

Lower secondary students' views about mathematicians depicted as mathematics teachers

Vesife Hatisaru

University of Tasmania, Australia

The present study examined lower secondary students' images of mathematics, comprised of stated attitudes to and perceived needs for mathematics, and views about mathematicians and their work. A group of 1284 lower secondary students drew a picture of mathematician at work and described their drawings. The students' drawings fell into two distinct groups: drawings that depicted their view of what a mathematician at work would look like, and drawings that depicted a mathematician who was clearly a mathematics teacher. This article presents the data regarding the latter group. Trends that emerged from the drawings in this sample included that mathematics teachers were: predominantly female; had a positive image; incorporated lectures, explanations, and demonstrations; and used whiteboards and books as tools of the profession. The article concludes with possible implications for practice and research.

Keywords

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Correspondence

vesife.hatisaru@utas.edu.au

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1 Introduction

Mathematics is “an enabling discipline for Science, Technology, Engineering, and Mathematics (STEM)-based university studies and related careers.” (Forgasz, Leder, & Tan, 2014, p. 369). Over time, much research has been published on the images of mathematics (e.g., Martin & Gourley-Delaney, 2014) and mathematicians (e.g., Aguilar, Rosas, Zavaleta, & Romo-Vázquez, 2016). This body of research shows that many students find mathematics boring (Stiles, Adkisson, Sebben, & Tamashiro, 2008), difficult, and complicated (Markovits & Forgasz, 2017). Moreover, students appear to rely on some negative views about mathematicians (Picker & Berry, 2000), and have a lack of knowledge about the work of mathematicians (Latterell & Wilson, 2012; Picker & Berry, 2000; Rock & Shaw, 2000). Those student images significantly relate to their performance in (Wong, Marton, Wong, & Lam, 2002) and attitudes to mathematics (Aguilar et al., 2016). Furthermore, students who have negative images of mathematics (Latterell & Wilson, 2004) and know little about the work of mathematicians are less interested in pursuing mathematics (Latterell & Wilson, 2012; Piatek-Jimenez, 2008) or math-related careers (Piatek-Jimenez, Cribbs, & Gill, 2018).

The attainment of STEM degrees within the young population in Turkey is important for the progress of its economy (PwC, 2017). One of the fundamental



concerns of business organizations is the need for an adequate number of qualified employers (e.g., The Turkish Industry and Business Association). On the other hand, the business sector needs a STEM-skilled workforce, “in order to stay in the race in the global economy, which is led by technology, innovation and digitalisation” (PwC, 2017, p. 9). On the other hand, between 2013 and 2016, the percentage of STEM graduates within the country was only approximately 17%. The performance of students in science and mathematics measured against international benchmarks has stalled or declined (Mullis, Martin, Foy, & Hooper, 2016) as has the participation in tertiary mathematics courses (Nesin, 2014) and interest in science related careers. A study comparing a total of 1,800 grade 3, grade 7, and grade 10 students’ perceptions of scientists and doing science across Turkey, China, India, South Korea and the United States of America (USA) revealed that Turkish students held stronger stereotypical views of scientists than students in India, the USA and China, and about half of the Turkish sample indicated they would not want a career in science or science-related areas (Narayan, Park, Peker, & Suh, 2013). Unpacking students’ images of mathematics and views about mathematicians is a useful first step in getting students to think about future careers in STEM (European Commission [EC], 2011).

A review of past studies indicated that relatively little research has been done on students’ images of mathematics or mathematicians in Turkey (Ucar, Piskin, Akkas, & Tasci, 2010; Yazlik & Erdogan, 2016). Ucar et al. (2010) examined a group of nineteen elementary school student attending a supplementary school, while Yazlik and Erdogan (2016) focused on the perceptions of high school students. The aim of the study reported here was to determine the image of mathematics held by a large group of Turkish lower secondary students’ (grades 6 to 8) through an examination of their drawings.

2 Framing the study

2.1 The image of mathematics

A review of the literature revealed that there is no universally-held view on the image of mathematics. Nevertheless, a consensus has been reached on the components that contribute to an individual’s image of mathematics such as attitudes, beliefs, views and emotions regarding mathematics.

Synthesizing Roger's (1992) and Thompson's (1996) conceptions of image, Sam and Ernest (2000) defined the image of mathematics as "a mental representation or view of mathematics, presumably constructed as a result of social experiences, mediated through interactions at school, or the influence of parents, teachers, peers or mass media." (p.195). They operationalized this definition of the image of mathematics to include eleven components including stated attitudes; feelings; descriptions or metaphors for mathematics; views about mathematicians and their work; and beliefs about the nature of mathematics, mathematical ability, or sex differences in mathematical ability.

Wilson (2011) proposed an operational construct to define the factors that might influence individuals' engagement in mathematical activity which coincides with the image of mathematics construct. He used the term 'disposition' composing of beliefs/values/identities, affect/emotions, behavioral intent/motivation, and needs (relating to the Maslow's hierarchy). Wilson (2011) accepted needs as a contributory factor influencing an individual's disposition. That is, an individual might value learning mathematics despite a lack of interest or enjoyment because s/he found it useful. The needs element was not explicitly stated in Sam and Ernest's (2000) conception of the image of mathematics, but it could coincide with the factors that influence people's images in their model (Lane, Stynes, & O'Donoghue, 2014).

