Chapter 10

Why Mathematics Is Valuable for Turkish, Turkish Immigrant and German Students? A Cross-Cultural Study

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Abstract This study investigated students' views regarding the value of mathematics. It reports on a smaller part of findings from a wider comparative study concerning student values of mathematics and mathematics education that belonged to Turkish students in Turkey, Turkish immigrant students in Germany, and German students in Germany. Students were in Grade 9 (14–15 years old) and the data was gathered through semi-structured interviews, and analyzed using the constant comparative method. The results revealed four major value categories for Turkish (practice, relevance, rationalism, and fun values) and German (relevance, fun, rationalism, and consolidating values) students while there were three major value categories for the immigrant students (relevance, rationalism, and communication).

Keywords Cross-cultural study · Turkish students · German students · Turkish immigrant students · Grade 9 students · Values · Mathematical values

10.1 Introduction

The process of values education occurs within a complex structure of the human interactions -such as learning, personal development, socializing and cognition- through the agencies of traditional customs, norms, and language. In other words, these interactions occur in the context of culture. Value systems are therefore an integral part of any cultural context (Thomas 2000). Although there is no consensus about the definition of the concept 'culture', often people have a general understanding of what culture is and what it requires. In this regard, culture consists of values, beliefs, and concepts that are shared within a society (Venaik and Brewer 2008). In this context, we examine and compare mathematics values of students living in different cultures (Turkish students in Turkey, Turkish immigrant students in Germany, and German students in Germany).

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10.2 Theoretical Background

This section discusses the relationships between mathematics and values, as well as learning about values through comparative research.

10.2.1 *Values and Mathematics*

Nowadays, although values are important to researchers and educators, the concept of values is elusive and broad, therefore the discussion of values can be found in most disciplines. The definitions of values can be extended from personal to collective levels and to many forms of knowledge (Lee and Manzon 2014). Indeed, the word “value” is used in different contexts for different meanings (see Seah and Bishop 2000). However, in general, values are general guides for the behavior emerging from one’s experiences and relations (Raths et al. 1987). From this point of view, values play a role in one’s choices, decisions, and behaviors consciously or unconsciously (FitzSimons et al. 2001). Seah (2003) also saw value as “an individual’s internalization, ‘cognitisation’ and decontextualization of affective constructs (such as attitudes and beliefs) in his/her socio-cultural context” (p. 2). As Ernest (2009) stated,

Mathematics is viewed as value-neutral, concerned only with structures, processes and the relationships of ideal objects, which can be described in purely logical language. ... In contrast, the (fallibilist) view of the new philosophy of mathematics is that the cultural values, preferences, and interests of the social groups involved in the formation, elaboration, and validation of mathematical knowledge cannot be so easily factored out and discounted (p. 57).

These two different points of view described by Ernest, related to mathematical philosophy, have quite different effects on how classroom practices are understood (see Ernest 1991). In this chapter we take the second perspective.

The USA National Council of Teachers of Mathematics [NCTM] (2000) regards mathematics as a part of the cultural heritage and describes it as one of the most important cultural and intellectual accomplishments of the human brain. Prediger (2001) characterizes mathematics as a “cultural phenomenon” (p. 23). Bishop (2001) also declared the importance of values (in mathematics education) as follows:

Values exist on all levels of human relationships. On the individual level, learners have their own preferences and abilities that predispose them to value certain activities more than others. In the classroom, values are inherent in the negotiation of meanings between teacher and students and among the students themselves. At the institutional level, we enter the political world. Here, members of organizations engage in debates about both deep and superficial issues, including priorities in determining local curricula, schedules, teaching approaches, and so on. The larger political scene is at the societal level, where powerful institutions determine national and state priorities for mathematics curricula, teacher-preparation requirements, and other issues. Finally, at the cultural level, the very sources of knowledge, beliefs, and language influence our values in mathematics education (p. 347).

