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Research Article

Changing High School Students' Attitudes Towards Mathematics in a Summer Camp: Happiness Matters

Iclal Can^{1,7}
Middle East Technical
University Northern
Cyprus Campus

Selda Koydemir^{2,8}
Middle East Technical
University Northern
Cyprus Campus

Salih Durhan³
Middle East Technical
University Northern
Cyprus Campus

Suheyda Ogan⁴
Middle East Technical
University Northern
Cyprus Campus

Cansu Gozukara⁵
Middle East Technical
University Northern
Cyprus Campus

Gizem Cokluk⁶
Middle East Technical
University Northern
Cyprus Campus

Abstract

The purpose of this study is to examine if and how high school students' attitudes towards mathematics can be positively changed through a summer math village experience and whether happiness exerts an influence on this change process. We employed a mixed research design in our study, and examined an existing intervention. We administered the Mathematics Attitude Scale and the Students' Life Satisfaction Scale to 57 students before and after they attended summer camp at a math village. We also conducted individual interviews with three lecturers and focus group interviews with 12 students to supplement the quantitative measures. The results indicated that the intervention had a positive impact on the students' attitudes and approach towards mathematics and their personal improvement process. The results further indicated that happy students benefited more from the math village in terms of changes to their mathematics attitudes.

Keywords

Attitudes towards mathematics • Attitude change • Math village • Math camp • Happiness • Informal mathematics • Out-of-school-time programs

1 **Correspondence to:** Iclal Can (PhD), Guidance and Psychological Counseling Program, Middle East Technical University Northern Cyprus Campus, 99738 Kalkanlı, Güzelyurt, Mersin 10, Turkey. Email: iclal@metu.edu.tr

2 Guidance and Psychological Counseling Program, Middle East Technical University Northern Cyprus Campus, 99738 Kalkanlı, Güzelyurt, Mersin 10, Turkey. Email: skoydemir@gmail.com

3 Mathematics Research And Teaching Group, Middle East Technical University Northern Cyprus Campus, 99738 Kalkanlı, Güzelyurt, Mersin 10, Turkey. Email: salihl@gmail.com

4 Guidance and Psychological Counseling Program, Middle East Technical University Northern Cyprus Campus, 99738 Kalkanlı, Güzelyurt, Mersin 10, Turkey. Email: ogan.suheyda@metu.edu.tr

5 Guidance and Psychological Counseling Program, Middle East Technical University Northern Cyprus Campus, 99738 Kalkanlı, Güzelyurt, Mersin 10, Turkey. Email: cansu.gozukara@metu.edu.tr

6 Guidance and Psychological Counseling Program, Middle East Technical University Northern Cyprus Campus, 99738 Kalkanlı, Güzelyurt, Mersin 10, Turkey. Email: gizem.cokluk@metu.edu.tr

7 Previously Iclal Sahin.

8 Currently in University of Bamberg, Department of Psychology, Personality and Assessment.

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Mathematics as a discipline is greatly important in many areas in academic, professional and daily life. For instance, it equips individuals with skills valued in many university courses and subjects including engineering, the sciences, and social sciences (Norris, 2012). Mathematical skills are also necessary to pursuing a wide range of good careers and being successful in the workplace (Hoyles, Noss, Kent, & Bakker, 2010; Vorderman, Porkess, Budd, Dunne, & Rahman-Hart, 2011). Moreover, mathematical skills foster many skills needed for problem solving, decision making and dealing with the complexities of daily life (English & Gainsburg, 2015; Jenning & Wattam, 1998). In line with rapid technological changes, the demand for mathematical skills is constantly increasing. Therefore, providing young people with a good basis for mathematics education is crucial. However, despite the importance of mathematics in different spheres of life, students often have negative attitudes towards mathematics, which is a major concern for mathematics education.

Psychological theories explain attitude as a tendency to evaluate a particular entity with a certain level of favor or disfavor (Eagly & Chaiken, 1993). Although researchers have debated the dimensionality of attitudes, one widely accepted model postulates that attitude consists of three basic components: cognitive, affective, and behavioral (Maio & Haddock, 2010). While the cognitive component refers to what a person thinks or believes, the affective aspect is concerned with the feelings or emotions associated with the object, and the behavioral component refers to the tendency to react to the object.

Attitude is a commonly used term in the mathematics education literature as well, yet it is a concept difficult to define precisely. In fact, the term has been used interchangeably with others such as mathematics anxiety, which actually refers to feelings of tension interfering with the individual's ability to solve mathematical problems in different academic contexts (Tobias, 1995). However, attitudes towards mathematics, just like other types of attitudes, do not necessarily entail negative feelings -- they are defined in a broader way. Although some scholars conceive of attitudes as a matter of liking or disliking mathematics, i.e., an emotional disposition to the subject (e.g., Eshun, 2004), others have argued that a multidimensional explanation including cognitive and affective aspects provides a better understanding (Hannula, 2002; McLeod, 1992). For instance, in an early study, Neale (1969) defined attitude as "a liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless" (p. 632). The importance of including cognition in the definition of attitudes has been stressed by other scholars as well (e.g., Leder, 1987). Adding a behavioral component, Hart (1989, as cited in Zan & Di Martino, 2007) stated that attitudes towards mathematics can be defined as the emotions individuals associate with mathematics, their beliefs towards mathematics, and

their behaviors. Ruffell, Mason, and Allen (1998) suggested that a multidimensional construct with three components -- cognitive (beliefs), affective (feelings) and conative (behavioral intent) -- better explains attitudes towards mathematics. In a series of studies, Zan and Di Martino (2007) and Di Martino and Zan (2010) identified a model comprised of three dimensions: a) emotional disposition towards mathematics, b) vision of mathematics, and c) perception of being /not being able to succeed (perceived competence) in mathematics.