Combining the definitions of Wilson (2011) and Sam (1999) with other research in the affective domain such as Hannula (2007), Lane et al. (2014) defined the image of mathematics as "a mental representation or view of mathematics, presumably constructed as a result of past experiences, mediated through school, parents, peers or society." (p.881). According to Lane et al. (2014), the term 'image of mathematics' is composed of three domains: the affective domain (attitudes, emotions, and self-concepts relating to mathematics and mathematics learning experiences), the cognitive domain (beliefs relating to mathematics and mathematics learning experiences), and the conative domain (motivation relating to mathematics learning). Consistent with Sam and Ernest (2000), in Lane et al.'s (2014) study, students' images of mathematics were influenced by their mathematics teachers, past experiences of mathematics, parents, peers, and prior mathematics achievement. However, participant students cited their mathematics teachers as the main influence on their images of mathematics which aligns with Yazlik and Erdogan's (2016) findings.

This study examined lower secondary students' images of mathematics which were found to be comprised of various components. The images of mathematics

provided were found to be well predicted by students' attitudes (Lane et al., 2014; Sam & Ernest, 2000; Wilson, 2011), perceived needs for mathematics (Wilson, 2011), and views about mathematicians and their work (Sam & Ernest, 2000). While in the larger study I researched these three components in relation to the image of mathematics, in the portion of the study presented here, I report on students' views about mathematicians and their work.

2.2 Drawings in exploring the views about mathematicians

In educational research, inquiring into students' own conceptions of their educational experiences is vital (Haney, Russell, & Bebell, 2004). One technique employed to document students' conceptions about their teaching and learning experiences is drawings (Gulek, 1999).

Historically, the research capturing individuals' views about mathematicians through drawings arose from Mead and Metraux's (1957) seminal work examining the perceptions students held about scientists. These authors asked approximately 35,000 high school students around the USA to write a short essay about their perspectives of science and scientists. Through the years the "Draw a Scientist Test (DAST)" (Chambers, 1983) was patterned from Goodenough's (1926) "Draw a Man Test" (see Thomas, Pedersen, and Finson (2001) for a comprehensive review). This effort opened the way for researchers such as Picker and Berry (2001) to consider having students draw a mathematician on a blank sheet of paper to describe the perceptions reflected in students' drawings of mathematicians, which was called "Draw a Mathematician Test (DAMT)". Over time, the use of drawings as a measure of the perceptions of young students was found to be a valid (Losh, Wilke, & Pop, 2008) and a less expensive alternative to systematic classroom observations (Haney et al., 2004), and a method which overcame students' reticence to completing a written questionnaire.

Below, I reported how existing studies provided evidence on students' views about mathematicians.

3 Views about mathematicians found in prior research

Picker and Berry (2000) investigated the perceptions of mathematicians held by lower secondary school students in the USA, the United Kingdom (UK), Finland, Sweden and Romania by using the DAMT, and compared students' images. The study

revealed seven themes in the students' drawings including "mathematics as coercion", "the foolish mathematician" and "the mathematician with special powers" in which mathematicians are drawn respectively as large authority figures, as crazy men, or as people who have some special power. The results showed that when asked about their perceptions of mathematicians, 21.4% of the students portrayed a mathematics teacher. In some drawings, teachers appeared to be intimidating, violent, or threatening, while in a few, the teacher was pictured pointing a gun at the student(s). The findings of Ucar et al. (2010) who used pictures and follow-up interviews to investigate the beliefs about mathematics and mathematicians of nineteen elementary school students attending a supplementary school, supported Picker and Berry's (2000) findings. Their results showed students mostly pictured mathematicians as lonely and unsocial, intelligent but weird people, while they viewed mathematics teachers as angry and unfriendly.

In their study of what students think about mathematicians, Rock and Shaw (2000) used three open-ended questions to survey students (kindergarten – grade 8) and invited them to draw a picture of mathematician at work. Their questions were: What do mathematicians do? What types of problems do they solve? and What tools do they use? A total of 215 students from kindergarten through eighth-grade participated in the survey and 132 students from kindergarten through fourth-grade drew a picture. The findings showed that students viewed mathematicians doing the same mathematics in their work as they themselves do in their mathematics classrooms. In most students' drawings mathematicians were shown in classrooms. Young respondents named tools with which they are familiar from their own classrooms (e.g., paper, pencils, whiteboards etc.) as tools of mathematicians, second and third grade respondents mentioned calculators, rulers, geometric shapes while fourth-grade and middle school students expanded their responses to include computers, calculators and protractors.

Grootenboer (2001) asked about forty pre-service primary teachers to draw a picture of their mathematics teachers. While some participants recalled particular teachers and drew them, others pictured caricatures to represent their memories of mathematics teachers. The author synthesized the participating teachers' descriptions and wrote three fictional characteristics: Mr Wilson, Mr Bates and Mr Dayman. The most common character was Mr Dayman who was depicted in several of the participants' pictures with horns and a pitch fork. He was a brilliant mathematician but did not have empathy for others who did not share this ability. Because of his

belittling and sarcastic comments, some students were resentful of him; one student did not even talk to him for two terms due to being too scared. As Grootenboer (2001) summarized, some students “failed miserably, hated mathematics, and went on to avoid mathematics at all costs” by the end of their year with Mr Dayman (p. 15).

