001; Yıldırım & Şimşek, 2016).

Participants and Setting

The research was conducted in a secondary school in a district 40 km away from the city of Konya, Turkey. The district was of a population of 2,000, with a majority of its residents working in agriculture and animal husbandry and considered of low socioeconomic status (SES) in the Turkish context. The school had 25 teachers, 251 students, and 5 classrooms.

A total of 13 fifth-grade students participated in the present study, which lasted 12 weeks. These participants were also the students of the third author, who worked as a mathematics teacher in that secondary school. In Class 5/A, students sat in two-seat benches arranged one behind the other. Classroom interaction among the students appeared to be good. The participants were generally disciplined and well-behaved but easily distracted during the class sessions. Their family environment (e.g., visitors, family chores such as caring for a sibling, helping with housework and farm work) was also known to have distracted students from studying adequately at home. These have also resulted in students' absences from school. No participating student had their own room at home, and most of them did not have a desk to study. Academically, they suffered from deficiencies in basic knowledge and skills in mathematics lessons. Parental expectations of education were also low: some parents had no plan to send their children to high school after secondary school.

Roles of the Authors

The authors assumed different roles in the study, namely the practitioner (the third author) and the researchers (all the other authors). After collaborating with the practitioner, the researchers developed an action plan. The practitioner implemented the plan under the guidance of the researchers. The practitioner also informed the researchers about the problems arising in the process. The researchers made suggestions to the practitioner on how to intervene to solve these problems. The practitioner continued the implementation according to these suggestions. The researchers finally guided the

practitioner on when and how to collect the data, observed the data collection processes, and made an evaluation by analyzing the data.

Data Sources

Four data sources, both quantitative and qualitative, were collected at different stages of the implementation to evaluate the action plan. Thus, the data were of mixed-methods and longitudinal nature to achieve triangulation (Johnson, 2015). These data sources included (a) quantitative data collected via two instruments, the Affective Entry Characteristics Scale for Mathematics (AECSM; Çalışkan & Serçe, 2016), the Attitude Observation Form towards Mathematics (AOFM; Boz & Çalışkan, 2018); and (b) qualitative data collected in the form of practitioner's research diary, and indirect observation. In general, the data collected through these sources at different times gave the opportunity to describe the changes in students' affective entry characteristics. Specifically, the AECSM, which is a valid and reliable Likert-type scale with 20 items, was used to measure students' affective entry characteristics. The AOFM, which is a valid and reliable Likert-type observation form with 11 items, was utilized to support and complement the quantitative data. According to Boz and Çalışkan (2018), in identifying affective characteristics, this form can be a useful tool to support the results obtained from the scale. The diary was employed for determining the students' allocation of time to study and other behaviors as indicators of affective entry characteristics. Hence, the practitioner recorded her observations, feelings, thoughts, and student comments about the process in the diary (Johnson, 2015). Finally, indirect (unobtrusive) observations were conducted through use traces (Shaughnessy et al., 2016) in order to identify whether the students allocated time to do their assignments and put some effort for achievement as a sign of affective entry characteristics.

Data Collection Process

The AECSM was administered twice, at the beginning and end of the implementation. The AOFM was applied for the observation sessions led by the practitioner in the first, sixth and last week over the 12-week span. Each session lasted 3 or 4 class hours. During the observations, the form was not used directly so as not to disturb the natural classroom setting. Therefore, the practitioner often checked the form to remember the observation units in it. The data were also recorded without any interpretation by using the memory-based notes method (Karasar, 2002). Accordingly, the practitioner filled out the form right after each class based on whether the behavior expressed in the observation unit was observed or not. Furthermore, the practitioner initially started observing only one student to keep in mind and master the observation units. In time, after enough practice, the number of students to be observed gradually increased.

The practitioner kept the research diary after the class or at the end of the day. Notes were taken under a separate entry for each student in the diary. At the end of the process,

a diary of 22 pages was obtained. The indirect (unobtrusive) observation, on the other hand, was made by measuring use traces. According to Shaughnessy et al. (2016), use traces involve the physical evidence remaining from the use or nonuse of an item. Therefore, we collected 12 weekly assignments of each student and examined physical evidence on the papers such as the student's operations or eraser marks to identify students' allocation of time to study and effort. For example, if a student did some operations on a question, deleted them but did not mark the correct answer or marked it incorrectly, we considered the student to have made an effort.

Procedures (Action Plan)

The action plan was developed based on the theoretical framework discussed above. Specifically, it may be postulated that prior learning, allocation of study time, achievement, and affective entry characteristics affected one another cyclically and reciprocally. Figure 1 presents a graphic illustration of this cyclic process.