Values are part of educational processes and one important aspect to the conative environment of mathematics teaching. Not only mathematical knowledge but also mathematical values are consciously and at times unconsciously learnt by students. So, it is important for teachers and their students to be aware of the values they hold and to develop an awareness of values and value preferences toward teaching and learning respectively (Chin 2006). Students' accepted values play important roles (positive or negative) in their adult lives and professional workplaces (see Bishop et al. 2001; Dawkins and Weber 2016; Rhodes and Roux 2004).

10.2.2 Learning About Values Through Comparative Studies

In this chapter we take the position that culture is a powerful determiner of mathematical values. We also acknowledge that different cultures possess different values (Seah 2003) and investigating different cultures might help us to understand the nature and diversity of our own value systems. In this manner, too, school education in one country can be better understood in comparison to education in other countries. Moreover, international comparative studies can not only provide data on diagnosing and making decisions about students' learning, they are also able to shed light on issues relating to education in general and learning and teaching mathematics in particular (Cai 2006). Crossley and Watson (2003) also discussed some benefits of conducting comparative studies.

In this sense, this study makes a contribution towards what we can learn from comparative studies. In particular, this chapter documents a small part of a larger comparative study of Turkish students, Turkish immigrant students in Germany, and German students regarding their values towards mathematics and mathematics education. They were asked why mathematics is valuable, and the underlying mathematical values were explored.

Turkey and Germany had been selected to be compared against each other in this study, because they are two nations with huge cultural differences between them. The Federal Republic of Germany is an example of Western, liberal culture and has a multicultural society. Turkey is often seen as a bridge between Western and Eastern cultures, and although it has taken a series of steps towards Westernization, Turkey is still quite different from Germany with regards to culture, language and religion in particular.

Therefore, this study has the potential to provide an explanation to better understand how the different groups of teenagers' values regarding mathematics are similar or different. Also, the results might constitute a rich resource of ideas for future studies in educational development. It is also suggested that cultural differences—with the different underlying values—may influence how the same mathematical content might be taught through different approaches and different assessment emphases (Seah 2003).

In addition, Turkey and Germany are two different countries in terms of educational systems and mathematics education. The Turkish Ministry of National Edu-

cation [MEB] is responsible for compulsory education in Turkey. Compulsory education in Turkey is free and it was first extended from 5 to 8 years in 1997 and later extended to 12 years in 2012, being implemented in the 2012–2013 academic year. The first four years of compulsory education are called elementary school, the second four years are called middle school, and the last four years are called high school. In other words, 7–10 year-old students generally attend elementary school, 11–14 year-old students generally attend middle school, and 15–18 year-old students generally attend high school. The Turkish education system is focused on high stake examinations with multiple-choice tests that are taken at the end of middle and high school. This situation causes a lot of pressure on the students. The results of large-scale national assessments (e.g. The University Entrance Exams), and international comparative studies (e.g. The Program for International Student Assessment [PISA] and The Trends in International Mathematics and Science Study [TIMSS]) report that Turkey achieved under-average mathematics scores (see MEB 2013, 2016). In order to improve performance, mathematics curricula reforms have been revised in Turkey. The curricula for both primary and secondary schools were first updated in 2005 and then revised again in 2013 and 2018. The purpose of the revisions was to change the mathematics curricula so that it would focus on learner-centered teaching and multidisciplinary approaches.