More recently, Aguilar et al. (2016) described the images of mathematicians held by a group of 63 high-achieving Mexican students, from their pictorial and written descriptions. They reported that students mostly imagined a mathematician as a mathematics teacher and predominantly pictured mathematicians as male, dressed casually or formally, intelligent people who enjoyed their work and were passionate about mathematics. The findings suggested that these high-achieving students held representations of mathematicians that were closer to reality. Yazlik and Erdogan (2016) investigated high school students’ perceptions of mathematicians through drawings and written responses to open-ended questions. They found that out of 150 participant students, 146 pictured their mathematics teachers and other four a mathematics teacher. The authors reported that students mostly viewed mathematicians as male; wearing a suit or well-groomed; clever, hardworking, helpful, entertaining or asocial; working in a classroom or office; and using pencils, books and (in few drawings) computers as materials. Participant students perceived mathematics teachers as the main influences on their perceptions of mathematicians.

4 The study

For this study, I drew on DAMT which has been used around the world to research students’ images of mathematics and/or views about mathematicians (e.g., Aguilar et al., 2016; Picker & Berry, 2000; Rock & Shaw, 2000; Stiles et al., 2008; Ucar et al., 2010). As previously described by Picker and Berry (2000), in this study students’ drawings fell into two distinct groups: drawings that depicted their view of what a mathematician at work would look like (19.8%, $n = 254$), and drawings that depicted a mathematician who was clearly a mathematics teacher (70.5%, $n = 905$). In this article I present the data that emerged from the latter group in relation to the research question: *What views do lower secondary students have about mathematicians when depicted as a mathematics teacher?* Whether gender or grade level differences were evident in the students’ views of mathematicians was also of interest.

4.1 Instrument and data collection

The study was primarily qualitative in which the DAMT (see Appendix A) developed by Picker and Berry (2001) was used (with permission) to collect data, by a research team led by the author. Combining drawings with written responses, DAMT consisted of a task and two open-ended items, and a section related to students' demographic information (namely grade level, age, and gender). Students were asked to draw a mathematician at work and then explain their drawing. The purpose of the descriptive narrative was to clarify or expand the information contained in the drawings and to help coding. Item 1 questioned students' views about why we would need mathematics and mathematicians aiming to seek students' views about the work of mathematicians and perceived needs for mathematics. Item 2 aimed to examine students' attitudes to mathematics by presenting the following stem and asking students to complete it: "To me, mathematics is ...". In this study both the drawings and associated written descriptions were analyzed.

We piloted the DAMT with 130 grade 6-8 level students at three schools not participating in the actual study to ensure the clarity of the instrument and determine the time necessary for completing it. After the pilot, the DAMT was sent to schools through the respective district Directorate of National Education, to maximize the response rate. In schools, teachers other than the mathematics teachers provided directions to and collected data from the students. Students were surveyed in classes other than mathematics to eliminate a possible mathematics teacher effect. The DAMT took students approximately thirty minutes to complete and schools returned the completed instrument in a sealed envelope to protect participant confidentiality.

4.2 Participants

The study focused on lower secondary students (aged 12 to 15 years) in order to tap into students' views about mathematicians at the beginning of their secondary education, prior to being influenced by their secondary coursework and the national university entrance exam. A convenience sample of 1284 students (grades 6 to 8) in Ankara, enrolled in twenty different lower secondary schools, with a mix of private and public, participated in data collection under the auspices of the Ministry of National Education (MoNE). The schools were co-educational metropolitan schools located in the center of the city, with a relatively middle or high socioeconomic population based on family income. Boys and girls were almost equally represented

across the cohort, but the number of grade 6 and grade 7 students were more than the number of grade 8 students (see [Table 1](#)).

Table 1. Distribution of participants by grade level and gender.

Grade Level	Girls	Boys	N/R	N
6	213	204	3	420
7	148	157	-	305
8	82	96	1	179
No response	-	-	1	1
Total	443	457	5	905

4.3 Data analysis

The data was analyzed using content analysis (Creswell, 2007) by utilizing a “descriptive and interpretive” approach (O’Toole & Beckett, 2010, p. 43). Instead of seeking the meaning behind each of the drawings, data analysis focused on identifying patterns in the drawings (Haney et al., 2004) documented using excel spreadsheets. A Chi-square test was used to compare perceived teacher gender difference by student gender and grade level.

Coding drawings: The coding began with reviewing a random subsample of drawings and recording the various aspects present in the drawings, and simultaneously reviewing past research to create a comprehensive list of the elements of the views about mathematicians pictured as mathematics teachers in student drawings. In particular I drew upon the work of Blake, Lesser and Scipio (2004), Aguilar et al. (2016) and Losh et al. (2008). To score students’ drawings of mathematicians, Blake et al. (2004) included gender (male, female, no gender), actions of main figure (e.g., teaching, working on problem, performing work), mathematics tools (e.g., books, blackboard, calculator, computer), equations (mathematical symbols, equation), and words (e.g., explaining action, mathematical words). Aguilar et al. (2016) used the following elements in the analysis of mathematician depictions produced by students: kind of clothing (formal, sporty, casual, and laboratory), gender (feminine, masculine), hairstyle (extravagant, formal, and bold), mood (smiling, serious, and angry), eyeglasses (with or without eyeglasses), settings (e.g., classroom, office, laboratory), mathematical symbols (e.g., Sets, Algebra, Geometry), and instruments (e.g., desks, blackboard, sheets, pen, calculator). Among others, Losh et al. (2008) coded occupational details (e.g., beakers, lab coats, or animals for scientists or veterinarians, and chalkboards, books, or pencils for teachers) and attractiveness of

the figure in drawings, i.e. whether the figure smiled or whether the drawing was of a fantasy figure (e.g., a monster). Thomas et al.'s (2001) Draw a Science Teacher Test Checklist consisted of three sections: Teacher (the teacher's activity such as demonstrating or lecturing and the teacher's position such as head of the classroom), Students (students' activity such as passive information receiver, responding to the teacher, and the position of the students such as seated in rows), and Environment (elements typically found inside classroom such as desks in rows, symbols of teaching like whiteboards and materials).