In general, attitude towards mathematics is conceptualized as having affective, cognitive, and behavioral components, just like any other attitude. However, despite the fact that many studies into attitudes towards mathematics have been conducted, there is still need for more comprehensive theoretical development of the concept of attitudes in mathematics education. In this study, we attempted to understand attitudes towards mathematics and whether and how they can be changed through a summer camp experience. Because of a need for a richer conceptual framework, we used a mixed methods approach which included both a quantitative and a qualitative study focusing on an existing intervention - a summer mathematics camp held at a math village in Turkey. In the quantitative study, we conceptualized attitudes towards mathematics in a multidimensional way and conducted our assessment accordingly. The qualitative study aimed at better understanding of the construct of attitudes towards mathematics.

Factors Affecting Students' Attitudes Towards Mathematics

Behaviors are largely influenced by attitudes. For instance, negative attitudes are positively associated with poor engagement with a course (Mayes, Chase, & Walker, 2008) and dropping out of the course (Ma & Williams, 1999). Moreover, despite the inconsistency of the empirical evidence (Ma & Kishor, 1997), there are also some studies that show a positive correlation between positive attitudes and achievement in mathematics (e.g., Nicolaidou & Philippou, 2003). McLeod (1992) points out that improvements in mathematics education can result in changes in the affective responses of individuals, addressing the importance of changing students' attitudes towards mathematics for the development of mathematics education. This requires an understanding of why students develop negative or positive attitudes towards mathematics and how educators can help students develop more positive attitudes.

One should note that neither achievement in nor attitudes toward mathematics can be explained by a single factor. Multiple factors such as individual, family, school, and cultural variables interact to influence achievement and performance in mathematics, as well as attitudes towards mathematics (Akey, 2006; Singh, Granville, & Dika, 2002). Influencing factors can be grouped as follows: student factors (e.g., self-efficacy, motivation), factors related to the home and society (e.g., parents' educational background, parental expectations), and factors related to the school and teacher

(e.g., teacher knowledge, learning environment, and teacher beliefs) (Mohamed & Waheed, 2011). Regarding school and teacher factors, research shows that the way students perceive teachers makes a difference in students' attitudes (Maat & Zakaria, 2010). In addition, research indicates that students may hold negative attitudes towards mathematics for several reasons, including the difficulty and abstractness of mathematics (Malmivuori, 2008), a non-supportive classroom climate (Samuelsson & Granström, 2007), and a lack of teacher support (Akey, 2006). Research studies also show that when students perceive the learning environment as supportive and positive in general, they are more likely to develop positive attitudes (Fraser & Kahle, 2007; Mata, Monteiro, & Peixoto, 2012). This is also mentioned by Hannula (2002), who suggests that students' social setting and how they interpret relevant situations play an important role in attitude formation.

Although the existing literature covers a range of contextual factors in terms of changing attitudes (e.g., Mohamed & Waheed, 2011; Singh et al., 2002), personal factors have received relatively less attention. To date, personal variables such as self-concept, anxiety level, and self-efficacy have been the subject of only a few studies examining attitudes towards mathematics (e.g., Nicolaidou & Philippou, 2003). In recent years, the importance of another concept, namely happiness, in relation to positive educational outcomes has also been stressed by scholars (Frisch, 2000; Gutman, Brown, Akerman, & Obelenskaya, 2009). There is empirical evidence that well-being and academic achievement may be mutually reinforcing (Greenberg et al., 2003). Subjective well-being models (e.g., Diener, Suh, Lucas, & Smith, 1999) conceptualize happiness as describing one's life as satisfying, and suggest that happiness has the potential to predict several positive outcomes across various aspects of the individual's life, including academic experiences. For instance, evidence shows that happy students are good problem solvers, are more successful, and show better work performance (Myers, 1992). Happy people are also cognitively more flexible in problem solving (Nadler, Rabi, & Minda, 2010). Frisch and colleagues (Frisch, 2000; Frisch, Cornell, Villanueva, & Retzlaff, 1992) argue that youth programs and program evaluations should consider student life satisfaction, given the impact of well-being on achievement. Moreover, Noddings (2003) argues that "happiness and education are, properly, intimately related: Happiness should be an aim of education, and a good education should contribute significantly to personal and collective happiness" (p. 1).

Although there is almost no empirical evidence explicating the relationship between happiness and students' attitudes towards and achievement in specific courses, based on the aforementioned arguments about happiness and the role of positive attitudes in promoting learning and creativity (Seligman Ernst, Gillham, Reivich, & Linkins, 2009), it seems reasonable to predict that student happiness, attitudes, and achievement are closely linked. In one study with college students, quality of

life predicted academic retention both on its own and in conjunction with academic success (Frisch et al., 2005). In a qualitative study, Smith (2010) demonstrated that unhappy students were more likely to discontinue mathematics education. Similarly, Raterink (2002) demonstrated that the most important factor for students' success was happiness. Thus, happiness seems to be a factor that should not be ignored when it comes to students' educational outcomes. In this study, we posit that considering students' happiness level may provide a better understanding of the effectiveness of educational interventions and test its moderating effect on the relationship between mathematics education and changes in attitudes towards mathematics. Happiness has been considered an important individually variant variable in accounting for the relationships among psychological variables (e.g., Howell, Chenot, Hill, & Howell, 2011; Uysal & Satici, 2014). We think it would be interesting to document the same effect in the educational context, and formulate our research questions accordingly.