On the other hand, responsibility for organizing the education system is shared among 16 Länder (states) and the federal government in Germany. Unless Grundgesetz awards legislative powers to the Federation, the Länder have the right to legislate. Länder have their own education ministries and are responsible for schools, higher education, adult education and continuing education. Co-ordination between them is ensured by several bodies. The Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (Kultusministerkonferenz [KMK]) co-ordinates education policies and makes recommendations for further developments in the area of primary and secondary education, higher education, research and cultural policy. Education is compulsory from ages 6 to 18 in Germany. System-level policies such as tracking, grade repetition, and academic selection can still hinder equity, especially for students with an immigrant background. PISA 2012 results indicated that these students' mathematics scores were 25 points lower than that of native students. Tracking begins at an early age in most Länder, and some Länder have strategies to limit its potentially negative effects on equity. In Hessen, for example, students can choose between 4- and 6-year primary schools, and in Berlin and Brandenburg, all primary schools are comprehensive until grade 6 (age 12) (OECD 2014). Grades 5 and 6 constitute a phase of particular promotion, supervision and orientation with regards to the pupil's future educational path and its particular direction. The general education qualifications that may be obtained after grades 9 and 10 carry particular designations in some Länder. Admission to the Gymnasiale Oberstufe requires a formal entrance qualification which can be obtained after grade 9 or 10. Since 2012, in the majority of Länder the Allgemeine Hochschulreife (Abitur-high school diploma) can be obtained after the successful completion of 12 consecutive school years (eight years at the Gymnasium) (KMK 2017). Although German students' mathematics scores in PISA 2000 were considered to be poor in

comparison to some Asian and European countries (Misek 2007; Schumann 2000), German students achieved above-average mathematics scores in PISA 2012. That also revealed a significant improvement in their performance since 2000 (OECD 2014). The results of PISA 2015 showed that German students' average score for mathematics decreased compared to the results of PISA 2012 (OECD 2016).

Given the different trends in the two countries' education systems and achievements in school mathematics in international comparative exercises, it is thought that an understanding of mathematical values of students from these two countries may contribute to relevant literature. For example, with the changes in performance, have there been corresponding changes in what the students value in their mathematics learning?

Thirdly, it is expected that the comparisons made would provide a significant contribution to the literature and discussion concerning which values may be learnt by immigrant students, in this case Turkish students in Germany. The majority of students in Germany mostly come from a multicultural background, whereas Turkish students usually come from a homogeneous background.

Although there are some studies in German schools that examine the skills of German/Turkish bilingual students regarding their language use in doing mathematics (Schüler-Meyer et al. 2017), not many specifically investigate these students' values towards mathematics and mathematics education.

As such, the research questions posed in this study were,

- (1) Is mathematics valuable to Turkish students, Turkish immigrant students in Germany, and German students?
- (2) If so, how are the values associated with such positions different and similar for Turkish students, Turkish immigrant students in Germany, and German students?

10.3 Methodology

10.3.1 Research Design

This data in this study was obtained from the 'Students Values in Mathematics Teaching in Germany and Turkey' [SVMGT] project, which took place over a one-year period in 2015/2016. The objectives of the SVMGT project were to document values of Turkish students, Turkish immigrant students living in Germany, and German students regarding mathematics and mathematics learning and to explore the cultural, social and connected nature of these students' values. The SVMGT project adopted a sequential mixed method research design in which quantitative and qualitative research methods are used together (see Creswell and Clark 2007). In this project, the first phase of this method was the quantitative data collection (with the translation and adaption of the international survey questionnaire within The Third Wave Project, "What I Find Important" (WIFI) project) and analysis. The results

of this phase will be reported as a separate study. In the second phase, based on the findings of the quantitative data, we gathered and analyzed qualitative data by means of semi-structured interviews. The aim has been to understand and compare the students' values towards mathematics and mathematics education.

10.3.2 Participants

Participants were chosen using the maximum variation sampling method. The participants of the study were 11 Turkish immigrant students living in Germany, 14 German and 10 Turkish students, all from Grade 9. All German students and Turkish immigrant students in Germany attended secondary schools (4 Gymnasiums and 7 high schools with average achieving students) in a province in northern Germany. Turkish students, on the other hand, attended secondary schools (4 Anatolian high schools with average and higher achieving students) in a province in the Central Anatolia Region.

10.3.3 Semi-structured Interviews

The interviews were carried out in a comfortable and an appropriate location by the researcher. The interviews were audio taped after obtaining the permission of each interviewee. Each interviewee was given an ID code (T1, ... for Turkish students, TG1, ... for Turkish immigrant students living in Germany, and G1, ... for German students). Each interview lasted about 10–25 min. The interviews were conducted in students' native languages except the Turkish immigrant students- they were interviewed in either Turkish or German according to their preferences. Hence language issues for students were minimized. The interviews with German students were translated to Turkish by the researcher. The same interviews were also independently translated into Turkish by two college students who were able to speak Turkish and German at an advanced level and were enrolled in educational sciences in a German university. After all translations were completed, the translated documents were compared with regards to differences and similarities in order to enable utmost agreement among translations.