By focusing on the elements that emerged in the students' drawings particular to this study and drawing on prior research, I focused on six elements in the analysis of the drawings and associated written words: (1) the gender of figure, (2) the physical environment, (3) the activity of the figure, (4) the content area, (5) the tools of the profession, and (6) attractiveness feature. Each of these elements comprised several codes as shown in Table 2. After defining the elements and associated codes, I developed statements about what constitutes those codes. The narrative descriptions of students assisted me in coding and allowed me to confirm or reconsider my interpretations.

Table 2. The codes of the elements in the student depictions.

Gender	Physical Environment	Activity	Mathematics content areas	The tools of the profession	Attractiveness
Female	Classroom	Teaching	Algebra	Whiteboard	Smiling
Male	Office	Working	Numbers and operations	Books	Serious
Undefined	No indication	Researching	Geometry	Concrete materials	Thinking
		Reading	Undefined	Exam papers	Angry
		No indication	No indication	Pinboard	Silly
				Technological tools	Bored
			No indication	Undefined	

I coded the gender of figure as female or male considering the physical appearance of the figure (e.g., hair, clothes, mustache) and/or student writing (e.g., the figure's name indicated by the student). If the drawing or writing was not clear enough to decide the figure's gender (e.g., the stick figure had no clothes or details), I created an undefined code.

The physical environment element corresponded to the setting or context in where the figure was depicted. I used the classroom code when the drawing consisted of elements typically found inside classrooms such as a whiteboard, desks, and/or students and the figure was teaching; whereas I used the office code when the figure was depicted at a table, working/studying alone, and the typical classroom elements were not included. When there was no indication to a context, I used a no indication code.

The activity element corresponded to the figure's action. The dominant activity was teaching or instructing, followed by working which included studying mathematics and solving questions. I coded the drawing as teaching when the figure was depicted in classroom, at the whiteboard or desk, instructing, demonstrating or explaining the content area to the students, and coded it as working when the figure was in an office environment alone and doing teaching related work (e.g., marking), studying, or solving questions. When the drawing or writing included no reference to the action of the figure, I used the no indication code.

The mathematical expressions and symbols that appeared in the drawings corresponded to the mathematics content areas element. Notably three areas appeared in the drawings: Numbers and operations, Algebra, and Geometry, but in some drawings, there was no indication to a content area, or the content area was ambiguous (e.g., doodles on a piece of paper). When there was ambiguity, I used the undefined code.

The tools element was occupational materials represented on drawings such as whiteboards, books, and concrete materials used in mathematics teaching. Similarly, on some drawings there was no indication to occupational materials. For those cases, I used the no indication code.

I coded the attractiveness feature through the perceived image of the figure. I coded whether the student's drawing appeared to be some kind of positive rendering such as a "smiling" figure, neutral rendering such as a "serious" or "thinking" figure, and negative rendering such as an "angry" or a "frustrated" figure. When the figure was turned away thereby obscuring its face and there was no any other evidence either in the drawing or writing, I used the undefined code.

In [Figure 1](#) and [Figure 2](#), I present typical examples of student drawings and descriptions to illustrate these codes.