Changing Students' Attitudes Towards Mathematics

Research suggests that children have relatively positive attitudes towards mathematics when they start school, but their attitudes become more negative over the course of high school (Nicolaidou & Philippou, 2003). Considering that there might be a link between attitude and achievement, understanding why students behave in a certain way might help educators effectively address changes in student attitudes and thus achievement. This raises the question of to what extent it is possible to change students' attitudes toward mathematics. Despite Tobias' (1995) claim that it is difficult to change negative attitudes, Eshun (2004) argued that attitudes are "a disposition towards an aspect of mathematics that has been acquired by an individual through his or her beliefs and experiences but which could be changed" (p. 2). In fact, there is some empirical data that lends support to the possibility of changing attitudes and shows that it is never too late to achieve this (e.g., Hodges & Kim, 2013; Pepin, 2011; Tichenor & Plavchan, 2010). For example, although not directly targeting attitudes, one summer camp (Tichenor & Plavchan, 2010) that aimed to reinforce students' math skills showed promising results by providing students with an environment that emphasized risk-taking and love of math. Similarly, a study conducted by Chacon and Soto-Johnson (2003) to evaluate a one-week summer math camp organized for female high school students revealed a statistically significant change in students' attitudes as well as self-confidence. A more recent study in a college setting also shows a positive change in students' attitudes towards mathematics as a result of an intervention (Hodges & Kim, 2013). In another study (Pepin, 2011), students' attitudes towards mathematics changed from positive to negative from Year 7/8 to Year 9, but changed from negative back to positive in Years 10 and 11. It was concluded from the qualitative data that the exchange value of mathematics has the potential to influence attitudes towards mathematics. Hannula's (2002) study was

also successful in changing attitudes and suggested that attitudes can sometimes be changed dramatically in a short period of time.

The current study also makes use of the social constructivist approach in that the intervention (a mathematics summer camp program) is partially rooted in constructivism. This theoretical approach postulates that knowledge is actively constructed by the learner, and that the social environment and the relationship between the individual and the environment are crucial to learning (Vygotsky, 1978). According to social constructivism, we selectively use our experiences and create mental structures which serve as the basis of our knowledge. Constructivism has been discussed in mathematics education (Bjorkqvist, 1998; Ernest, 1998), and is known to have practical implications for instructional design (Bauersfeld, 1992). For instance, a large body of literature indicates that employing certain effective instructional practices that are in line with the constructivist approach might help educators change students' attitudes towards mathematics. These practices include a supportive group climate, collective discussions (Samuelsson & Granström, 2007), the competent use of manipulatives as well as 'hands-on' approaches (Bullmaster-Day, n.d.) and interaction with students (Moyer & Jones, 2004). The literature also indicates that the perception of activities as meaningless is negatively correlated with happiness and well-being, and positively correlated with irritation, stress, and withdrawal (Compton, 2000; Natvig, Albreksten, & Qvarnstrom, 2003). This might suggest that meaningful instructional activities and materials in interventions could help students develop more positive attitudes towards mathematics. We believe that interventions employing at least some of the aforementioned effective practices have the potential to influence students' attitudes towards mathematics.

More recently, attention has focused on the provision of out-of-school opportunities for learners of mathematics to encourage students to develop positive attitudes towards mathematics and more competence in mathematics. These opportunities might include after-school programs or summer programs of varying duration. What we know about effective instructional practices in traditional mathematics classrooms also applies to out-of-school mathematics contexts where students are exposed to informal mathematics. For instance, previous research findings for out-of-school mathematics programs indicate that effective instructional practices include the use of hands-on approaches, utilizing challenging materials, creating supportive group learning opportunities, and fostering shared discussion environments (e.g., Chacon & Soto-Johnson, 2003; Morrow & Schowengerdt, 2008; Wiest, 2010). In addition, high-quality teaching staff has been suggested as one of the strengths of successful mathematics camps (Wiest, 2010). It is also important to note that out-of-school programs, especially summer camps, differ from regular mathematics classrooms in offering social opportunities to learners along with academic learning environments.

Chacon and Soto-Johnson (2003) found that social activities such as watching a movie, swimming, and attending a concert during a one-week summer camp served as a break from the hard work. Furthermore, in his comprehensive review of the literature, Wiest (2010) suggested that social opportunities in out-of-school programs encourage students to build better relationships with their peers and staff and enhance academic dialogue among students as well as between teaching staff and students.

The Present Study

According to Programme for International Student Assessment (PISA) reports, Turkish students' scores in mathematics are lower than those in many other OECD countries (ranking 44 out of 65 countries in PISA 2012; and 50 out of 72 countries in PISA 2015). In particular, students in Turkey have difficulty learning to solve challenging problem situations. Although Turkish students are not prepared to apply the strategies and skills taught in schools in daily life, many believe that learning and applying mathematics is very important to getting a job in the future (Bilican, Demirtaşlı, & Kilmen, 2011), highlighting the increasing importance of mathematics among students in Turkey. It can therefore be argued that interest in and demand for non-traditional educational opportunities aimed at improving and expanding Turkish students' attitudes towards mathematics as well as their mathematical skills are increasing. However, the effect of these out-of-school experiences is not yet known. The focus of our study is a mathematics village, which provides mathematics enrichment opportunities to high school and university students.

The Mathematics Village (MV) was founded as a non-governmental organization in 2007 in Turkey with the aim of providing mainly high school and university students with opportunities to learn and think about mathematics through two-week programs. There are no special exams or assessments of knowledge and talent in mathematics involved in admission to this program. The only criterion for acceptance is willingness. Students who wish to be considered for the programs at the math village fill in an application form including questions about their achievement in mathematics and motivation to attend the programs at the village. Although some students participating in the programs are already talented in mathematics, other students hope to improve their math skills and abilities and/or change their negative attitudes towards mathematics. The Math Village welcomes prominent international scholars in mathematics as volunteer lecturers. Students are generally offered courses such as “graph theory, probability, combinatorics, game theory, and basic analysis and algebra” depending on their interests and experience (Alladi & Rino-Nesin, 2015, p. 655).