10.3.4 Data Analysis

We analyzed the data collected from the semi-structured interviews by using the constant comparative method (Strauss and Corbin 1998). The analysis of the data collected in the study was continued until the saturation was reached (Arber 1993). It was assumed that students might not be able to relate to values directly, so the

questions in the interviews were about different learning activities that would be regarded as value indicators. This enabled the researcher to reflect on the problem of marking a difference between a value and a value indicator (Andersson and Österling 2013). For example, the learning activity “connecting mathematics to real life” in the semi-structured interviews was categorized as an indicator of the value of relevance. In this regard, a German student (G10) (Grade 9, 14 age, and mathematics score: 1–2 which represent the high levels in Germany) responded to the question from the interviewer:

I: Is mathematics valuable for you?

G10: Yes, it is so valuable

I: Why?

G10: I find it fun. It's easy for me since primary school. For this reason, I have no a problem in mathematics ... (pause). It is absolutely important. I will need math in my future career. I want to study engineering and so I will have to solve complex problems. I can solve them with mathematics. I care so much now that it's important for my job ... (pause). In that sense, it's the only reason. And I find math easy. That's why I love mathematics.

For G10, the statements of “I find it fun” and “That's why I love mathematics” both correspond to the value of *fun*. On the other hand, the statement “I will need math in my future career... I want to study engineering...” corresponds to the value of relevance. Transcripts of all the interviews were analyzed using the same coding process.

10.3.5 Trustworthiness

The categories emerged in this study were compared with Lim and Ernest's (1997) category of values taught in mathematics lessons, Bishop's (1988) category of mathematical values, and Hofstede's (2009) category of cultural values so that “theoretical triangulation” (Cohen et al. 2007, p. 142) was performed on the categories. In order to categorize the data gathered from semi-structured interviews and to identify common expressions, interview transcripts were read several times. Students' expressions were transcribed without any changes and these verbatim transcripts were submitted to the approval of the students, which provided “member check” (Creswell 1998) for the reliability of the interview data. “Peer review” was also applied for the reliability of the research data. According to Lincoln and Guba (1985), peer review is an external control mechanism for the research reliability. Thus, major and sub-categories created by the researcher were sent to two separate researchers—one of them had a Ph.D. degree in mathematics education and the other had a Ph.D. degree in science education. According to the expert opinions, sub-categories were revised.

10.4 Results and Discussion

The results revealed that there were 9 different value indicators (preparing for examinations tests, mathematics in daily life, relationships to other subjects in school, future career, and understand real-world) and 4 corresponding values (practice, relevance, rationalism, and fun) for the Turkish students, 7 different value indicators (mathematics in daily life, relationships between mathematics concepts, future career, calculation, reasoning, universal language) and 3 corresponding values (relevance, rationalism, and communication) for the Turkish immigrant students, and 14 different value indicators (mathematics in daily life, applicability, relationships between mathematics concepts, relationships to other subjects in school, understand real-world, future career, game, structural, reasoning, systematic, precise, calculation, visualization, and concretization) and 4 corresponding values (relevance, fun, rationalism, consolidating) for the German students. Out of these values, the value of *rationalism* pertains to the mathematical values of Bishop (1988) or epistemological values of Lim and Ernest (1997), whereas the values of relevance, fun, practice, consolidating, and communication pertain to mathematics educational values of Bishop (1988) and to social and cultural values of Lim and Ernest (1997) to some extent. The value indicators and their corresponding values were also categorized into two types of thinking: isolated thinking and connected thinking. Isolated thinking reflects that mathematics is seen as a set of isolated concepts and procedures whereas connected thinking reflects that connected values such as connections among mathematical ideas and ideas from other disciplines usefulness, process, communication, and creativity (see Dede 2012; Ernest 2004). Description of value indicators, their corresponding values, and the types of thinking are summarized in Table 10.1.