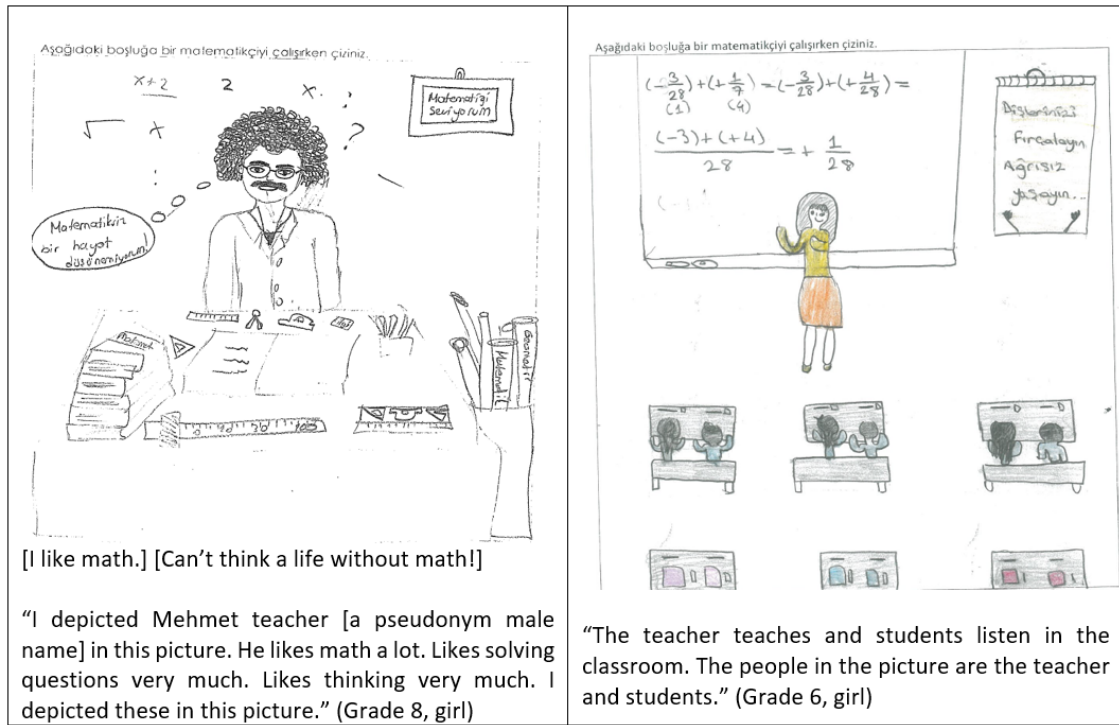


Figure 1. Examples of student drawings and descriptions illustrating the following codes in Table 2, respectively: (on the left) male; office; working (solving questions); Algebra; books, pinboard, and concrete materials; neutral (serious, thinking); and (on the right) female; classroom; teaching; Numbers and operations; whiteboard; smiling.

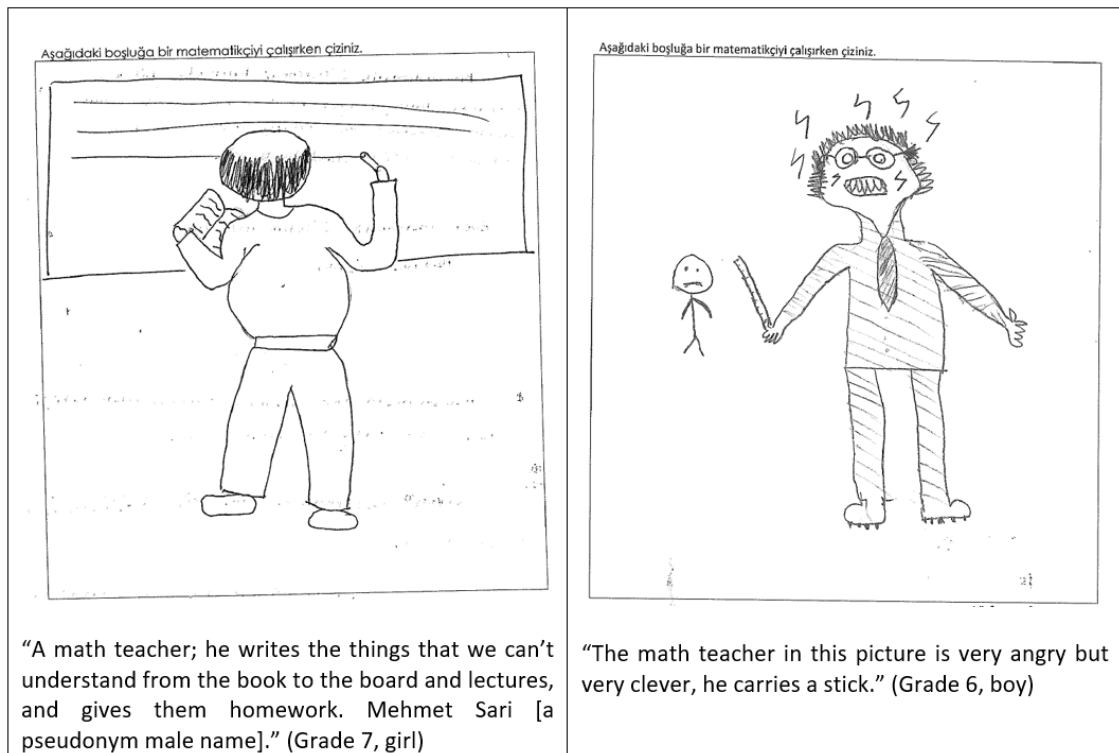


Figure 2. Examples of student drawings and descriptions including illustrating the following codes in Table 2, respectively: (on the left) male; classroom; teaching; undefined; book and whiteboard; undefined; and (on the right) male; no indication; no indication; no indication; no indication; negative (angry).

To ensure reliability of the results, I worked with a second researcher in the research team to code the drawings. Through frequent discussions, we decided the elements in drawings that the data analysis would focus on and described the indicators for each element. We independently coded a random subsample of drawings ($n = 50$) and calculated a high (96%) independent coder agreement. To settle disagreements, we had a re-coding session for the 4% discrepancies. This led to us resolving inconsistencies and reaching consensus about our interpretations. Once finalized, I continued coding for the remainder of the drawings. However, throughout the coding process, I consistently discussed issues that required attention or needed resolution with the second researcher. Wherever possible, I used students' own words in my analysis and reporting.

5 Results

A summary of the elements and respective associated codes that emerged in the depictions that students created to describe the mathematician depicted as a mathematics teacher are presented in [Table 3](#). It is important to note that some responses were coded in more than one category (e.g., across the Algebra and Geometry categories), and therefore the responses did not align perfectly. Below, I present the results in four sections around the elements and use students' own words to illustrate them. Except for the perceived teacher gender, the results did not vary across grade level or student gender, therefore the results have been presented for the whole group.

Table 3. A summary of results classified by the elements in depictions ($N = 905$).