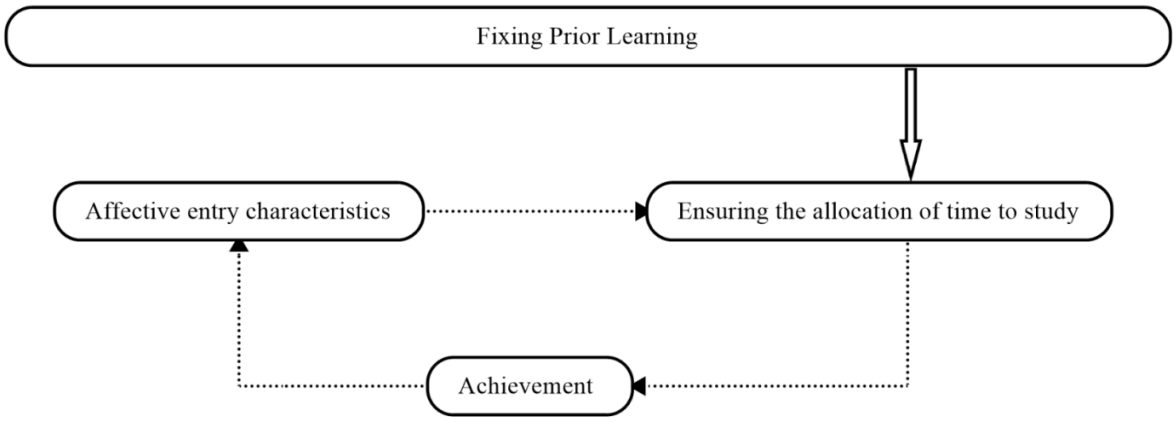

Figure 1. The Cyclic Process of Prior Learning, Allocation of Time to Study, Achievement, and Affective Entry Characteristics

As shown in Figure 1, this action plan gave us the opportunities to plan, act and reflect throughout the implementation. Therefore, we were able to come up with a new solution by thinking deeply during the process. In order to achieve the aim of the study, the implementation focused on fixing the students' deficiencies in prior learning and promoting their allocation of time to study. Accordingly, the following procedures were implemented throughout 12 weeks:

1) This step aimed to fix deficiencies in prior learning before the instruction of a new unit. For example, the first unit was fractions. In this unit, students were expected to learn topics such as simplification, expansion, and equivalent fractions. However, they must have previously mastered multiplication and division to achieve this. Therefore, a cognitive entry behaviors test was prepared and applied by the practitioner. The test included questions assessing multiplication and division skills. It also comprised other questions to examine the prior learning of all the topics in the unit. The test results generally revealed some deficiencies in all of the students' multiplication and division

skills. Thus, these deficiencies were remedied before they started the unit. In cases where there was not enough class time to do it, take-home assignments and tasks were also given. When necessary, one-on-one tutoring was provided for the students after school. After-school tutoring took a longer time in the first two weeks than the following weeks, as students showed positive growth and needed less tutoring. The same process was repeated for each new learning unit throughout the implementation.

2) After the deficiencies in prior learning were fixed and instruction of the new unit started, the second step included the attempts to ensure that the students allocated enough time to study. Therefore, the practitioner tried to motivate the students by explaining the importance of the issue in class. One-on-one interviews were also held when necessary. In addition, the practitioner and each student prepared a particular study plan together. The practitioner also closely monitored to what extent the students stuck to the study plan. Furthermore, a meeting was held to inform the parents about the activities and get their support. Those parents who could not attend the meeting were reached by phone. Moreover, letters were sent to the parents twice during the process. The content of the face-to-face/telephone interviews and the letters covered the following topics: a) arranging a suitable study environment at home, b) duties of parents in having students gain regular study habits, c) suggestions for establishing good communication with their children, d) factors that may prevent students from studying and remedies. In this regard, the issues that inhibited students from studying such as television, family visits, and household chores were particularly dealt with.

3) This step covered student assignments. At the end of each week, the students were given assignments for the topics covered during the week. The purpose of these assignments was to both evaluate the week and collect data for the indirect observation. There were also some other assignments, which were given to remedy the deficiencies in prior learning and lesson review.

Data Analysis

Descriptive statistics of the scores obtained from the pretest and posttest of the AECSM were calculated, and the mean scores of the two tests were analyzed with the paired samples t-test. Frequency analysis was done for the data obtained from the AOFM. Thus, the number of students who demonstrated the behavior expressed in the observation unit in each observation was calculated. Inductive analysis (Johnson, 2015) was used to analyze the data obtained from the research diary. Accordingly, the entries in the research diary were examined, and recurring items and themes were searched. Similar expressions were coded and moved into categories. Frequency analysis was performed for the data obtained from the indirect observation of student assignments. Therefore, the number of students “doing assignments”, “not doing assignments”, “making an effort” and “not making an effort” was generated.

The data sources of the scale, observation form, research diary and indirect observation were utilized to observe the changes in the affective entry characteristics. In this way, triangulation was achieved and the situation was analyzed from diverse viewpoints. Similar patterns were sought in the data from different sources in order to ensure accuracy and credibility.