As can be seen from Table 10.1 again, 14 value indicators (five of them are related to isolated thinking and nine to connected thinking) for German students, 9 value indicators (three of them are related to isolated thinking and six to connected thinking) for Turkish students, and 7 value indicators (two of them are related to isolated thinking and five to connected thinking) for the immigrant students emerged from the interviews. These findings indicated that German students identified a wider range of values than the Turkish and the immigrant students for both of the value indicators. And it also reflected that all groups of students put more emphasis on the connected values. Moreover, the findings indicated that there were similarities and differences (discussed below) among Turkish, Turkish immigrant, and German students' value indicators and their corresponding values regarding to why mathematics is valuable.

10.4.1 Similarities

As can be seen from Table 10.1, four value indicators (mathematics in daily life, relationships to other subjects in school, future career and reasoning) are common among three groups of students. Common values across the three groups of students

Table 10.1 Comparison of the students' value indicators, corresponding values and types of thinking

Value indicator (corresponding value)*			
Type of thinking	Turkish	Turkish immigrant students in Germany	German
Connected thinking	<ol style="list-style-type: none"> 1. Preparing for examinations (high stake tests), tests (Practice) 2. Mathematics in daily life (Relevance) 3. Relationships to other subjects in school (Relevance) 4. Future career (Relevance) 5. Understand real-world (exp. golden ratio) (Relevance) 6. Puzzle, game (Fun) 	<ol style="list-style-type: none"> 1. Mathematics in daily life (Relevance) 2. Relationships between mathematics concepts (Relevance) 3. Relationships to other subjects in school (Relevance) 4. Future career (Relevance) 5. Universal language (Communication) 	<ol style="list-style-type: none"> 1. Mathematics in daily life (Relevance) 2. Applicability (Relevance) 3. Relationships between mathematics concepts (Relevance) 4. Relationships to other subjects in school (Relevance) 5. Understand real-world (Relevance) 6. Future career (Relevance) 7. Game, puzzle (Fun) 8. Visualization (Consolidating) 9. Concretization (Consolidating)
Isolated thinking	<ol style="list-style-type: none"> 1. Reasoning (Rationalism) 2. Precise (Rationalism) 3. Clear (Rationalism) 	<ol style="list-style-type: none"> 1. Calculation (Rationalism) 2. Reasoning (Rationalism) 	<ol style="list-style-type: none"> 1. Structural (Rationalism) 2. Reasoning (Rationalism) 3. Systematic (Rationalism) 4. Precise (Rationalism) 5. Calculation (Rationalism)

*The corresponding value is given in parentheses

are rationalism and relevance. The value indicators corresponding to these two values indicate that German students offer a larger variety of value indicators than the other groups for both rationality and relevance values. On the other hand, fun was a common value for only the German and Turkish students. As mentioned above, these results indicated that all three groups of students put emphasis on the values of relevance and rationalism. Similar results for the student valuing of relevance had been reported for the three Chinese regions of Chinese Mainland, Hong Kong and Taiwan (Zhang et al. 2016). Equally significantly, both these values (i.e. relevance

and rationalism) were also found to be embraced by both Turkish and German teachers (Dede 2012). Indeed, Australian primary school teachers were also observed to subscribe to similar values (Bishop et al. 2001). This might suggest that mathematics teachers in different cultures, like the three groups of students in the present study, hold common approaches with regard to the values related to the scientific discipline of mathematics (e.g. rationalism) (Atweh and Seah 2008). Also, these results are in line with the Platonist view of mathematics, which is not surprising for the German students. Kaiser and Vollstedt (2007) suggest that “the Gymnasium shows a strong dominance of theoretical subject-related reflections.” (p. 346). The values of *relevance* and *fun* are also generally consistent with the objectives and expectations of the primary and secondary I and secondary II level mathematics curricula (see Rahmenplan Grundschule Mathematik [RGM], Rahmenlehrplan für die Sekundarstufe-I [RSS-I], Rahmenlehrplan für die Gymnasiale Oberstufe [RGO]). At the same time, this result is in line with the fallibilist view of mathematics. For example, RSS-I in Germany (Berlin) consists of the following principles (RSS 2006):