% Gender	% Physical environments	% Activity	% Mathematics content areas	% The tools of the profession	% Attractiveness
Female 57.1	Classroom 78.7	Teaching 76.5	Numbers and	Whiteboard 73.3	Smiling 52.4
Male 39.9	Office 14.4	Working 20.1	operations 41.8	Books 33.5	Serious 16.7
Undefined 3.0	No indication 7.0	Researching 0.3	Algebra 20.3	Concrete materials 7.3	Thinking 7.1
		Reading 0.1	Geometry 14.7	Exam papers 1.5	Angry 6.4
		No indication 3.0	Undefined 18.6	Pin board 0.7	Silly 0.5
			No indication 4.5	Technological tools 0.4	Bored 0.7
				No indication 5.5	Undefined 20.0
Total 905	905	905	963	1106	939

5.1 Gender

The analysis revealed that students tended to view the mathematics teacher as female. More than half of the students (58.6%) depicted the mathematics teacher as female (see [Table 4](#)). Compared to boys, girls showed statistically significant tendency to depict a female mathematics teacher [$\chi^2_{(1)} = 75.27, p < 0,05$]. That is, 73.1% of girls depicted a female and 26.9% of a male mathematics teacher, whereas 44.1% of boys pictured a female and 55.9% of a male mathematics teacher.

Table 4. Depicted teacher gender difference in student gender.

Student gender		Depicted teacher gender		Total
		Female	Male	
Girls	n	320	118	438
	%	73.1	26.9	100
Boys	n	192	243	435
	%	44.1	55.9	100
Total	n	512	361	873
	%	58.6	41.4	100

$\chi^2 = 75.27$ $sd = 1$ $p = 0.000$

The tendency of picturing the teacher as a female became less strong by grade level. The higher the grade level, the number who depicted the mathematics teachers as female decreased. Less grade 8 students depicted teachers as female (49.1%) (see [Table 5](#)) compared to grade 6 (58.9%) and grade 7 (63.8%). In grade 8, the percentage of students who depicted teachers as male or female was almost equal. Depicted teacher gender difference in grade level difference was found significant [$\chi^2_{(2)} = 9.65, p < 0,05$].

Table 5. Depicted teacher gender difference in grade level.

Grade level		Depicted teacher gender		Total
		Female	Male	
6	n	241	168	409
	%	58.9	41.1	100
7	n	187	106	293
	%	63.8	36.2	100
8	n	84	87	171
	%	49.1	50.9	100
Total	n	512	361	873
	%	58.6	41.4	100

$$c^2 = 9.65 \quad sd = 2 \quad p = 0.008$$

5.2 Activity

The teacher was commonly depicted in the classroom (78.7%) and at the whiteboard. In about 15.0% of depictions, the teacher was in an office or a room, but even in some of these depictions they were portrayed at the whiteboard or at the desk.

Key aspects of the teacher's activity in the classroom were lecturing, explaining, solving exercises, or disciplining. In 76.5% of depictions, the teacher pictured when teaching. The mathematical content included in the drawings was generally simple calculations and basic arithmetic. The expressions and symbols that appeared in the drawings corresponded to the primary or lower secondary subject areas such as Numbers and operations (41.8%), Algebra (20.3%), and Geometry (14.7%). In some, the subject being taught was vague. In two drawings, the teacher was seen to be explaining the importance of mathematics. Some verbal expressions on the drawings provided more detail about the teacher's pedagogies and focus, for example:

“Who would like to do this calculation?” (Grade 6, boy).

“Ok, class! We will study Integers today.” (Grade 7, girl).

“Come on, let's do the questions.” (Grade 7, girl).

“Solve this very simple questions!” (Grade 7, boy).

“If there is anyone who has not understood, I will repeat.” (Grade 7, girl).

“If $5x + 1$ is 10, what is x ? Whoever solves get 100 points.” (Grade 8, boy).

In 20.1% of drawings, the teacher was depicted as working, or the students implied that the teacher was working. In 41 of these depictions, students stated that the teacher's work was related to class teaching such as preparing for the class, marking,

or writing exam questions. In the remainder the teacher was shown to be studying mathematics or solving questions, as these student quotations exemplify:

- “The teacher is studying with great ambition.” (Grade 7, boy).
- “He is studying and trying to solve the challenging question.” (Grade 7, girl).
- “Thinking [$5 \times 1005 = 5025$].” (Grade 7, boy).
- “Doing the calculations [$2 + 2 = 4$; $5 + 6 = 11$].” (Grade 8, boy).
- “Solves a million of problems.” (Grade 6, girl).
- “Studying the Fractions.” (Grade 6, boy).

In three drawings, the teacher was depicted as being busy with research, but their research activity could not be defined. While in another the teacher was reading, there was no indication of the teacher’s activity in the remaining scripts.

5.3 Attractiveness

In general, the references in drawings and/or writings reflected a positive mathematics teacher image. In 52.4% of drawings, the students’ rendering of the teacher was positive. Within this group, in most depictions the teacher was pictured as smiling while in four of them the teacher was portrayed as an angel. One drawing showed that the teacher was upset because “She could not solve a million questions.” (Grade 6, boy), and in another, because “The students did not do well [in the exam].” (Grade 8, girl), indicating that the students perceived that their teachers wanted to be good at mathematics and wanted their students to do well in mathematics. In their descriptions, students were observed to have positive views toward their teachers.

In 23.8% of drawings, the student’s rendering appeared to be neutral. In this group, the teacher was sometimes portrayed as serious (16.7%) and/or in mathematical contemplation (7.1%) through either thought-balloons drawn next to the teacher’s head or in their statements.

Although more commonly there was evidence of love for the teacher, negative views or even loathing of the teacher were presented in the students’ depictions (7.6%). For example, the teacher was angry or annoyed in 6.4% of the drawings, because, according to the students, the teacher was cross and scolding them. Some expressions incorporated into the drawings showing the teacher was angry included:

- “You girl! Why did you not do your homework? Copy the board down into your notebook, come on!” (Grade 6, boy).