Ethical Considerations

We took some measures to ensure research ethics in this study. Firstly, the study did not entail any procedures to give biased/false information to the participants in any way, or to keep the purpose of the study completely confidential. In addition, participation in the study and the content of the data collection tools did not pose any risk or harm to the physical, social or psychological health of the participants. To ensure privacy and confidentiality, the data of the participants were hosted on the researchers' personal computers and safeguarded by a password. The report also contained no identifying information about the participants in any part of the article.

The study did not require official approval from an institutional ethical review board in Turkey because we collected the data in 2019. It should be noted that such approval was not needed in Turkey for the studies which collected data before the year 2020. However, in this study, all rules stated within the scope of "Higher Education Institutions Scientific Research and Publication Ethics Directive" were followed. None of the actions stated under the title "Actions Against Scientific Research and Publication Ethics", which is the second part of the directive, were taken.

RESULTS

One of the data sources in the study was the AECSM. It was observed that the data obtained from the AECSM did not deviate excessively from normal distribution. The skewness and kurtosis coefficients ranged between -1.294 and 1.479. Therefore, the pretest and posttest mean scores were analyzed with paired samples t-test, and the results are summarized in Table 1.

Table 1

t-test Results for the AECSM Pretest-Posttest Mean Scores

Measurement	*n*	*M*	*SD*	*df*	*t*
Pretest	13	64.85	15.18	12	-2.446*
Posttest	13	72.92	6.28		

*$p < .05$

As shown in Table 1, the results showed a significant improvement of students' affective entry characteristics in mathematics after the implementation (M = 72.92, SD = 6.28) as compared to their pre-implementation level (M = 64.85, SD = 15.18), t(12) = −2.446,

p = .02). Accordingly, it can be stated that the implementation made a difference in the posttest scores compared with the pretest scores. In other words, the implementation was effective in the development of positive affective entry characteristics compared to the initial situation.

The second data source in the study was the AOFM. The data obtained from the form were analyzed using the frequency method and the results are shown in Table 2.

Table 2

Number of Participants by Observation Unit Across the Three Observations

Observation Units	Observation		
	First	Second	Third
The student struggles with a problem until finding a solution.	7	12	12
The student is not engaged in other things.	4	11	13
The student solves problems without difficulty.	6	9	9
The student listens attentively to the teacher.	5	13	12
The student does his/her homework carefully.	9	8	10
The student wants to speak up.	11	13	12
The student keeps notes.	12	13	13
The student asks when not understanding.	2	6	12
The student wants to solve questions on the board.	9	13	12
The student makes eye contact with the teacher.	9	13	13

As can be seen in Table 2, compared to the results of the first observation, there was an increase in the number of students exhibiting behaviors of positive attitude in the subsequent observations. For example, while there were only 2 students asking about a point they did not understand in the first observation, this number rose to 6 and 12 in the second and third observations, respectively. In addition, the number of students who displayed the following behaviors had been stable across observations: doing their assignments carefully, wanting to speak up, and taking notes. In general, these add to the evidence that the implementation was effective in developing positive affective entry characteristics.

The third data source in the study was the practitioner's research diary. As a result of the inductive analysis of the diary, three main categories were reached, namely "obstacles", "time allocated to study" and "affective entry characteristics." The frequency of the subcategories recurring in the diary was also calculated. The results are presented in Table 3.

Table 3

Categories and Subcategories Obtained From the Analysis of the Research Diary with Frequencies

Categories and Subcategories	Frequency
Obstacles	**18**
The family does not care about attendance to school.	1
The student lacks suitable environment to study (no private room, has to study in front of the television).	1
The family goes on visits and receives visitors frequently.	1
The student is absent from school with an excuse.	3
The student is absent from school without any excuse.	8
The student has to help the family with the chores such as housework, farm work, sibling and animal care.	4
Time allocated to study	**53**
The student has started to study systematically and regularly.	11
The student allocates 15 to 90 minutes to study.	9
The student comes prepared for classes.	3
The student does lesson reviews at home.	9
The student lacks stability (sometimes studying, sometimes not)	9
The student does not study enough (spends too little time).	7
The student does not allocate time to study.	3
The student does not review lessons.	2
Affective entry characteristics	**111**
The student does homework regularly.	13
The student does more than the assigned homework.	4
The student has not done the homework.	11
The student develops and uses different strategies (e.g. asking questions and explaining to each other, oral repetition, marking the points s/he does not understand and asking the teacher, writing and answering questions)	13
The student makes arrangements (e.g. for creating a quiet environment)	2
The student takes more interest in the lesson.	9
The student is indifferent to the lesson.	2
The student keeps a tidier notebook.	7
The student gets happier as success comes.	4
The student makes an effort.	8
The student studies from different sources as well.	4
The student is more self-confident in mathematics now.	5
The student does not hesitate to ask when not understanding.	9
The student is excessively bored with school.	1
The student enjoys the lesson and finds it fun.	8
The student gets bored in class and does not want to listen.	1
The student is willing to come to the blackboard and speak up.	9
The student is afraid to come to the blackboard and speak up.	1

Each category in Table 3 was defined and explained below:

Obstacles

This category included the factors that negatively affected the students' allocation of time to study and the expected positive contributions of the implementation. School

absence and the obligation to help the family with the chores can be listed as important obstacles for students to allocate time to study.

Time allocated to study

This category included the time that students devoted to studying mathematics in the implementation process. When the subcategories were examined, it was understood that students generally started to study systematically and regularly, reviewed lessons at home, and thus allocated time to study. However, there were some instances when some students did not show consistency, did not spend enough or any time to study, and did not review lessons.

Affective entry characteristics

This category included behaviors that indicate interest, attitude and self-confidence in mathematics such as taking interest in mathematics, enjoying the lesson, doing assignments regularly, making an effort and using different strategies. An examination of the subcategories in Table 3 foregrounded the positive aspects of these behaviors, although there were occasions when students did not do their homework, were indifferent to the lesson, bored in class, and afraid to come to the blackboard and speak up. Therefore, we overall concluded that the implementation was effective in developing positive affective entry characteristics.

The final data source in the study was the indirect observation performed with the use traces. Therefore, the physical evidence on student assignments was analyzed. The results are shown in Table 4.

Table 4

Results of the Analysis of Data Obtained from the Indirect Observation

Assignment	Did not do assignment	Did assignment	No effort	Made an effort
A1	1	12	8	4
A2	1	12	6	6
A3	2	11	4	7
A4	-	13	3	10
A5	1	12	2	10
A6	2	11	4	7
A7	1	12	4	8
A8	3	10	4	6
A9	3	10	6	4
A10	5	8	4	4
A11	4	9	6	3
A12	4	9	6	3

When the high number of students who did each assignment was examined in Table 4, it was understood that students allocated time to study. However, a slight decrease was observed in the last three assignments. On the other hand, considering the argument of the

research, an increase would normally be expected in the number of students who make an effort while doing assignments from the first to the twelfth. This is because affective entry characteristics determine whether the students will make an effort or not in a task. Accordingly, an increase in the number of students making an effort in the process is explained by a positive change in affective entry characteristics. As seen in Table 4, the results in the first five assignments supported the argument of the research. In the rest of the assignments, a gradual decrease was observed in the number of students making an effort. Nevertheless, the number of these students was relatively high in A6 to A8. In contrast, the number was the lowest in the last four assignments, A9 to A12. In this case, it can be said that the implementation was effective in the allocation of time to study, but its effect on developing positive affective characteristics was not long-lasting for some students.

DISCUSSION AND CONCLUSION

This study aimed to examine the effectiveness of an action plan, which was implemented to improve students' affective entry characteristics towards mathematics by specifically fixing the deficiencies in prior learning and promoting the allocation of time to study. The findings are discussed and concluded below.

Two of the data sources in the study were the AECSM and the AOFM. First of all, the analysis of the AECSM mean scores revealed a significant difference in favor of the posttest. In addition, the analysis of the data obtained from the AOFM showed an increase in the number of students exhibiting behaviors as indicators of positive attitude from the first to the third observation. The findings from these two data sources confirmed that there were positive changes in the students' affective entry characteristics towards mathematics. Therefore, we concluded that the implementation was effective in achieving the aim of the study. This result is in line with the research findings (Edirmanasinghe, 2020; Samuelsson, 2021), which report that affective characteristics can be improved through various interventions. On the other hand, the positive changes in the affective entry characteristics may be interpreted as follows: Students became more successful after fixing the deficiencies in prior learning and promoting the allocation of time to study mathematics (Bloom, 1998; Dochy et. al, 1999; Hailikari et al., 2008; Kitsantas et al., 2011; Thompson & Zamboanga, 2004). The enhanced achievement, in turn, positively affected students' affective entry characteristics (Ganley & Lubienski, 2016; Ma & Xu, 2004).

Another data source in the study was the practitioner's research diary. The inductive data analysis revealed some interesting findings regarding the 3 main categories, "obstacles", "time allocated to study" and "affective entry characteristics". We firstly reached some positive findings after the examination of the subcategories. We found out that students generally began to study systematically and regularly, reviewed lessons at home, and thus allocated time to study. This showed that they took time to study mathematics. As mentioned in the literature (Anderson & Bourke, 2000; Reyes, 1984),

devoting time to studying is the result of a positive change in affective entry characteristics. In addition, students mostly exhibited positive behaviors of interest, attitude and self-confidence. For example, they got more interested in mathematics, enjoyed the lesson, were willing to participate and ask questions, did assignments regularly, made an effort and used different strategies. Therefore, we overall concluded that the implementation was effective in improving students' positive affective entry characteristics, which supported the findings of the AECSM and the AOFM. On the other hand, we had some negative findings. For example, there were some occasions when some students did not show stability, spend adequate or any time to study, do lesson reviews or assignments, were indifferent to the lesson and bored in class. This situation may be attributed to the factors, which were described in the category of "obstacles". It seemed that a combination of these family-related factors such as frequent family visits, family chores (e.g. caring for a sibling, helping with housework and farm work etc.), and lack of a suitable study resulted in students' school absence. This may have prevented some students from allocating time to study and thus developing positive affective entry characteristics. Based on these findings, we concluded that the implementation worked for the students who had a supportive family home environment. In other words, the students who had a family home environment supporting the activities at school became more successful in mathematics after the implementation. This success, in turn, positively affected their development of affective entry characteristics. Therefore, it can be argued that fixing the deficiencies in prior learning and encouraging students to devote time to studying at school was not enough alone. The family home environment should have supported these endeavors. The significance of family-related factors is also highlighted in the literature. For instance, Özer and Anıl (2011) state that family characteristics (e.g. education level of parents, the number of books in the house, having a computer and related equipment) are key variables regarding mathematics achievement. According to Grootenboer & Hemmings (2007) affective factors in combination with socioeconomic status predict mathematics achievement. Berberoğlu et al. (2003) also add that the most important factor determining mathematics achievement is socioeconomic level.

The last data source in the study was the indirect observation, which was realized through the use traces. Firstly, we found out that students allocated time to study mathematics considering the high number of students who did each assignment. However, the analysis of the physical evidence on the assignment papers showed an increase in the number of students making an effort in the first five assignments, and then a gradual decrease in the following ones. The decrease was even larger in the last four assignments. Therefore, it can be argued that the implementation was effective in allocation of time to study, but its effect on developing positive affective characteristics was not long-lasting for some students. Effort is one of the most important indicators of affective entry characteristics. A student with positive affective entry characteristics makes an effort when faced with difficulty (Bloom, 1998). The reason for the decline of effort in

the final weeks of the implementation can be explained by the increase in the housework and farm work with the arrival of the spring months. Thus, the students had to either go to the field or take care of their siblings at home. Even if they wanted to allocate time to their homework, this didn't seem possible. Based on this finding and interpretation, it can be concluded that the family home environment should be in a manner that supports the endeavors made at school. It is also worth mentioning that this result is in line with the finding of the research diary.

In conclusion, it is possible to summarize the results of the study as follows: Remedying the deficiencies in prior learning and enabling the students to allocate time to study ensured student achievement in mathematics; this achievement, in turn, resulted in positive affective entry characteristics; positive affective entry characteristics motivated the students to devote time to studying in subsequent learning units; however, in order for all these to happen, the family home environment should support these processes. As a final word, it can also be added that non-modifiable variables (such as family home environment) may be as important as or even more important than modifiable ones in the development of positive affective entry characteristics towards mathematics.

REFLECTIONS OF THE PRACTITIONER AND RECOMMENDATIONS

As the practitioner and the mathematics teacher of Class 5/A, the third author's reflections on the process are presented below. We think this will give useful information about the contribution of the implementation to her professional development and some ideas for future researchers.

At the beginning of the implementation process, I thought that some of my students would not be able to reach our target, or even would not want to make an effort for it. However, over time, I generally observed that the students experienced a sense of achievement as I worked on their deficiencies in prior learning and encouraged them to devote time to studying mathematics. The feeling of success made them more self-confident and motivated to learn. So, they put more effort into studying mathematics at home. Seeing the successful results of their effort made a great difference in the following weeks.

The situation I had observed in most of the students at the school where I worked was that the things learned were soon forgotten. In the implementation process, since students did lesson reviews at home, I realized that their learning often became permanent and meaningful. This process we experienced together also increased the teacher-student interaction. The fact that almost the entire class was enthusiastic during classes was motivating for me as well. I observed the same participation in collaborative activities. Everyone contributed to the process, and the classroom atmosphere was more vibrant than before. I, too, was looking forward to the lessons in Class 5/A.

I realized positive changes in the students' attitudes towards mathematics during the process. For example, I observed an increase in behaviors such as wanting to come to the board, raising hands, and doing more homework. Even the students who formerly had difficulty in participating in the lesson began to insist on taking part in the activities. Especially, I noticed that the students who were previously afraid of raising their hands and making eye contact with me when I asked a question became more self-confident as the process progressed. Thus, the lessons were very fun. My students also started asking questions to make sense of the subject. I had no problem with classroom management, but I observed that the students who did not previously pay attention to the lesson were more interested in the lesson than before, even if not in the entire lesson. It was great pride and rewarding for a teacher to see that her own students began to love mathematics more than before and developed a positive attitude.