The main goals of the courses at the village are (a) to create new perspectives about mathematics by introducing students to ‘real mathematics’, which is different from what is offered as part of formal education in schools and provides “a glimpse

of what university-level mathematics is” (Alladi & Rino-Nesin, 2015, p. 655), (b) to enable students to develop abstract thinking in mathematics, (c) to encourage students to develop mathematical thinking skills and abilities by refraining from rote memorization and spoon feeding, and most importantly (d) to help students develop self-efficacy in learning and thinking about mathematics. To achieve these purposes, various instructional methods, techniques, and materials (e.g., interactive discussions, math games, challenging math questions) are used in accordance with the lecturers’ educational philosophy and approach. Although the sessions mostly take the form of lectures, these lectures are generally supplemented “by eclectic exercise sessions where students are introduced to such problems as Hilbert’s Hotel and encouraged to construct their own proofs” (Alladi & Rino-Nesin, 2015, p. 655). In addition, Socratic questioning is used to make the sessions more thought-provoking, and active student involvement is encouraged.

What makes the Math Village interesting and appealing to both parents and students is that during the camp, students become part of the village community. Specifically, students stay in stone and clay houses or tents and share almost all chores (e.g., cleaning toilets, helping the cook) with their peers so as to contribute to village life. They also spend quality time interacting with their peers, lecturers, and volunteer staff in different village environments. Thus, apart from the mathematics-related aims, the natural expected outcome of village life and the shared responsibilities is for students to improve their collaboration skills, social skills and sense of responsibility and to learn to overcome prejudices towards strangers.

With this background in mind, the current study was designed to test the effectiveness of a non-traditional short summer math camp in changing students’ attitudes towards mathematics by evaluating an existing intervention at the math village in Turkey. We also considered level of happiness, conceptualized as life satisfaction (Diener et al., 1999), to help us understand this possible change and aimed to gather some important insights into the effect of village life on students. We specifically aimed to find answers to the following research questions:

1. What is the effect of education at the Math Village on the students’ attitudes towards mathematics?
2. To what extent does life satisfaction affect the change in students’ attitudes towards mathematics?
3. How do the qualitative results explain the effect of education in the Math Village on the students’ attitudes towards mathematics?

Based on data gathered at a non-traditional math camp in a national context, our research provides an exciting opportunity to advance our knowledge of if and

how students' attitudes towards mathematics can be changed positively through a two-week summer camp. It also enhances our understanding of the extent to which happiness works to change student attitudes towards mathematics.

Method

It has been argued that a mixed method approach involving both quantitative and qualitative measurement of the relevant concepts is more effective in recognizing possible factors behind certain attitudes (Hannula, 2002). This kind of methodology is especially useful if there is a shortage of data on the subject matter. In particular, the use of narratives in studies of attitudes towards maths is considered important for assessing and understanding individuals' perceptions (e.g., Brown & Cooney, 1991). Our approach therefore makes use of both quantitative data and narratives derived from participants' explanations of their experiences. We collected quantitative data through the use of questionnaires and used qualitative interviews to supplement the quantitative measures.

Participants

Students. Out of 80 students who attended the 2-week program at the MV during the 2015 summer school for high school students, 67 students participated in the first phase (pre-intervention) of our study. After some drop outs, we ended up with 57 students (23 females and 34 males) who participated in both phases of the quantitative part of our study. As Table 1 shows, the age of the students ranged from 14 to 19 ($M = 15.91$, $SD = 0.97$), and they were enrolled in Grades 9 to 12.

Table 1
Characteristics of Participants (n = 57)

		<i>n</i>	%
Gender	Male	34	59.6
	Female	23	40.4
Age	14	3	5.3
	15	15	26.3
	16	27	47.4
	17	9	15.8
	18	2	3.5
	19	1	1.8
Grade	9	20	35.1
	10	26	45.6
	11	10	17.5
	12	1	1.8

Among the students who filled in the questionnaires in the first phase of the study, we randomly selected 12 students for focus group interviews through maximum variation sampling based on their gender and grade level. This is an approach which “increases the likelihood that the findings will reflect differences or different perspectives” (Creswell, 2013, p. 157). However, as three students we selected did not wish to participate in the focus group interviews, we asked for volunteers among the other students and selected three students accordingly. As Table 2 shows, seven female and five male students participated in the study. The participants’ ages varied from 14 to 17 and their grade levels ranged from 9 to 11.

Table 2

Focus Group Participant Characteristics

Students	Gender	Grade	Age	Location of school
S1*	F	9	14	Balıkesir
S2	M	11	17	Manisa
S3	F	10	16	Ankara
S4	M	9	15	Izmir
S5	M	10	15	Istanbul
S6	F	9	15	Mersin
S7	F	10	16	Ankara
S8*	F	10	16	Bursa
S9	F	10	16	Burdur
S10*	F	9	16	Izmir
S11	M	9	16	Izmir
S12	M	9	16	Batman

Note. Abbreviations: F = Female, M = Male, * = Did not participate in the second interview.

Lecturers. Using individual interviews, we also collected qualitative data from three lecturers (one female, two males) teaching at the math village on a voluntary basis. These lecturers had Ph.D.s in mathematics from well-known universities and were professors of mathematics at reputable Turkish universities. They had been teaching at the village since its founding.

Data Collection Instruments

Mathematics Attitude Scale (MAS). We used the Mathematics Attitude Scale developed by Duatepe and Cilesiz (1999) for Turkish students. The MAS is a multidimensional scale focusing on beliefs, emotions, and behaviors about mathematics. Each item was rated on a 5-point scale from 1 (disagree strongly) to 5 (agree strongly). The alpha reliability for MAS in the current study was .60.