“Are you dumb or something? Study, don’t do it like that, sit, shut up. Didn’t you get it again? Hey son, do you have a problem? Be a man. Behave yourself!” (Grade 7, boy).

In nine of these drawings the teacher was portrayed as evil, like a monster, alien, or a devil, and as explained in three drawings, due to the teacher asking difficult questions, for example:

“The teacher asks questions at his own level [beyond the students’ level].” (Grade 6, boy).

“The teacher asks about the subjects that are not in the curriculum.” (Grade 8, girl).

What was manifested in such drawings was a lack of love towards the teacher and even hatred. Depictions that showed hatred for the teacher were evident in drawings from twelve schools, yet they were intense particularly in six schools (6-13 mentions). The frequency of mentions in the other six schools was lower (1-3 mentions). An important observation in twenty-one depictions was that the loathing of teachers resulted in unhappiness in mathematics classes and loathing of mathematics, as exemplified in these quotations:

“Horrible with this teacher!” (Grade 8, girl).

“Important, but we have come to hate it, thanks to our teacher.” (Grade 6, boy).

“The thing I dreaded the most in life, because I don’t like my teacher.” (Grade 7, girl).

The teacher was bored and quite overwhelmed in about 0.7% of the depictions, with students explaining the causes of this boredom as:

“The teacher is bored with his own class.” (Grade 6, boy).

“The teacher is writing some boring things on the board; he is having difficulty comprehending them.” (Grade 7, girl).

In 0.5% of the depictions, some of which were in the form of caricature, the teacher appeared confused while in the others (20.0%), the teacher’s attitude could not be defined.

5.4 The tools of the profession

The occupational tools that appeared most frequently in the drawings were whiteboard (73.3%) and/or book(s) (33.5%). In 7.3% of the drawings, concrete materials such as a ruler (46 mentions), geometric objects (6 mentions), a compass, a protractor, or a miter (13 mentions), and test tubes (1 mention) were depicted. Technological tools appeared the least often (0.4%) in these drawings and included a smart board (1 mention) and computer (3 mentions).

6 Concluding words and recommendations

The use of the drawings to tap into lower secondary students' (grades 6 to 8) views about mathematicians was informative. The most common patterns that emerged in the drawings and associated writings were that mathematics teachers: are predominantly female; are viewed positively; do lecture, explain and demonstrate; and use whiteboards and books as tools of the profession.

The student views on the gender of mathematics teachers might be influenced by their personal experiences and/or by the society as a whole. In Turkey, it is not uncommon to have more female than male teachers in schools, including mathematics teachers. Moreover, although teaching is also a sought-after career path for males, the school teaching profession is viewed more as a female profession in Turkish society. These data complement the findings of the literature on students' images of teachers that showed that a typical teacher is more likely to be viewed as a female (Kestere, Wolhuter, & Lozano, 2013), and in a significant portion of girls' drawings (Weber & Mitchell, 2003). Losh et al. (2014) explained this as an occupational sex or same-sex preference. In this study it was found that as the grade level increased, the portrayal of female teachers decreased. It seems that as the grade level increases, students' possible occupational sex or same-sex preference becomes less strong, and they might view teaching as a profession equally valid for males and females. However, more research is needed.

Overall, the drawings and descriptions rendered positive images of mathematics teachers. When these drawings are considered together with the drawings rendering negative images of mathematics teachers, it would appear that students' stated attitudes about mathematics itself are influenced by their perceived images of mathematics teachers. In some drawings, it was observed that the perceived negative image of the mathematics teacher resulted in unhappiness in mathematics classes and

a loathing of mathematics. While such a connection has been widely reported in prior research (e.g., Boaler, 2006; Grootenboer, 2001), less of the earlier research is based in evidence. The next step of this research would be focusing on the connection between students' views about mathematics teachers and their stated attitudes in Item 2 (“To me, mathematics is:”, please see [Appendix A](#)).

Based on the findings from this study, I would make four recommendations. First, mathematics education research would benefit from explicit and cohesive definitions, in particular in relation to the image of mathematics and views about mathematicians as mathematics teachers. Secondly, given that some of the students' drawings and descriptions in this study cited mathematics teachers as the main influence on their relationship with mathematics (see also Lane et al., 2014), it is increasingly important that teachers are aware of student views and emotions in mathematics classes (Picker & Berry, 2000, 2001). Teachers can use drawings to access and become aware of student views and emotions about mathematics and mathematics learning (Stiles et al., 2008), and use such understanding as a basis for reflecting on their own views. As a result, teachers may focus on alleviating negative emotions and replace loathing with loving (Darragh, 2018). However, this would require teachers to be critically reflective of their own practice, have a trusting relationship with their students, and mindful of the power differential between the teacher and students in classroom environments.

My third recommendation emerges from my observation that students' views of the activity and tools of the mathematics teacher might mirror their classroom experiences. Most students pictured their actual mathematics teachers and classrooms, and some expressed their teaching and learning practices. The classroom environment that emerged from these depictions, in terms of the activity and role of the teacher (instructing, demonstrating, or explaining and general knowledge giver), the tools of the profession (mostly whiteboard and books), and instructional practices (generally direct teaching methods), are worrying because these teacher-centered approaches negatively impact students' attitudes (Hasni & Potvin, 2015), making it difficult for students to remain engaged in STEM subjects (EC, 2007). Such trends have longer term implications for students' mathematics learning, and it is my recommendation that this area be a focus of further research. For instance, it would be worthwhile to investigate both student-perceived and actual mathematics classroom environments and determine their relationship to student outcomes such as attitude to and views about mathematics, and their interest in STEM careers.