The students wanted me to notice in class the studies they made at home. Therefore, they were eager to tell me that they reviewed lessons at home, even before I asked. Generally, I could feel the excitement of the students when I entered the classroom. I think this process gave the students the feeling of "I can make it". Giving regular assignments made it easier for students to remember their responsibilities. Since the students studied at home, I did not have to spend a long time repeating the previous lesson as before. This enabled us to devote more time in class to different question types, and to learn the subject in a more comprehensive and versatile way.

I noticed that students' studying together during the breaks and especially after school increased the communication between them. Consequently, there was a more positive atmosphere in the classroom. On the other hand, I think that the lack of internet and computers at home limited their opportunities to study together.

Although the implementation process was generally positive, I experienced some negative situations. Since there was a progressivity relationship between the topics of mathematics, a student who did not attend one class could have difficulty in the next one. The students who did not attend classes tried to overcome the resulting gap, sometimes with their own efforts, sometimes with peer support and sometimes with my help. However, with the warming of the weather in spring, there was a significant increase in the absence of some students, and we had difficulty in compensating for the days they were absent. They began to lose interest in the lesson. I think this situation made them unable to do their homework and decreased their motivation.

I guided the students on how to study, and at the beginning of the process, I sent letters to the parents to increase their awareness. I contacted the parents I deemed necessary by phone. I was not expecting to receive such positive feedback from the process in this school, which can be called 'disadvantaged' because most students did not have their own rooms in their homes. Besides, except for a few students, the parents of the others did not want them to go to high school after secondary school. Therefore, the

parents were not interested in their children's progress at school. Nevertheless, particularly some students made great progress in-class participation, listening to the lesson and doing homework, and so their self-confidence increased. Regular lesson reviews at home ensured that the topics were not forgotten easily. Thus, when we moved to a new topic, which was a continuation of the previous subject, the students did not have much difficulty.

In this process, I realized once again how important prior learning of the students was. Fractions, especially addition and subtraction with fractions, and ordering of fractions are topics of mathematics that students have misconceptions about. In order to check the students' incomplete and incorrect learning in the process, I tried to observe the operations they performed as much as I could. Trying to deal with the students individually during classes was sometimes difficult, but when I did so, it was easier for the students to learn. Naturally, I could not do this for all students and at all times. Nevertheless, I tried to deal with the students individually, as much as I could, according to their individual differences and prior learning.

As a result of this process, I realized the importance of giving regular assignments. In this way, students can gain the habit of disciplined study. Now, I make a point of giving assignments to the class I teach every week. We decide together on the day I will check the assignments and they do their homework on the day we set throughout the semester. This makes students more organized and systematic. I also realized that a unit should be divided into smaller learning units and homework should be given after each unit was completed. In this way, learning deficiencies could be detected earlier.

I would like to repeat this experience in another school with students who have a better and more adequate family home environment (with separate rooms, internet, sourcebooks, different parent profiles). I really think this implementation will be more effective for students living in such an environment. In this way, I can have the opportunity to compare the results of my experiences. I may also have a chance to examine the effects of different variables in more detail. So, I can recommend researchers interested to repeat this study with participants who have a supportive family home environment. Their results can be compared with the results of this study. Thus, different perspectives can be gained on the effectiveness of the implementation. Finally, I hope the present study will contribute to the related literature.

REFERENCES

Anderson, L. W., & Bourke, S. F. (2000). *Assessing affective characteristics in the schools* (2nd ed.). Lawrence Erlbaum Associates Publishers.

Berberoğlu, G., Çelebi, Ö., Özdemir, E., Uysal, E., & Yayan, B. (2003). Üçüncü uluslararası matematik ve fen çalışmasında Türk öğrencilerin başarı düzeylerini etkileyen etmenler

[Factors effecting achievement level of Turkish students in the third international mathematics and science study]. *Eğitim Bilimleri ve Uygulama*, *2*(3), 3-14.

Berg, B. L. (2001). *Qualitative research methods for the social sciences* (4th ed.). Allyn and Bacon.

Bloom, B. S. (1998). *İnsan nitelikleri ve okulda öğrenme* (3th ed.) [Human characteristics and school learning] (D. A. Özçelik, Trans). MEB Yayınları.

Boz, H., & Çalışkan, M. (2018). Developing an attitude observation form towards mathematics. *Research on Education and Psychology (REP), 2*(2), 95-110.

Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research, 65*(3), 245-281. https://doi.org/10.3102/00346543065003245

Carpenter, D. M., & Clayton, G. (2014). Measuring the relationship between self-efficacy and math performance among first-generation college-bound middle school students. *Middle Grades Research Journal*, *9*(2), 109-126.

Cvencek, D., Kapur, M., & Meltzoff, A. N. (2015). Math achievement, stereotypes, and math self-concepts among elementary-school students in Singapore. *Learning and Instruction*, *39*, 1-10. https://doi.org/10.1016/j.learninstruc.2015.04.002

Çalışkan, M. (2014). Bilişsel giriş davranışları, matematik özkavramı, çalışmaya ayrılan zaman ve matematik başarısı arasındaki ilişkiler [The relationships between cognitive entry behaviors, mathematics self-concept, the time allocated for studying mathematics and mathematics achievement]. *Türkiye Sosyal Araştırmalar Dergisi*, *18*(1), 345-357.

Çalışkan, M., & Serçe, H. (2016). Matematiğe yönelik duyuşsal giriş özellikleri ölçeği: Geçerlik ve güvenirlik çalışması [Affective entry characteristics scale for mathematics: A study of reliability and validity]. *International Journal of Eurasia Social Sciences*, *7*(22), 137-160.

Chiu, M. M., & Klassen, R. M. (2010). Relations of mathematics self-concept and its calibration with mathematics achievement: Cultural differences among fifteen-year-olds in 34 countries. *Learning and Instruction, 20*(1), 2-17. https://doi.org/10.1016/j.learninstruc.2008.11.002

Dochy, F., Segers, M., & Buehl, M. M. (1999). The relation between assessment practices and outcomes of studies: The case of research on prior knowledge. *Review of Educational Research*, *69*(2), 145-186. https://doi.org/10.3102/00346543069002145

Edirmanasinghe, N. (2020). Using youth participatory action research to promote self-efficacy in math and science. *Professional School Counseling, 24*(1), 1-12. https://doi.org/10.1177/2156759X20970500

Ehmke, T., Drechsel, B., & Carstensen, C. H. (2010). Effects of grade retention on achievement and self-concept in science and mathematics. *Studies in Educational Evaluation*, *36*(1-2), 27-35. https://doi.org/10.1016/j.stueduc.2010.10.003

Evans, J., & Tsatsaroni, A. (1996). Linking the cognitive and the affective in educational research: Cognitivist, psychoanalytic and poststructuralist models. *British Educational Research Journal, 22*(3), 347-358. https://doi.org/10.1080/0141192960220307

Ganley, C. M., & Lubienski, S. T. (2016). Mathematics confidence, interest, and performance: Examining gender patterns reciprocal relations. *Learning and Individual Differences, 47*, 182-193. http://dx.doi.org/10.1016/j.lindif.2016.01.002

Ganley, C. M., & Vasilyeva, M. (2011). Sex differences in the relation between math performance, spatial skills, and attitudes. *Journal of Applied Developmental Psychology, 32*(4), 235-242. https://doi.org/10.1016/j.appdev.2011.04.001

Grootenboer, P., & Hemmings, B. (2007). Mathematics performance and the role played by affective and background factors. *Mathematics Education Research Journal, 19*, 3-20. https://doi.org/10.1007/BF03217459

Gunderson, E. A., Ramirez, G., Levine, S. C., & Beilock, S. L. (2012). The role of parents and teachers in the development of gender-related math attitudes. *Sex Roles, 66*, 153-166. http://doi.org/10.1007/s11199-011-9996-2

Hailikari, T., Nevgi, A., & Komulainen, E. (2008). Academic self-beliefs and prior knowledge as predictors of student achievement in mathematics: A structural model. *Educational Psychology, 28*(1), 59-71. https://doi.org/10.1080/01443410701413753

Hailikari, T., Nevgi, A., & Lindblom-Ylänne, S. (2007). Exploring alternative ways of assessing prior knowledge, its components and their relation to student achievement: A mathematics based case study. *Studies in Educational Evaluation, 33*(3-4), 320-337. https://doi.org/10.1016/j.stueduc.2007.07.007

Johnson, A. P. (2015). *Eylem araştırması el kitabı* [A short guide to action research] (Y. Uzuner & M. Özten Anay, Trans. Eds.) Anı Yayıncılık.

Karasar, N. (2002). *Bilimsel araştırma yöntemi* [Scientific research method]. Nobel Akademik Yayıncılık.

Kitsantas, A., Cheema, J., & Ware, H. W. (2011). Mathematics achievement: The role of homework and self-efficacy beliefs. *Journal of Advanced Academics, 22*(2), 310-339. https://doi.org/10.1177/1932202X1102200206

Lee, K., & Anderson, J. (2015). Gender differences in mathematics attitudes in coeducational and single sex secondary education. In M. Marshman, V. Geiger, & A. Bennison (Eds.), *Mathematics education in the margins* (Proceedings of the 38th annual conference of the Mathematics Education Research Group of Australasia, pp. 357-364). MERGA. https://eric.ed.gov/?id=ED572489

Lebens, M., Graff, M., & Mayer, P. (2011). The affective dimensions of mathematical difficulties in schoolchildren. *Educational Research International, 2011*, 1-13. https://doi.org/10.1155/2011/487072

Leder, G. C., & Forgasz, H. J. (2002). Measuring mathematical beliefs and their impact on the learning of mathematics: A new approach. In G. C. Leder, E. Pehkonen, & G. Törner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 95-113). Springer. https://doi.org/10.1007/0-306-47958-3_6

Li, X., & Li, Y. (2008). Research on students' misconceptions to improve teaching and learning in school mathematics and science. *School Science and Mathematics, 108*(1), 4-7. https://doi.org/10.1111/j.1949-8594.2008.tb17934.x

Liston, M., & O'Donoghue, J. (2009) Factors influencing the transition to university service mathematics: part 1 a quantitative study. *Teaching Mathematics and Its Applications, 28*(2), 77-87. https://doi.org/10.1093/teamat/hrp006

Ma, X., & Xu, J. (2004). Determining the causal ordering between attitude toward mathematics and achievement in mathematics. *American Journal of Education, 110*(3), 256-280. https://doi.org/10.1086/383074

Maass, J., & Schlöglmann, W. (Eds.). (2009). *Beliefs and attitudes in mathematics education: New research results*. Sense Publishers.

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development, 76*(2), 397-416. https://doi.org/10.1111/j.1467-8624.2005.00853.x

Özer, Y., & Anıl, D. (2011). Öğrencilerin fen ve matematik başarılarını etkileyen faktörlerin yapısal eşitlik modeli ile incelenmesi [Examining the factors affecting students' science and mathematics achievement with structural equation modeling]. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 41*, 313-324.

Pantziara, M., & Philippou, G. N. (2015). Students' motivation in the mathematics classroom. Revealing causes and consequences. *International Journal of Science and Mathematics Education, 13*(2), 385-411. https://doi.org/10.1007/s10763-013-9502-0

Peters, M. L. (2013). Examining the relationships among classroom climate, self-efficacy, and achievement in undergraduate mathematics: A multi-level analysis. *International Journal of Science and Mathematics Education, 11*, 459-480. https://doi.org/10.1007/s10763-012-9347-y

Reyes, L. H. (1984). Affective variables and mathematics education. *The Elementary School Journal, 84*(5), 558-581. https://doi.org/10.1086/461384

Samuelsson, J. (2021). Developing students' relationships with mathematics. *Educational Action Research*. https://doi.org/10.1080/09650792.2021.1899012

Seel, N. M. (2012). Bloom's model of school learning. In Norbert M. Seel (Ed.), *Encyclopedia of the sciences of learning* (pp. 466-469). Springer. https://doi.org/10.1007/978-1-4419-1428-6_979

Shaughnessy, J. J., Zechmeister, E. B., & Zechmeister, J. S. (2016). *Psikolojide araştırma yöntemleri* (1st ed.) [Research methods in psychology] (İ. Göz, Trans. Ed.). Nobel Akademik Yayıncılık.

Thompson, R. A., & Zamboanga, B. L. (2004). Academic aptitude and prior knowledge as predictors of student achievement in introduction to psychology. *Journal of Educational Psychology*, *96*(4), 778-784. https://doi.org/10.1037/0022-0663.96.4.778

Wang, J. (2006). An empirical study of gender difference in a relationship between self-concept and mathematics achievement in a cross-cultural context. *Educational Psychology, 26*(5), 689-706. https://doi.org/10.1080/01443410500390863

Yıldırım, A., & Şimşek, H. (2016). *Sosyal bilimlerde nitel araştırma yöntemleri* (10th ed.) [Qualitative research methods in the social sciences]. Seçkin Yayıncılık.

Biographical notes:

Muhittin Çalışkan: He works as a professor for the Department of Curriculum and Instruction at Necmettin Erbakan University, Ahmet Keleşoğlu Faculty of Education. His research interests and expertise include academic achievement, instructional and learning strategies, executive cognition, and affective factors in learning.

Hüseyin Serçe**:** He works as an assistant professor for the Department of Curriculum and Instruction at Selçuk University, Faculty of Education. Among his research interests are English language teaching, language and vocabulary learning strategies, learning and teaching methodology, action research, and teacher education.

Hatice Uysal**:** She is a Ph.D. student at the Department of Curriculum and Instruction, Necmettin Erbakan University, Ahmet Keleşoğlu Faculty of Education; also mathematics teacher for Turkish Ministry of National Education. Her research interests include teaching and learning mathematics, and teacher education.

Tianlan Wei**:** She is an associate professor of Educational Psychology in the Department of Counseling, Educational Psychology, and Foundations, College of Education, Mississippi State University. Her research activities are situated into three subcategories: gender and ethnic differences in learning and performance, academic emotions and motivation, and quantitative methodology and psychometrics.

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