Students’ Life Satisfaction Scale (SLSS). We employed the Students’ Life Satisfaction Scale (SLSS; Huebner, 1991) to measure students’ evaluations of their lives in general. Each item was rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). We used the Turkish version of the SLSS (Siyez & Kaya, 2008). The alpha reliability for the SLSS was .84 in the present study.

Interview schedules. We developed three interview schedules in line with our research questions, the related literature, and the quantitative measures we used in our study to extend our understanding of the factors influencing the change in students' attitudes towards mathematics. After developing the interview schedules, we collected expert opinions on them. We developed the lecturer interview schedule to obtain data on the aims, instructional methods, activities and materials as well as the overall framework and concept of the Mathematics Village. We also developed two focus group interview schedules. The first interview schedule, which was administered before the students started their education at the MV, included questions on the students' perceptions of their abilities in mathematics and the possible impact of the MV on the students and their attitudes towards mathematics. The second interview schedule, which was used after the students completed their education at the MV, focused on the impact of the MV on students and their attitudes towards mathematics and what instructional and village life practices had been effective in triggering students' change process.

Data Collection

We collected the data in two phases: Figure 1 presents the data collection procedure employed in our study.

Phase I. The first phase of the study was conducted before the Mathematics Village started. Prior to the data collection process, we emailed an informed consent form to the parents of all students who would attend the Mathematics Village. We also called the parents to answer any questions they might have about the study. After getting parental approval, we asked students who were interested in participating in the study to fill in the MAS and SLSS using a link we sent them via email. We then conducted two focus group interviews (with each group comprising six participants) prior to the students' education at the village using the focus group interview schedule we developed. Two researchers acted as moderators in the interviews. The focus group interviews included demographic questions, questions about how the students had found out about the math village, and students' attitudes towards mathematics. We tape recorded the interviews after getting approval from the students.

Phase II. The second phase of the study took place after the students' education at the village. In the second phase, we again asked students to fill in the MAS and SLSS. We conducted the second focus group interviews with the same participants who attended the first focus group interviews to examine the impact of their education at the math village on their attitudes toward mathematics and their life satisfaction level. As three students did not wish to attend the second focus group interviews, the total number of participants at this stage was nine. In addition, we conducted individual interviews with three lecturers who taught at the MV.

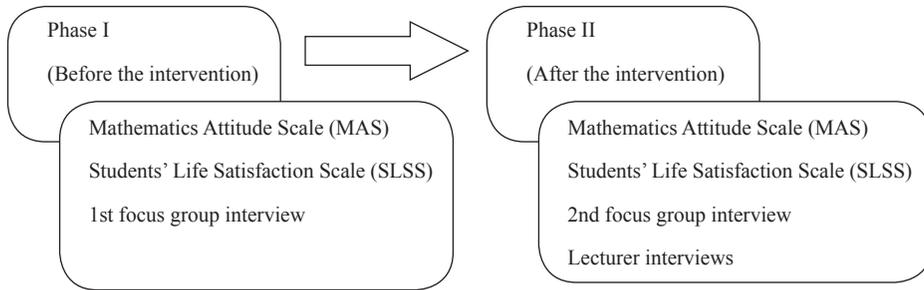


Figure 1. Data collection process.

Data Analysis

We analyzed the quantitative data with SPSS 20 (IBM Corp, 2011) and the MBESS R package Version 1.1-9 (R Core Team, 2015). We used QSR NVivo 10 (QSR International, 2012) to conduct content analysis of the interview data. For the qualitative data, we conducted data collection and analysis hand-in-hand, as suggested by Creswell (2014). We first transcribed the focus group and individual interviews and used labels to protect the participants' privacy (e.g., S1 for Student 1; L1 for Lecturer 1). We uploaded the transcriptions to NVivo. We then coded the data using the preliminary code list we had prepared on the basis of our research questions, the related literature, and the quantitative tools (i.e., MAS, SLSS) we used in our study. We also added new codes that appeared during the coding process to the preliminary code list. Among the codes we used were "abstract mathematical thinking", "change in attitudes", and "meeting and interacting with peers". After we coded the interviews, we double-coded the data to reduce redundant codes and group the codes under themes (Creswell, 2013). Using a computer program for data analysis helped us "build levels of analysis and see the relationship between the raw data and the broader themes" (Creswell, 2013, p. 206).

Results

Quantitative Results

We used R to answer our research questions on the effect of education at the math village on students' attitudes towards mathematics and the moderating role of life satisfaction on this relationship. We formed mixed effects models with the *lme4* (Bates, Maechler, Bolker, & Walker, 2015) package for R to test our hypotheses.

The variables of interest have skewness and kurtosis between 1 and -1, with the exception of life satisfaction (kurtosis = -1.123 at Time 1); as such, the normality assumption is not violated. Our dependent variable was measured via MAS, which is a 38-item scale, with each item scored from 1 to 5; the lowest possible score is 38 and

the highest possible score is 190. MAS had a mean of 149.9 ($SD = 9.6$) at Phase 1 and a mean of 153.2 ($SD = 10.3$) at Phase 2, with $N = 57$. The null model is

$$M_0: y_{ij} = \beta_{0j} + \epsilon_{ij} \quad (1)$$

where y_{ij} is the MAS score of respondent j at time i , β_{0j} is the mean MAS score of respondent j and ϵ_{ij} is the error term. The model M_0 represents the *null hypothesis*; that is, the change in MAS score of each respondent is not related to the educational program. The model which was built to capture the first research question is

$$M_1: y_{ij} = \beta_{0j} + \beta_1 x_i + \epsilon_{ij} \quad (2)$$

where y_{ij} is the MAS score of respondent j at time i , β_{0j} is the intercept for respondent j (which is not the same as β_{0j} from the null model), x_i is the time variable (so x_1 is 1 and x_2 is 2) and β_1 is the slope. The model M_1 incorporates the time variable into the model M_0 and therefore accounts for the effect of the educational program. The model corresponding to the second hypothesis is

$$M_2: y_{ij} = \beta_{0j} + \beta_1 x_i + \beta_2 z_i + \epsilon_{ij} \quad (3)$$

where everything is as in M_1 and z_i represents the *interaction* between time and respondents' life satisfaction scores. Respondents' life satisfaction scores were converted to z-scores.

These models were fitted to the data with the *lme4* package. The results of the Type-III ANOVA comparing the fit of the three models are presented in Table 3. We compared the models to each other consecutively. The p-values represent the probabilities corresponding to these comparisons.

We found that M_1 is a better fit than M_0 with $p < .05$. Therefore, M_1 explains the data better than the null model M_0 , and we conclude that the effect of the educational program is significant with $p < .05$. Moreover, M_2 is a better fit than M_1 with $p < .01$. Therefore, the effect of life satisfaction on the change in students' MAS scores is significant with $p < .01$. The slopes of the models are given in Table 3 as well. These coefficients show that education at the math village increased respondents' MAS scores by 3.36 points on average. Beyond this 3.36 point base-level increase in MAS scores, respondents with life satisfaction one standard deviation above the mean had a 2.04 point additional increase in their MAS score. Hence, a student with life satisfaction equal to the mean ended up with a 3.36 point increase in his MAS score, and a student with life satisfaction one standard deviation above the average ended up with a 5.4 point increase in his MAS score.

Table 3
ANOVA Results Comparing the Fit and Slopes of the Models

	Log Likelihood	Deviance	p	β_1	β_2
M_0	-421.12	842.23			
M_1	-418.54	837.09	0.023	3.36	
M_2	-413.35	826.71	0.001	3.36	2.04

Qualitative Results

The qualitative analysis of the interview data on NVivo revealed two major themes: changes in attitudes and approach towards mathematics and personal improvement. Figure 2 presents the themes and sub-themes that emerged from the data.

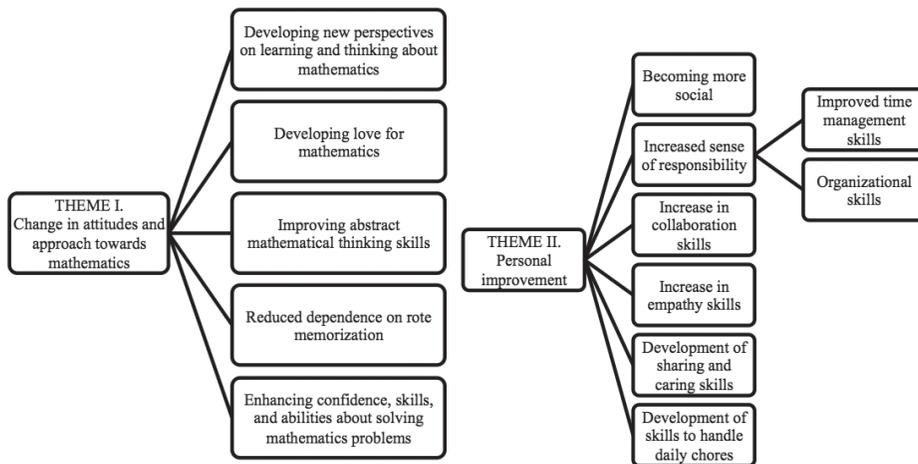


Figure 2. Themes and codes that emerged from the qualitative data.

Change in attitudes and approach towards mathematics. The first theme emerging from the interviews was the *change in attitudes and approach towards mathematics*. The data from the focus group interviews indicated that the math village positively changed students’ attitudes and approach towards mathematics in a number of ways. Firstly, as seen in Figure 2, we found that education at the MV helped the students notice that mathematics was an extremely diverse subject and not limited to the mathematics topics they learned in school. This enabled the students to develop new perspectives on learning and thinking about mathematics. To illustrate, S11, (male, 9th grader) stated that:

...I’ve developed an idea about how to think [about mathematics] and how to approach [mathematics] problems [at the math village]. I don’t believe that I’ve completely gained that ability for sure; however, I notice a change in my approach to some problems. I can observe this.

In line with this, the data from the focus group interviews also revealed that the math village enabled the students to develop a love for mathematics, improve abstract

mathematical thinking skills and reduce their dependence on rote memorization. It also enhanced their confidence, skills, and ability to solve different mathematics problems. We found that some instructional practices employed at the MV were successful in triggering the change in students' skills, abilities and attitudes about mathematics. Most sessions took the form of lectures, which were accompanied by various instructional practices. Among the effective practices supplementing the lectures were: introducing the students to the idea that math was a vastly diverse subject through different activities, creating thought provoking sessions based on interesting mathematics topics and examples, using Socratic questioning to promote abstract and mathematical thinking skills, presenting different ways to solve mathematics problems, teaching students how to solve problems instead of giving answers of the problems, and using humor in classes. To illustrate, S5 (male, 10th grader) stated that:

For example, there were lots of interesting questions in X's [name of the teacher] class. I mean, s/he approached the problems in different ways...This attracted my attention.

Similarly, S11 (male, 9th grader) said:

Well, we created lots of [mathematics] problems and thought about alternatives to their solutions. It is easier to understand [the questions] through different perspectives.

In line with this, S6 (female, 9th grader) said that:

... the proof methods we learned here enable us both to check the validity of something and to solve problems. I think this helps us to gain a perspective [on mathematics]. I mean it gives a new perspective to any problem, even to the easiest problem.

Responding to a question asked by the interviewer about the things that made the classes enjoyable and meaningful, S4 (male, 9th grader) stated that:

X's [name of the teacher] sense of humor... For example, he writes down long problems on the board and calls it meaningless algebra. He turns abstract to concrete at the end. Then, there is something [meaningful]. I get surprised.

Apart from effective instructional practices, the results also indicated that teacher competencies, namely teachers having a high level of field-specific knowledge, asking original and interesting math questions, and providing immediate responses to math questions asked by the students enabled the students to develop positive attitudes towards mathematics and their education at the math village, and to enjoy being there. To illustrate this point, S6 (female, 9th grader) stated that:

They [the lecturers] also have deep knowledge in their areas of interest... Most probably, as far as we see, they are qualified on all topics...This enables them to respond immediately to a

question without thinking about it or enables them to write an original [mathematics] question [on the board]. That's why it [the education] might be more enjoyable.

Similarly, S7 (female, 10th grader) said that:

The lecturers' being very sincere and teaching as if I were having a chat with my friends... For example Lecturer X [name of the lecturer] beautifies mathematics through providing philosophical information, making analogies...These were enjoyable things for sure.

The results indicated that the abovementioned practices and competencies not only enabled the high school students to develop positive attitudes and approaches towards mathematics and education at the math village but also created an emerging need and interest to improve their own abstract mathematical thinking and math skills and abilities by raising the students' mathematics self-efficacy and learning motivation. In line with this, the results also indicated that although the students believed that the changes in their attitudes and approach to mathematics would not directly affect their school grades, they expected an indirect impact of these changes on their school performance. To illustrate, S6 (female, 9th grader) said that:

Well, I use school [mathematics] education as a vehicle. ... non-relevance of math village education to school education is fine for me...Well, as we improved here, this would definitely have an influence on classes at school.

Personal improvement. The second theme emerging from the interviews was *personal improvement*. The data from the focus group interviews indicated that the MV positively influenced the students' personal improvement process in a number of ways. One of the important effects of the MV on students was that it enabled them to meet and interact with peers and/or lecturers, and thus engage in socialization. By way of illustration, S9 (female, 10th grader) noted that:

It was great to meet new people. I met new cultures by meeting them [my new friends]....I learnt their life styles. It was very different. I am very happy to have met them.

Similarly, S4 (male, 9th grader) said that:

I enjoyed [being here] very much. I was very happy...I met new friends...Apart from this, there were times that I had a chat with the teachers. We had great discussions. I enjoyed the classes. I was happy.

Secondly, the results showed that sharing responsibilities (e.g. making tea, cleaning toilets, helping the cook), informal gatherings among participants in the evenings, and contributing to daily life in the village had a positive impact on the students' personal improvement process by increasing their sense of responsibility, collaboration skills, empathy skills, and sharing and caring skills, which were found

to be four interrelated sub-themes. For example, reflecting on the impact of the MV on his self-development process, S11 (male, 9th grader) noted that:

We were too individual [when we came here]. I mean simple ambitions and the desire to outshine the others have faded away to the moments [here] when everybody helps each other more, is tolerant, and thinks about the others instead of being arrogant.

Next, the results also indicated that sharing chores in the MV equipped students with the ability to deal with the demands of everyday life by developing their skills to handle daily chores. To illustrate, S9 (female, 10th grader) stated that:

...For example the things we have learned here could be applied at home. I will have more self-confidence when I start university. I will not think about who will cook at home. I'll cook myself.

Similarly, S12 (male, 9th grader) said:

I have done chores I hadn't done in my life before here, such as cleaning the toilets. This was a good thing too. I had thought I would never do this, but I came here and changed a bit.

Another notable example is as follows:

I thought this while we were washing the dishes together [with my friends]: I mean if I weren't a student, if I were abroad, and if I didn't have any money, I could wash the dishes. I noticed this...[Normally] It [washing the dishes] is not an enjoyable thing, but it can be enjoyable. It was a different kind of enjoyment that we had responsibility; because, we, in fact, were maintaining order in the village all together... (S7, female, 10th grader)

Conclusions and Discussion

In this study, by addressing a point of international concern in mathematics education, we aimed to find out (a) if and how students' attitudes towards mathematics can be positively changed through an out-of-school-time program (in our case, a summer math program) and (b) if students with higher life satisfaction showed more improvement in their math attitudes. The quantitative results indicated that a two-week summer math camp did change students' attitudes towards mathematics in a positive way, which is consistent with the findings of [Zan and Di Martino \(2007\)](#), [Eshun \(2004\)](#), and [Hannula \(2002\)](#), who demonstrated that attitudes towards mathematics can be changed in a short time. It is also encouraging to compare this result to other studies (e.g., [Hodges & Kim, 2013](#); [Pepin, 2011](#)) that found a significant increase in students' math attitude scores as a result of mathematics interventions and with those that achieved similar results in out-of-school-time program contexts (e.g., [Chacon & Soto-Johnson, 2003](#); [Tichenor & Plavchan, 2010](#); [Wiest, 2010](#)).

The data from qualitative interviews helped to contextualize the quantitative data and provided some evidence for a positive change in students' attitudes towards mathematics. More importantly, the qualitative data also offered some insights into the possible factors that affected this change. Based on student and lecturer interviews, we found that their education at the village enabled the students to develop more abstract mathematical thinking skills, a better understanding of how to solve mathematics problems, and new perspectives with regard to learning and thinking about mathematics. The results also indicated that the students had positive attitudes towards the instructional practices employed in the village. Among the effective instructional practices contributing to the aforementioned changes were use of active learning, interesting/meaningful topics, mathematics problems and anecdotes, a sense of humor, Socratic questioning, and activities enhancing abstract mathematical thinking and problem solving skills. These results might suggest that students' emotions about the use of these practices had an effect on their attitudes towards mathematics. As suggested by the studies of [Fraser and Kahle \(2007\)](#) and [Mata et al. \(2012\)](#), when students perceive the learning environment as positive and supportive, they are more likely to develop positive attitudes. It is possible, therefore, that as the students experienced positive feelings about the new approach towards learning mathematics (compared to traditional classrooms) and developed new skills and strategies for learning and understanding mathematics, they developed a love for mathematics and more positive attitudes towards mathematics.

Additionally, the results indicate that attitude is a multidimensional concept, with both emotions and cognition playing an important role in attitude formation, as suggested by [Hannula \(2002\)](#). These results further support previous research that showed the importance of effective instructional practices in changing attitudes (e.g. [Bullmaster-Day, n.d.](#); [English & Gainsburg, 2015](#); [Samuelsson & Granström, 2007](#)), and indicate that mathematics education should move beyond traditional instruction (e.g., rote memorization, a lack of student involvement) in order to enable students to develop more positive attitudes towards mathematics.

It is also interesting to note that lecturer competencies (e.g. a high level of field-specific knowledge, asking original and interesting math questions, and providing immediate responses to student questions) were found to have a positive influence on students' attitudes towards mathematics as well. This finding is in agreement with the ideas of [Wiest \(2010\)](#), who suggested high quality staff as one of the strengths of successful mathematics camps. It corroborates the findings of [Maat and Zakaria \(2010\)](#), who found that students' perceptions of their teachers made a difference in students' attitudes. It is therefore likely that a teacher who has a high level of content and pedagogical knowledge might make a difference in changing students' attitudes towards mathematics. This finding has important implications for the recruitment of

mathematics teachers with high competencies and/or increasing teacher competencies to provide students with high-quality education.

Another important finding revealed in both the quantitative and qualitative analyses is that students' happiness level did matter in explaining the change in students' attitudes towards mathematics. Using a highly reliable life satisfaction scale, we found that the math attitudes of students with higher life satisfaction changed more positively compared to their counterparts with relatively lower happiness scores. Although the relationship between happiness and students' attitudes towards a certain course has not been directly investigated empirically so far, it is possible to predict that student happiness and attitudes are linked in a positive way. In this respect, our results support the ideas of Myers (1992), who suggested that happy students are more successful and better problem solvers, and those of Lyubomirsky (2001), who found that happy individuals were more flexible in problem solving compared to relatively unhappy individuals. Approaching the term attitude in a multidimensional sense, we believe that happy students interpreted their experiences in the math village more positively, resulting in more positive attitudes towards mathematics. It can therefore be assumed that there is a relationship between happiness and attitudes towards mathematics. On the other hand, in order to develop a fuller picture of this relationship, additional experimental and longitudinal studies are needed.

In addition, the qualitative results suggested that aside from creating a positive change in students' attitudes towards mathematics and competence in mathematics, the village had a positive impact on the students' self-development process. The results indicated that being part of a community, sharing responsibilities, and interacting with peers, teachers, and volunteers in the village enabled the students to socialize; have an increased sense of responsibility, collaboration skills and empathy skills; and develop their skills in handling daily chores. The qualitative interview data suggests that this kind of self-development may have increased students' life satisfaction, which in turn enabled them to develop more positive attitudes towards the math education at the village. These findings are consistent with the results obtained in Chacon and Soto-Johnson's (2003) study, which revealed that social activities were an effective practice during a summer math program. These findings might also support Singh et al.'s (2002) suggestion that students' attitudes towards mathematics are influenced by multiple factors. Thus, it appears that interventions aimed at creating positive changes in students' mathematics attitudes should address multiple factors, and place particular emphasis on affective and cognitive factors.

There are certain limitations to this study. Firstly, the sample size was small, which prevented us from running further analyses. Secondly, the participants in this study were from families with middle to upper middle class socio-economic backgrounds,

so the findings can only be generalized to student populations with similar socio-economic characteristics. Thirdly, we used a mathematics attitude scale which mainly assessed beliefs, emotions, and behaviors about mathematics. It would be interesting to use different mathematics attitude scales that focus on different dimensions to assess the change in attitudes towards mathematics. Regarding this scale, the low alpha reliability coefficient also represents a limitation. We also believe that further research may benefit from using different measures of happiness, such as those measuring positive affectivity or subjective happiness. Apart from this, an issue that was not addressed in this study was the sustainability of the impact of the summer math camp on students' attitudes towards mathematics and self-improvement processes. Future studies may wish to focus on the longitudinal impact of the mathematics village on students' attitudes and personal improvement processes to find out to what extent it is sustainable. In addition, it would also be interesting to assess the effects of contextual factors -uncontrolled factors in our study - on students' attitudes towards mathematics. Finally, an important limitation of this study is that the student participants already had positive attitudes towards mathematics when they came to the village, which may have made it easier to improve their attitudes. It would be useful for future studies to work with a more heterogeneous sample with attitude scores ranging from negative to positive.

Notwithstanding these limitations, this study is the first to empirically test the effectiveness of an existing non-traditional mathematics education program at a math village in Turkey and, as such, provides valuable data on whether mathematics attitudes can be changed in a positive way. We not only found support for this, but also for the argument that an important individual-level variable - happiness - can make a difference in understanding this change. Apart from contributing to the literature on attitudes towards mathematics, this study therefore further highlighted the importance of student happiness on positive educational outcomes, which has been emphasized in a number of studies. Although we did not specifically focus on the relationship between the level of student motivation and the effect of village life on students' mathematics attitudes and personal improvement processes, based on the data we gathered, we can state that the nontraditional instructional approaches, social activities and being part of a village community might help students who have no motivation or a low level of motivation develop positive attitudes towards mathematics and make some gains with regard to personal improvement. We believe that these qualitative results need to be further explored in quantitative studies to shed more light on this matter. Although the present study was carried out at a national level, we believe that it offers some international insights on designing effective interventions to improve student attitudes towards mathematics, especially in similar out-of-school-time programs.

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