Mathematics is a science which can be applied to several areas. It allows capturing and also solving the math structures and problems from both science and technical and real life ... Mathematics, in this way, develops methods and examines objects and opinions. Mathematics encourages improving humanistic thinking, creativity and problem solving skills in science and real life (p. 9).

On the other hand, the findings about *practice*, *relevance* and *rationalism* values related to the Turkish sample are generally consistent with the objectives of the Turkish curriculum (MEB 2005):

Learning and teaching the system of mathematical thinking; relating basic mathematical skills (e.g. problem solving, reasoning, connections, generalization, and affective and psycho-motor skills development) and abilities based on these skills to real life problems; improving their mathematics skills and abilities while preparing youth for real life through math studies;... understanding some of the elements on which math is based; assessing our place in earth, culture and society; teaching the importance of math in the artistic dimension; teaching that math is systematic knowledge and a computer language; ... (pp. 4–5).

10.4.2 Differences

As can be seen from Table 10.1, consolidating appeared to be valued by the German students only, whereas practice was a value that was embraced by only the Turkish students. Similarly, communication was a value for only the immigrant students. And while the immigrant students valued *rationalism* just like their German peers and fellow Turkish peers in Turkish schools, their valuing was associated with only two value indicators, namely, calculation and reasoning. It is also interesting that the fun value was not found in the immigrant students’ statements. The valuing of practice may reflect the Turkish education system’s focus on high-stakes examinations as indicated in the literature section. With these exams, Turkish students’ mathematical skills are assessed as well as their ability to use time in the most efficient manner

possible. That means, if students want to succeed in these exams, they should solve a lot of mathematical questions and problems. Similarly, the result for communication value in the immigrant students may be related to several factors such as integration, language barriers and multilingualism. Besides that, communication value can be considered within the collectivism dimension of Hofstede's cultural values (2009) as well as societal values (see Dede 2013).

10.5 Moving On

This study has provided evidence that the values for the nature of mathematics (rationalism) and the way of teaching (relevance) are common for the students in two different cultures. The study also showed evidence that mathematics could be a tool for the immigrant students to communicate with the culture they live in. Also, the study has pointed out evidence that values across the three groups of students generally consistent with the objectives of their mathematics curriculum.

It has also demonstrated how comparative studies can help us to understand education systems, teachers' work, and students' learning in ways which are not evident or possible with studies drawing their data from one culture only. Indeed, the results of the current study have revealed interesting similarities and differences in terms of students' mathematical values in Germany and Turkey. These similarities and differences would not have been as visible in a study involving German students or Turkish students alone.

Questions regarding the causes and impacts of these similarities and differences may also be identified. For example, further research may be carried out to elaborate the reasons underlying the results for fun and communication values that came from immigrant

Turkish students as well as for consolidating value held by the German students and for practice value held by the Turkish students. Moreover, further research focusing on the values of communication and fun may be carried out based on the concepts of Bishop's proposed enculturation (1988) and acculturation (2002).

As mentioned earlier, the study is limited with the students' views to the question of "why mathematics is valuable?" in two different countries. For this sense, a further study could employ classroom observations and in-depth interviews with more questions with the students in both countries in order to explain how the causes and impacts of the similarities and differences came about. Moreover, further research could examine students' mathematical values in different cultures for different mathematics contexts (e.g. preparing for mathematics lessons, learning methods, and decision-making process etc.). By doing so, more information on students' mathematical values can be collected. Finally, due to the small sample size, it is difficult to generalize the findings of this present study to other settings. Further research could examine whether similar results can be obtained from a study with a larger sample.

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