Finally, researchers must take care when using drawings (with descriptive stems) and short answer questions to interrogate student perceptions. As Losh et al. (2008) found, students in this study took the drawing task seriously and put some considerable amount of effort and thought into completing it. While drawings provide a valid alternative measurement of perceptions/understandings in mathematics education, including classroom environment research, extreme caution is needed in both implementing the task and analyzing the data. Notably, when students are asked about mathematics or mathematicians, it is their mathematics teachers that immediately come to their minds. It is important, therefore, for researchers who aim to interrogate student images of mathematics or mathematicians take this into account in the prompts they provide. Prompting students to describe their depiction is necessary for interpreting their perceived views but no matter how thoroughly a prompt is given, unanticipated interpretations of what is expected in the task may arise. For example, in this study students were asked to look back at their drawing and describe it so that anyone looking at it would understand what it meant. Some students simply wrote that if their classmates looked at the drawing, they would understand it! This meant the student drew their mathematics classroom, but without further explanation made interpretation of the drawing difficult (e.g., activity of the figure).

7 Limitations and further research

The data for this study was collected from students at twenty schools in a region within Turkey. The sample might not be representative of the entire population of lower secondary students within Turkey or in other countries. An interesting study would be to see how lower secondary students' perceptions about mathematicians change throughout their secondary education and if this varies due to their branches, i.e. language, literature and art; social sciences, and mathematics and natural sciences.

Another limitation of this study is that interviews which allowed students to reflect on their thinking and to explain and clarify their drawings and answers to the open-ended items were not used. A future study would be to collect interview data from a subsample of participants to enable data triangulation and help overcome this limitation of this study, but also to tease out any possible differences that may exist between the drawing and interview data.

Finally, students' (DAMT) drawings in this study fell into two distinct groups with the present article only providing the data regarding the drawings that clearly represented a mathematics teacher. The results are therefore being regarded in isolation from the remaining data from the overall study and should be interpreted with caution. The study demonstrated, however, that we need to develop measurements that assess the views of mathematics teachers or mathematics teaching held by young students. These measurements may help identify possible reasons (e.g., approaches to teaching mathematics at schools, the teaching resources used) for the low levels of enjoyment of mathematics that have been found among students. Further use of drawing tasks with students from different countries might also highlight the efficacy of the use of drawings in revealing views about mathematics teachers or mathematics teaching.

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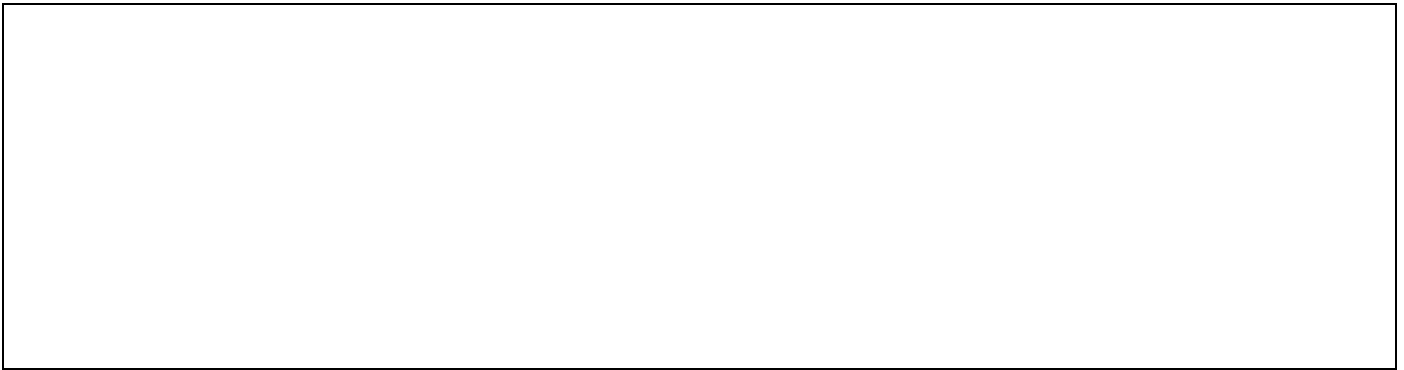
Appendix A: Draw a Mathematician Test

Dear Students;

This survey aims to explore your images of mathematics. You are invited to draw a mathematician at work on the first page; and then describe your picture and answer the two questions on the second page. Please read each item carefully before answering them. Your drawings and responses will just be used for this study and keep confidential. Thank you for your participation.

SIDE 1: PLEASE COMPLETE THIS SIDE BEFORE SIDE 2

In the space below draw a mathematician at work.



SIDE 2: PLEASE COMPLETE AFTER SIDE 1

Grade: Grade 6 Grade 7 Grade 8

Age:

Gender: Female Male

Look back at the drawing you made of a mathematician at work and write an explanation of the drawing so that anyone looking at it will understand what your drawing means and who the persons are in it.

1. If you have a leaky faucet, you need to hire a plumber; if you break your leg, you need the services of a doctor. With this view in mind, to you;

(a) Why would you need mathematics?

(b) Why would you need mathematicians?

2. Please complete this sentence:

To me, mathematics is: