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Developing a Questionnaire to Evaluate Turkish Students' Mathematics Values and Preferences

Türk Öğrencilerin Matematiksel Değer ve Tercihlerini Değerlendirmek İçin Bir Ölçeğin Geliştirilmesi

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ABSTRACT: The aim of this study was to construct a questionnaire: the mathematics values questionnaire (MVQ). Because a little is known about students' mathematics values and no assessment tool is available to measure students' mathematics values to obtain more insight into their perspectives. For this, the proportional stratified random sample of the study consisted of Grade 5 (11-12 years old) and Grade 9 (14-15 years old) students attending schools in Turkey. The data were subjected to descriptive and inferential statistical analyses by using a recently developed and validated survey instrument. The questionnaire's structural and predictive validities were investigated using a Principal component analysis (PCA) and an item analysis (item-total correlations and comparison of differences in means for distinctly different groups). Six components were extracted: relevance (C1), practice (C2), information and communications technology (ICT) (C3), feedback (C4), learning approach (C5), and consolidating (C6). Our results showed that Grade 5 students placed more importance than Grade 9 students for all the six value components.

Keywords: mathematics values, questionnaire development, students, validation, values.

ÖZ: Bu çalışma, matematiksel değerler ölçeğini geliştirmeyi amaçlamaktadır. Zira öğrencilerin matematiksel değerleri hakkında çok az şey bilinmektedir ve öğrencilerin kendi perspektiflerinden onların matematiksel değerlerini belirlemeye çalışan ölçme araçları da fazla yoktur. Bu bağlamda; bu çalışmanın katılımcıları, Türkiye'de 5. (11-12 yaş) ve 9. (14-15 yaş) sınıflarda okuyan ve tabakalı seçkisiz örnekleme yöntemine göre seçilen öğrencilerden oluşmuştur. Veriler, betimsel ve yordayıcı istatistiksel analizler kullanılarak analiz edilmiştir. Ölçeğin, yapısal ve yordama geçerliği, Temel Bileşenler Analizi ve Madde Analizi (madde- toplam korelasyonları ve farklı grupların aritmetik ortalamalarındaki farklılıkların karşılaştırılması) kullanılarak incelenmiştir. 6 bileşen elde edilmiştir: uygunluk, pratik, bilgi ve iletişim teknolojisi, geribildirim, öğrenme yaklaşımı ve pekiştirme. Çalışmanın sonuçlarından biri, 5. sınıf öğrencilerinin 9. sınıf öğrencilerine göre 6 değer bileşenini de daha önemli gördüklerini ortaya koymaktadır.

Anahtar kelimeler: matematiksel değerler, ölçek geliştirme, öğrenciler, geçerlik, değerler.

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Introduction

Although values are generally related to the civic, moral, religious, and ethical beliefs of the individual and although it is often thought that there is no place in the mathematics curriculum for values, they can also, indeed, facilitate effective mathematics teaching and learning (Seah, Andersson, Bishop, & Clarkson, 2016). Values are often ignored by teachers, researchers, and curriculum makers, as well as by parents in their work context (Bishop, 2016). It has been argued that education and mathematics education in particular are not value-free (Ernest, 1998; Seah & Bishop, 2002). However, values are generally taught implicitly rather than explicitly in the mathematics classroom (Clarkson, FitzSimons, Bishop, & Seah, 2000). Rokeach (1972) identified an individual value as “a type of belief that is centrally located within one's total belief system, about how one ought or ought not to behave, or about some end-state of existence worth or not worth attaining” (p. 124). Raths, Harmin, and Simon (1987) considered values as a general guide for the behaviors emerging from people’s relations in their daily life and experiences. Randolph (2007) considered values as “the worth of something” (p. 259). Chin and Lin (2001) also saw values as the preference of individuals related to their personal standards of thoughts and acts that are important and worthwhile to themselves. Similarly, Seah and Andersson (2015) defined values as “the convictions, which an individual has internalized as being the things of importance and worth” (p. 169). In the same vein, Chin and Lin (2001), Seah (2002) and Swadener and Soedjadi (1988) defined values as personal preferences for stating if a thought and statement are of importance and worthwhile for the individual. In this current study, this last value definition is adopted.

The Relationships among Attitudes, Beliefs, and Values

Attitude can be described in very different ways, but it is interconnected with belief, value, interest, and opinion (Leder & Forgasz, 2006). Beliefs are the cognitive basis for attitudes, and they provide information used in forming an attitude about any object or person while values are more complex than attitudes; and concepts such as equality, justice, and symmetry are typical examples of values (Koballa & Glynn, 2007). None of these concepts can be directly observed; each must be inferred from speech, behavior, or answers given to specially designed instruments (Leder & Forgasz, 2006). Goldin (2002) distinguished attitudes, beliefs and values in mathematics education:

> … (2) *attitudes* (moderately stable predispositions toward ways of feeling in classes of situations, involving a balance of affect and cognition), (3) *beliefs* (internal representations to which the holder attributes truth, validity, or applicability, usually stable and highly cognitive, may be highly structured), and (4) *values, ethics, and morals* (deeply-held preferences, possibly characterized as “personal truths”, stable, highly affective as well as cognitive, may also be highly structured). (p. 61)

Values in Mathematics Teaching and Learning Environments

The goal of values teaching at all school levels is to encourage students’ awareness of having values and their corresponding relationship to the world in which they live (Harecker, 2012). It is assumed that values are inherently crucial in the learning and teaching processes, educational environments in general, and classroom affective environments in particular at all school levels. They are therefore an important influence on the ways students choose to engage (or to not engage) with mathematics. In addition, they also play a key role in establishing a sense of personal and social identity for the student at the micro level (FitzSimons, Seah, Bishop, & Clarkson, 2001). Bishop (1996) proposed three pairs of values in the tradition of "Western" mathematics: general educational values, mathematical values, and mathematics educational values. General educational values are related to general society values such as honesty, respect, etc. Mathematical values are the three pairs of complementary values, which reflect the scientific the theoretical structure and nature of mathematical knowledge: rationalism-objectivism, control-progress, and mystery-openness (see Bishop 1988, for details). Mathematics educational values are the values related to the cultures, traditions, norms, and practices that emerged from teaching and learning mathematics (Atweh & Seah, 2008). Additionally, Bishop (1998) clearly explained in terms of some examples these values in the mathematics classroom as follows:

> …when a teacher admonishes a child for cheating in a test, the values of "honesty" and "good behavior" derive from the general educational and socializing demands of society. Then when a teacher proposes and discusses a task such as the following: "Describe and compare three different proofs of the Pythagorean Theorem" the mathematical values of "rationalism" and "openness" are being conveyed. However, there are other values being transmitted, which are specifically associated with the norms of the institutions within which mathematics education is formally conducted. (p. 34)

Education System and Mathematics Education in Turkey

In Turkey, the Ministry of National Education (Turkish: Milli Eğitim Bakanlığı-MEB) for compulsory education and the Higher Education Council (Turkish: Yükseköğretim Kurumu -YÖK) are in overall control of policy, funding, and direction. Compulsory education in Turkey is free and it was firstly extended from 5 years to 8 years in 1997. Then, it was again extended from 8 years to 12 years in 2012 and it was implemented in the 2012-2013 academic year. The first four years of compulsory education are called primary school, the second four years are called as middle school, and last four years are called high school. In this situation, 7-10 year-old students generally attend primary school, 11-14 year-old students generally attend middle school, and 15-18 year-old students generally attend high school. It can be argued that the Turkish education system is often focused on high stake exams with multiple-choice tests (Yıldırım, 2008). Therefore, students at all levels of compulsory education in Turkey have to continuously prepare to pass those multiple-choice exams. This situation may cause a lot of pressure on the students.

On the other hand, the results of large-scale national assessments such as the Basic Proficiency Test (Turkish: TYT) and Subject Proficiency Test (Turkish: AYT) that emphasize the use of knowledge and prioritize the production of new knowledge, rather than measuring the level of memorized knowledge (YÖK, 2017) and international comparative studies (e.g., Program for International Student Assessment [PISA] and Trends in International Advanced Mathematics and Science Study [TIMSS]) reported that Turkish students' mathematics achievement was lower than the students' mathematics achievement in other high-performing countries (MEB, 2003, 2007; The Organization for Economic Cooperation and Development [OECD], 2002). For example, according to the research result of PISA 2003, the mathematics average of Turkish students was 417 points while the mathematics average of the OECD countries was 496 points (MEB, 2003). In order to overcome this issue, mathematics curricula have gradually been revised in Turkey. In this context, mathematics curriculums in the primary and secondary schools were firstly updated in 2005 and then they were lastly revised in 2013. After the last revision, the mathematics curricula focus on learner-centered teaching and multidisciplinary approaches. So, the primary mathematics curriculum includes five learning streams such as numbers, geometry, measurement and statistics, probability, and algebra, while the secondary mathematics curriculum includes three learning streams such as numbers and algebra, geometry, and data, counting, and probability. On the other hand, it was also emphasized in both the primary and the secondary curricula that students' affective development such as attitudes, self-confidence, self-regulation, and mathematics anxiety should be taken into consideration when mathematical concepts and skills are developed (MEB, 2013). With these revisions in the mathematics curricula, although Turkish students improved their mathematics average according to the results of PISA 2012 but it was still not considered enough by the Turkish authorities. Turkey was ranked 44th out of 65 countries and the mathematics average of Turkey was 448 points while mathematics average of the OECD countries was 494 points (MEB, 2013). More recently, the results of PISA 2015 indicated that the mathematics average of Turkish students had decreased compared to the results of PISA 2012. So Turkey was ranked 50th out of 72 countries and the mathematics average of Turkey was 420 points while the mathematics average of the OECD countries was 490 points (MEB, 2016).

Method

Research Design

In this study it was aimed to construct a mathematics value questionnaire for secondary and high school students in Turkey. The research and development approach was utilized to ensure the validity of the questionnaire. The main element of this method is sequential inquiry that includes design principles which was compiled from related literature. Firstly, an item pool was generated and these items were submitted to experts for face validity. Following the experts' feedback, a pilot version of the questionnaire was developed. After implementing the pilot version of the questionnaire to secondary school students, the validity and reliability analysis were conducted.

Purpose and Importance of the Study

The aim of this study was to develop a questionnaire that can measure the mathematics education values of middle and high school students. Grade 5 is the first year of middle school and Grade 9 is the first year of high school in Turkey. In this sense, the questionnaire developed in this study was developed within the scope of "What I Find Important in my mathematics learning (WIFI)" Study. The international WIFI Study was conducted using a validated questionnaire (Seah, 2013), which has been used by 21 research teams in 17 different education systems around the world (More information about the WIFI study is given in the following sections). Turkey was one of the participant countries. In this sense, it is thought that this study could develop a deeper understanding of students' values during mathematics learning from a cross-national perspective because the findings of this present study can be compared to the findings of other national studies such as Japan, Sweden, Taiwan, Hong Kong, and

Australia within the WIFI project. And such a comparison could also provide valuable information on what could be learned from educational settings and practices in different countries and cultures in order to improve students' learning of mathematics (Cai, Perry, Wong, & Wang, 2009; Correa, Perry, Sims, Miller, & Fang, 2008). Also, this study could contribute empirically to the saturation and development of theories of values in the mathematics education research literature. Moreover, the results of this study could help mathematics educators to see the big picture about values in mathematics learning and it could provide a better understanding of the values in mathematics education. Thus, curriculum-makers and teachers can plan their educational contexts and activities in terms of harnessing values in mathematics teaching and learning for middle and high school levels. In addition, it is thought that this developed questionnaire could make a significant contribution to the understanding of students' values during mathematics learning because there are not many studies measuring middle and high school students' values in the Turkish context. So this current research may add momentum to studies conducted with Turkish students to examine their mathematical values. And this study could also provide an opportunity to see whether middle and high school students in Turkey may experience change in their own values in terms of the factors of questionnaire throughout their education process.

Participants

The sample consisted of Grade 5 (11-12 year-old) students and Grade 9 (14-15 year-old) students attending schools in Turkey. Grade 5 is the first year of middle school in Turkey and Grade 9 is the first year of high school. In this way, the students' values and preferences will be investigated after graduation from elementary and middle school. The data were obtained from the Ministry of National Education of Turkey (MEB) in 2013. Due to the size of the sample, a proportional stratified random sampling was used. In stratified sampling, the population is divided into homogeneous subpopulations or strata and sample items are selected from each stratum (Cohen, Manion, & Morrison, 2000; Kothari, 2004). In this study, the geographical region was a sampling unit in the stratified sampling method while the school was the sampling unit in the random sampling method. A proportional stratified sampling method was used in this study because data were collected from seven geographical regions of Turkey. Two provinces form each region were selected. This selection was based on a study by Baday Yıldız, Sivri, and Berber (2012). The authors of the study determined social and economic development index rankings for provinces of Turkey. Based on this index, the two provinces that had the highest and the lowest index rankings were chosen from each of the seven geographic regions of Turkey. For example, in the Marmara Region, the Istanbul province (highest index) and the Sakarya province (lowest index) were chosen. A similar process was used for the remaining six regions, in order to determine the 14 provinces to be included in the sample. Each province's representation rate was calculated based on the stratified sampling by taking into consideration the number of students (Grade 5 and Grade 9) in the general population (81 provinces). A similar process was used for the target population (14 provinces). Finally, the total number of students in Grade 5 and Grade 9 in the sample was multiplied by the representing proportion in the target population of each province. In this way, the sample size for each province was calculated and the proportion of the strata in the population was the same as the proportion in the sample. A total of 1017 students (506 Grade 5 and 511 Grade 9) from14 provinces of Turkey participated in the study. Students were recruited from government middle and high schools (Grade 5 and Grade 9 respectively) and they were from all socio-economic levels. Table 1 provides the representation of student groups for each province in the sample.

Table 1

The Sample

Province	Grade 5				Grade 9			
	Number of Students	Representing proportion in the total population (Turkey)	Representing proportion in the target population	Number of Students in the Sample	Number of Students	Representing proportion in the total population (Turkey)	Representing proportion in the target population	Number of Students in the Sample
Afyon	11594	0.89	2.27	11	11510	0.87	2.14	11
Ankara	71147	5.49	13.92	70	83108	6.30	15.45	77
Antalya	31485	2.43	6.16	31	35502	2.69	6.60	33
Bayburt	6588	0.10	1.29	6	7428	0.12	1.38	7
Bolu	9820	0.29	1.92	10	10283	0.34	1.91	10
Elazığ	9823	0.76	1.92	10	12383	0.94	2.30	12
Gaziantep	40788	3.15	7.98	40	36347	2.75	6.76	34
İstanbul	211866	16.35	41.45	207	230100	17.43	42.78	214
İzmir	52361	4.04	10.24	51	63436	4.81	11.79	59
K.Maraş	22672	1.75	4.44	22	20150	1.53	3.75	19
Muş	12309	0.95	2.41	12	6526	0.49	1.21	6
Sakarya	15043	1.16	2.94	15	15512	1.18	2.88	14
Şırnak	13909	1.07	2.72	14	8622	0.65	1.60	8
Yozgat	7756	0.60	1.52	8	8592	0.65	1.60	8
Total	517161	39.03	100.00	506	549499	40.75	100.00	511

Instrument Development

The development sequence of the mathematical values questionnaire includes design principles, which was derived from related literature. The items were developed by taking into account the targeted group's context and language. An item pool was constructed and translated. The validity and usability of selected items was revised according to experts' feedbacks. Pilot version of the questionnaire was tested; these results were used for this study - students' mathematics values questionnaire (MVQ) - in the creation of an experimental version.

Structure of the MVQ and the WIFI study. As indicated above, the questionnaire developed in this study was developed within the scope of the WIFI Study. The study was conducted to investigate what students from differing cultures valued most (Zhang, Barkatsas, Law, Leu, & Seah, 2016). The target of the WIFI study has been to find out what 11-12-year-old students (Grade 5) and 14-15-year-old students (Grade 9) value in their mathematics learning experiences. The WIFI Study was also based on Bishop's (1996) pairs of complementary mathematical values (rationalism-objectivism, control- progress, openness-mystery) and Hofstede's (2009) cultural dimensions (power distance index, individualism vs. collectivism, masculinity vs. femininity, uncertainty avoidance index, long term orientation vs. short term orientation). The WIFI questionnaire consists of four sections. Section A consists of 64 five- point Likert items (from absolutely important = 1 to absolutely unimportant = 5) to indicate the extent that the students find something important in mathematics and mathematics learning. For example, item 3 of Section A of the WIFI questionnaire asks respondents to indicate how they personally find 'small group discussions' from absolutely important to absolutely unimportant. For this item, a respondent's choice will indicate the extent to which s/he values the mathematical value of openness. Section A with 64 items includes a learning activity in mathematics and mathematics learning such as alternative solutions (item 15) and whole-class discussions (item 7). In here, low scores indicate a high importance value in mathematics and mathematics learning. Section B consists of 10 continuum dimension items while Section C includes an open-ended question, common and contextualized in a scenario with 4 items. Finally, Section D includes questions about personal features (e.g., nationality, gender, grade level, and age). In this study, the results of Section A will be reported.

To provide a validation of the questionnaire during this process, the results of the Principal Component Analysis (PCA), item analysis and reliability analyses were used to verify that the resulting questionnaire was a valid and reliable instrument.

Validation of the MVQ. The validity of a questionnaire includes language validation, cultural adaption and instrument psychometry to ensure understandability of the items, to measure expected construct and how the expected construct was consistently measured. Linguistic considerations included translations and back-translations. Validity and reliability were examined with different approaches.

Language and cultural adaptation. To use the WIFI questionnaire in a Turkish context required a translation and a cultural adaptation. As a consequence, the TRAPD Team Translation Model (Harkness, Villar, & Edwards, 2010) was used. The steps in the TRAPD model are; *Translation*, where two translators make two independent translations; *Review*, where the translations are compared and refined; *Adjudication*, where the translation is separated from review with focus on, amongst other things, *a cultural adaptation*; *Pilot test* and finally *Documentation* of every step in this process. In addition, the challenges in the translation and cultural adaptation processes of an international survey were also considered (Andersson & Österling, 2014).

Content validity. Three experts used a checklist by panel to ensure content validity of the instrument. The panel members were university staff who gave math courses, education measurement and evaluation, or Turkish language courses. The expressions of the items were also evaluated in terms of the relevancy, fluency and appropriateness of the language structure. Based on the opinions of the experts, some of the items were rewritten or rearranged according to the Turkish context and none of the items were deleted, for example:

#9: "Mathematics debates were rewritten as mathematics debates" (discussion of opposing ideas).

Pilot Study: After alterations based on the experts' suggestions, the Turkish pilot version was explored with 42 middle and high school students. The pilot study revealed that the students had not understood some of the statements, for example:

#3: "Small group discussions were rewritten as small group discussions" (different but not contradictory ideas).

Structural and predictive validity. The analysis of structural and predictive validity of MNQ were made in two ways: exploratory factor analysis and item analysis (item-total correlations and comparison of mean differences for significantly different groups). The revised questionnaire was implemented to 506 5th grade and 511 9th grade students, totally 2017 students. Kaiser-Mayer-Olkin Approach (KMO) and the Barlett's Sphericity Test (BTS) measures firstly examined to check the sample size adequacy for factor analysis. The results were shown [KMO = 0.938) and BTS ($p < 0.001$)] that the sample was adequate to run a factor analysis. Exploratory factor analysis was employed to examine the subscales of the questionnaire and verify the psychometric structure of the MVQ.

Items analysis methods, useful approaches to verify an instrument's predictive validity, revealed that items contributed to the total measures and items and sub-dimensions of scales were sensitive to expected differences. The item correlation scores and the total score were assessed to demonstrate the correlations between item score and the total MVQ scores. The sensitivity of the instrument and the differences between high and low performed groups were compared by second item analysis. Thus, based on total MVQ scores the students were divided in to three groups (top 27% = high, middle 46% = moderate, and bottom 27% =low). The group differences according to each subscale were examined with ANOVA. By using ANOVA it was aimed to establish each subscale's and item's capacity to differentiate between high and low performed individuals.

Results

The results are presented in two ways: the verification of the instrument and the findings related to students' mathematics values.

The Validation of the Students' Mathematics Values Questionnaire (MVQ)

To show that the MVQ was a valid and reliable instrument, the findings of the principal component analysis, item analyses, reliability analyses, and correlations among the components were performed on items and subscales.

Principal component analysis (PCA). A PCA with a Varimax rotation was used to ensure that the factors remain uncorrelated. The Varimax rotation resulted in six components with eigenvalues greater than one, which accounted for 40.97% of the total variance, with the first component (C1) accounting for 14.93% of the variance, the second component (C2) accounting for 12.06%, the third component (C3) accounting for 4.40%, the fourth component (C4) accounting for 3.43%, the fifth component (C5) accounting for 3.11%, and the sixth component (C6) accounting for 3.02%. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.943 and the Bartlett's Test of Sphericity (BTS) was statistically significant ($p<0.001$) and so factorability of the matrix was assumed.

Four items were deleted due to double-loading. The deleted items: #5: "Teacher explains to the whole class", #8: "Learning the proof", #27: "Different ways of solving a problem", and #41: "Teacher helps me individually. Communalities (h^2) of items were between 0.22-0.73 and item-total correlations were between 0.27- 0.60 (see Table 2).

Table 2

PCA and İtem-Total Correlations: Rotated Factor Loadings, Communalities (h^2), İtem-Total Correlations, Means, and Standart Deviations (SD) for the 60 Retained İtems

Item	Component						h^2	Item -Total Correlation	Mean	SD
	1	2	3	4	5	6				
Q39LookingOutForMathsInRealLife	0.734						0.350	0.402	2.07	1.12
Q61StoriesAboutMathematicians	0.731						0.342	0.308	2.54	1.33
Q17StoriesAboutMathematics	0.729						0.355	0.423	2.63	1.25
Q18StoriesAboutRecentDevelopmentsInMathematics	0.721						0.394	0.275	2.50	1.21
Q62CompletingMathematicsWork	0.693						0.221	0.355	1.93	1.08
Q11AppreciatingTheBeautyOfMathematics	0.672						0.363	0.479	2.03	1.13
Q34OutdoorMathematicsActivities	0.653						0.370	0.454	2.14	1.17
Q12ConnectingMathsToRealLife	0.637						0.310	0.460	1.98	1.07
Q21StudentsPosingMathsProblems	0.588						0.513	0.489	1.99	1.09
Q20MathematicsPuzzles	0.581						0.479	0.455	1.96	1.01
Q57MathematicsHomework	0.580						0.448	0.409	1.91	1.14
Q1Investigations	0.546						0.416	0.334	1.77	0.89
Q26RelationshipsBetweenMathsConcepts	0.532						0.377	0.462	1.88	0.92
Q9MathematicsDebates	0.514						0.321	0.454	2.17	1.07
Q10RelatingMathematicsToOtherSubjectsInSchool	0.498						0.601	0.515	2.19	1.15
Q19ExplainingMySolutionsToTheClass	0.472						0.595	0.548	1.76	0.96
Q29MakingUpMyOwnMathsQuestions	0.471						0.382	0.488	2.07	1.15
Q25MathematicsGames	0.458						0.427	0.477	2.40	1.21
Q32UsingMathematicalWords	0.448						0.445	0.467	1.63	0.87
Q47UsingDiagramsToUnderstandMaths	0.420						0.469	0.397	1.72	0.89
Q59KnowingTheTheoreticalAspectsOfMathematics	0.409						0.734	0.455	1.69	0.92
Q40ExplainingWhereTheRulesFormulaeCameFrom	0.404						0.706	0.423	1.89	1.01
Q60MysteryOfMaths	0.402						0.429	0.481	1.75	1.07
Q36PractisingWithLotsOfQuestions		0.642					0.463	0.519	1.36	0.61
Q13PractisingHowToUseMathsFormulae		0.611					0.310	0.290	1.47	0.82
Q58KnowingWhichFormulaToUse		0.603					0.397	0.375	1.35	0.62
Q43MathematicsTestsExaminations		0.596					0.433	0.471	1.43	0.79
Q50GettingTheRightAnswer		0.586					0.338	0.386	1.31	0.65
Q63UnderstandingWhyMySolutionIsIncorrectOrCorrect		0.563					0.361	0.448	1.47	0.80
Q2Problemsolving		0.547					0.359	0.425	1.35	0.60
Q54UnderstandingConceptsProcesses		0.539					0.480	0.513	1.46	0.74
Q37DoingALotOfMathematicsWork		0.537					0.361	0.400	1.50	0.76

Q49ExamplesToHelpMeUnderstand		0.533					0.473	0.390	1.45	0.74
Q38GivenAFormulaToUse		0.530					0.442	0.473	1.50	0.77
Q33WritingTheSolutionsStepbystep		0.486					0.331	0.362	1.63	0.92
Q42WorkingOutTheMathsByMyself		0.467					0.564	0.486	1.58	0.83
Q56KnowingTheStepsOfTheSolution		0.466					0.342	0.470	1.30	0.57
Q55ShortcutsToSolvingAProblem		0.428					0.298	0.379	1.49	0.78
Q30AlternativeSolutions		0.428					0.456	0.395	1.70	0.85
Q35TeacherAskingUsQuestions		0.416					0.592	0.514	1.41	0.68
Q64RememberingTheWorkWeHaveDone		0.413					0.564	0.530	1.50	0.82
Q28KnowingTheTimesTables		0.407					0.213	0.284	1.33	0.75
Q6WorkingStepbystep		0.400					0.462	0.547	1.47	0.71
Q31VerifyingTheoremsHypotheses		0.381					0.452	0.601	1.93	1.01
Q46MeAskingQuestions		0.358					0.419	0.444	1.67	0.98
Q23LearningMathsWithTheComputer			0.828				0.440	0.375	3.19	1.29
Q24LearningMathsWithTheInternet			0.817				0.257	0.326	3.13	1.304
Q22UsingTheCalculatorToCheckTheAnswer			0.668				0.481	0.547	3.00	1.37
Q4UsingTheCalculatorToCalculate			0.556				0.375	0.541	3.43	1.32
Q44FeedbackFromMyTeacher				0.716			0.467	0.481	1.83	0.90
Q45FeedbackFromMyFriends				0.693			0.312	0.315	2.22	1.08
Q51LearningThroughMistakes				0.357			0.291	0.370	1.59	0.94
Q14MemorisingFacts					0.468		0.460	0.448	1.59	0.93
Q16LookingForDifferentPossibleAnswers					0.411		0.369	0.315	2.03	0.96
Q15LookingForDifferentWaysToFindTheAnswer					0.408		0.357	0.478	1.59	0.80
Q3SmallgroupDiscussions					0.386		0.280	0.407	2.19	0.97
Q7WholeclassDiscussions					0.372		0.581	0.520	2.16	0.97
Q52HandsonActivities						0.550	0.574	0.553	1.87	1.01
Q53TeacherUseOfKeywords						0.418	0.445	0.418	1.69	0.96
Q48UsingConcreteMaterialsToUnderstandMathematics						0.412	0.323	0.420	1.91	0.98

The six components were named as follows:

Component 1 (Relevance). The first factor (F1) includes 23 items with a reliability coefficient 0.93, which explains 14.93 % of the total variance. This component focuses on certain learning activities or materials relevant to mathematics learning, such as mathematical stories (Q17, Q61), games (Q25), puzzles (Q20), outdoor mathematics activities (Q34) and mathematics in real life (Q12).

Component 2 (Practice). This component consists of 22 items with a reliability coefficient 0.89, which explains 12.06% of the total variance. This component focuses on the importance of practice and problem solving activities with regard to mathematics and mathematics learning, such as practicing with lots of questions (Q36), mathematics tests examinations (Q43), knowing the steps of the solution (Q56) and shortcuts to solving a problem (Q55).

Component 3 (Information and Communication Technology - ICT). The third component includes 4 items with a reliability coefficient 0.75, which explains 4.40% of the total variance. This component reflects the use of technology during mathematics learning, such as learning mathematics with the computer (Q23), learning mathematics with the internet (Q24) and using the calculator to calculate (Q4).

Component 4 (Feedback). The fourth component consists of 3 items with a reliability coefficient 0.58, which explains 3.43% of the total variance. This component focuses on receiving feedback from teachers and student partners or learning through mistakes during mathematics learning (Q44, Q45, and Q51 respectively).

***Component 5 (Learning Approach)*.** The fifth component includes 5 items with a reliability coefficient 0.56, which explains 3.11% of the total variance. It focuses on the importance of discussion environments (Q3), small or whole class discussions (Q7), and to look for different possible answer or different ways to find the answer during mathematics learning.

***Component 6 (Consolidating*).** The sixth component consists of 3 items with a reliability coefficient 0.62, which explains 3.02% of the total variance. This component focuses on *consolidating* during mathematics learning, such as using concrete materials to understand mathematics (Q48) and hands on activities (Q52).

Item Analysis

The correlations between the total score and each item score were computed to show the associations between the total questionnaire and individual items. The second item analysis compared the differences between lower and upper performance groups and the sensitivity of the questionnaire. Therefore, the 1010 respondents were divided into three groups based on their total questionnaire scores (low = bottom 27%, moderate = middle 46%, and high = top 27%) and the group differences on each sub-factor were analyzed by a multivariate analysis of variance (MANOVA) to determine the consistency of the statistically significant differences and to establish each sub-factor and item's ability to differentiate between low and high values. The MANOVA indicated that there were statistically significant differences among students with low, moderate, and high values in mathematics learning for the six components and that the effect sizes of the values for the entire questionnaire and the six factors were large (Fan, 2001). The effects of the components [Component 1: $F(2,1007) = 452.02$, $p<0.001$, $\eta^2 = 0.47$; Component 2: $F(2,1007) = 262.27$, $p< 0.001$, $\eta^2 = 0.34$; Component 3: $F(2,1007) = 159.81$, $p<0.001$, $\eta^2 = 0.24$; Component 4: $F(2,1002) = 194.60$, $p<0.001$, $\eta^2 = 0.27$; Component 5: $F(2,1007) = 341.77$, $p< 0.001$, $\eta^2 = 0.40$; Component 6: $F(2,1007) = 423.63$, $p<0.001$, $\eta^2 = 0.45$) and the entire scale $F(2,999) = 1963.68$, $p< 0.001$, $\eta^2 = 0.79$] supported the claim that the questionnaire could distinguish among low, moderate, and high values.

Internal Consistency (Cronbach's α). Table 3 shows the means, standard deviations (SD), variance, kurtosis, skewness, and internal consistency (Cronbach's α) for the entire questionnaire and its components. The acceptable Cronbach's α (coefficients > 0.60) for the entire questionnaire and the six components confirmed the satisfactory internal consistency of the questionnaire (Table 3).

Table 3

Internal Consistency (Cronbach's α), Means, and Standart Deviations (SD), Skewness, and Kurtosis for the Questionnaire

Questionnaire	Item no	Mean	*SD*	Skewness	Kurtosis	Variance	*α*
Component 1	23	2.02	0.67	0.70	0.22	0.45	0.93
Component 2	22	1.48	0.43	1.81	5.64	0.18	0.89
Component 3	4	3.18	1.01	-0.06	-0.64	1.02	0.75
Component 4	3	1.87	0.73	0.89	0.70	0.54	0.58
Component 5	5	1.91	0.56	0.62	0.82	0.32	0.56
Component 6	3	1.82	0.76	1.08	1.11	0.58	0.62
Entire Questionnaire	60	2.05	0.46	0.40	1.15	0.21	0.94

The results of the correlations between the questionnaire components showed that there was a positive and significant correlation among the questionnaire components. The components were generally lower and moderately correlated. However, there were significant and positive associations (r = 0.63, p<0.01; r = 0.11, p<0.01; r = 0.32, p<0.01; r = 0.60, p<0.01; r = 0.61, p< 0.01) between component 1 and other components, respectively. There was also a significant and positive relationship (r=0.43, p<0.01; r = 0.53; p<0.01; r = 0.54; p<0.01) between component 2 and components 4-6, respectively and component 3 and components 4-6 (r = 0.13, p<0.01; r = 0.15; p<0.01; r= 0.15; p <0.01), respectively. Similarly, there was a significant and positive relationship (r = 0.33, p<0.01; r=0.29; p<0.01) between component 4 components 5-6, respectively and component 5 and component 6 (r = 0.44, p<0.01). On the other hand, there was no significant relationship (r= 0.00, p>0.05) between component 2 and component 3. Collectively, these findings indicate that the questionnaire is a valid and reliable instrument in identifying values in mathematics and mathematics learning.

Turkish Students' Mathematics Values

The results are presented in two ways: grade level differences and gender differences in terms of students' mathematics values.

Grade Level Differences. A MANOVA was conducted for each independent and dependent variable pair. A Bonferroni alpha level was used as 0.05/6=0.008 in the analysis of these findings (Pallant, 2007). The analysis indicated that there were statistically significant differences for each of the following components by Grade Level: Component 1 with large effect size, and components 2, 5, and 6 with medium effect sizes, $F(1,1000)=591.59$, $p<0.001$, $\eta^2=0.372$; $F(1,1000)=66.21$, $p<0.001$, $\eta^2=0.062$; $F(1,1000)= 98.38$, $p<0.001$, $\eta^2= 0.090$; $F(1,1000) =154.90$, $p<0.001$, $\eta^2= 0.134$, respectively ($\eta^2=0.372$ indicates that 37.2% of the variation in Component 1 can be explained by differences between Grades). There were no statistically significant differences between Grade Level and Components 3 and 4 (F (1, 1000) = 0.43, p>0.05; F (1,1000) = 6.45, p<0.01), respectively. A Tukey Honest Significant Difference (HSD) post hoc multiple comparisons test was performed in order to explore differences for each value dimension. It was found that Grade 5 and Grade 9 students' scores had significantly different mean values for Component 1 (Relevance).

Considering the mean scores, it was concluded that Grade 5 students had lower mean scores (indicating a high degree of importance) than Grade 9 students for all the six components, with mean values 1.63 (Grade 5) compared to 2.45 (Grade 9), 1.38 (Grade 5) compared to 1.59 (Grade 9), 3.16 (Grade 5) compared to 3.20 (Grade 9), 1.82 (Grade 5) compared to 1.94 (Grade 9), 1.75 (Grade 5) compared to 2.09 (Grade 9), and 1.56 (Grade 5) compared to 2.12 (Grade 9), respectively. In terms of the five-point Likert-type scale, these mean scores showed that the values expressed on the six components (except for the ICT factor, with a mean value of 3.16), were very positive for Grade 5 students, while the practice and feedback components were very positive, the relevance, learning approach, and consolidating were positive, and ICT factor was almost somewhat neutral for Grade 9 students. Furthermore, the mean scores of practice in both Grade 5 and Grade 9 students were also the lowest compared to the other five components. According to these results, both Grade 5 and Grade 9 students see practice as the most important value for their mathematics and mathematics learning within six components. Conversely, ICT component was valued least by both Grade 5 and Grade 9 students when compared to the other five components. The descending order of the mean scores (low scores indicate a high degree of importance during mathematics learning) for Grade 5 and Grade 9 were practice-consolidating-relevance-learning approach-feedback-ICT and practice-feedback- learning approach-consolidating-relevance-ICT, respectively (for further details see Table 4).

Gender. No statistically significant differences between gender and any of the six components were found, indicating that students' valuing was gender neutral.

Table 4

Grade 5 and Grade 9 Means and Standard Deviations for the Six Value Components

Component	Student				F Test	Effect Size (η^2)
	Grade 5		Grade 9			
	Mean	*SD*	Mean	*SD*		
Relevance	1.63	0.45	2.45	0.61	591.59, p=0.000	$\eta^2 = 0.372$, Grade 5 < Grade 9
Practice	1.38	0.36	1.59	0.47	66.21, p=0.000	$\eta^2 = 0.062$, Grade 5 < Grade 9
ICT	3.16	1.07	3.20	0.94	0.43, p=0.510	-
Feedback	1.82	0.75	1.94	0.70	6.45, p=0.011	-
Learning Approach	1.75	0.53	2.09	0.54	98.38, p= 0.000	$\eta^2= 0.090$, Grade 5 < Grade 9
Consolidating	1.56	0.60	2.12	0.81	154.90, p=0.000	$\eta^2= 0.134$, Grade 5 < Grade 9

** A low score indicates a high importance during mathematics learning.*

Discussion and Implications

The results showed that the MVQ consists of six value components. These components are: Relevance (C1), Practice (C2), ICT (C3), Feedback (C4), Learning Approach (C5) and Consolidating (C6). The questionnaire items, which loaded onto the first component, are associated with the students' valuing of *relevance*. These reflect the relevance espoused by many Turkish students, which is rather well documented in the literature (e.g., Bond, 1996, Dede, 2007, 2011, 2012). Findings of the current study indicate that both Grade 5 and Grade 9 students value relevance in their mathematics and mathematics learning highly. In this regard, Turkish students want mathematics to be taught in relation to daily life. Atweh (2007) emphasized the importance of teaching mathematics in relation to everyday life as follows:

> The development of mathematical knowledge through real world activities demonstrates the usefulness of mathematics at the same time as engaging students. Further, this engagement of mathematics with the life of the student should be an engagement not only with the physical world and the economic world, but also with the social world; not only with the world as the student will experience as an adult, but their current world; it should aim at developing an understanding not only of mathematics but also an understanding of the world. (p. 9)

The second value component is *practice* and its valuing is reflected in ways that the student respondents emphasize the importance of mathematics in class and homework. Everyone, regardless of their abilities, has the opportunity to strive for better success in life. In addition, success at school constitutes a transition to this life-long success. Thus, entering and emphasizing practice value is an expression of efforts. However, the belief that "practice makes perfect" puts a great deal of pressure on students (Zhang et al., 2016). As indicated in the literature section, the Turkish education system is centered on the high-stakes exams. With these exams, Turkish students are measured for their mathematical skills as well as their ability to use time in the most efficient manner possible. For this reason, if students want to succeed in these exams, they should solve a lot of mathematical questions and problems. In this sense, the results of the study indicate that both Grade 5 and Grade 9 students value practice in their mathematics and mathematics learning highly.

The third component arising from the data analysis is *ICT*. The use of ICT in education has been promoted since the 1990s (Wong, 2003) and was once again the foci in the mathematics curriculum reform at the turn of the millennium (Wong, Han, & Lee, 2004). Many resources, such as the internet, computers, calculators (including Computer Algebra Systems calculators - CAS) and a range of software have been incorporated into the school system, in particular those in the Chinese regions since then, in particular to assist those who are economically disadvantaged to have access. Similarly, in Turkey, the use of ICT in education in general and in mathematics education in particular has been strongly encouraged by the MEB since the 2000s. Encouragement on the use of ICT in education is increasing on a daily basis. In this regard, the effective and proper use of ICT is one of the mathematical competences that Turkish primary and secondary mathematics programs aim to develop (see, MEB 2013). However, findings of the current study reveal that both Grade 5 and Grade 9 students value ICT in their mathematics and mathematics learning neutrally. From this perspective, it is thought that it does not replace the traditional teaching methods although ICT has been gradually incorporated into the day-to-day teaching and learning activities in Turkish educational settings. In fact, it is possible that ICT would be valued more highly if its use was perceived as an integral part of concept development as well as an intellectually challenging tool supporting communication and exploration in realms within and beyond the classroom-and not just the routine drill and practice tool as is commonly the practice. Similar results have been reported for the three Chinese regions such as Chinese Mainland, Hong Kong and Taiwan (Zhang et al., 2016). These considerations could explain why the mean score of the ICT component is around 3.0, which means neither important nor unimportant for both the Grade 5 and the Grade 9 students.

The fourth value component is *feedback*. Turkish students also value the importance of feedback from teachers and friends. According to Hattie and Timperley (2007), feedback has a potentially significant effect on student learning. The reason that feedback is highly regarded by the students can basically coincide with earlier studies on students' preferred learning environment for mathematics (Ding & Wong, 2012; Wong, 1993). Similarly, studies in Turkish education settings indicate that type of feedback that pre-service primary school mathematics teachers prefer in mathematics classes is descriptive feedback (Çabakçor, Akşan, Öztürk, & Çimer, 2011) and Turkish mathematics teachers also use descriptive feedback in their teaching (Çetinkaya & Kögce, 2014). This feedback reflects lack of understanding and improper interpretations (Earl, 2003) and it gives students the opportunity to learn about current achievements in reaching an objective and plan future steps (Stiggins, Arter, Chappuis, & Chappuis, 2004). The descriptive feedback provides targeted information about the right or wrong of the activities of the students than the evaluative feedback so this feedback supports the understanding of the activity/task of the students (Davies, 2003). In Turkish primary and secondary mathematics programs, students are asked to "give feedbacks to support their learning" (p.11) when constructing mathematics learning/teaching environments (see, MEB 2013). Results of the present study also showed that the value feedback was very positive for both the Grade 5 and the Grade 9 students.

The fifth component is *Learning Approach*: It focuses on the importance of discussion environments small or whole class discussions, to look for different possible answers or different ways to find the answer during mathematics learning. Group and collaborative learning environments such as small or whole class discussions pertain to creating and maintaining such highly social learning environments (Johnson, Johnson, & Smith, 1991). The results of the study by Dede (2013) support this view. Dede found that the underlying values of the Turkish teachers' decision making processes in group work could be categorized under three main headings: productivity, socialization, and flexibility/authority. Findings of the current study indicated that the Grade 5 and the Grade 9 students valuing of the learning approach was very positive. Similar findings were also found in the study carried out by Dede and Yaman (2006). They study's outcomes revealed that group work was preferred more than individual learning by Grade 6, 7, and 8 Turkish mathematics students.

Similarly, Turkish contemporary primary and secondary mathematics programs emphasize that the use of positive approaches in the process of mathematics learning and teaching, such as cooperation and solidarity, should be adopted (MEB, 2018a, 2018b). However, studies with different outcomes regarding group work in the Turkish education literature have also been reported. For example, Dede (2010) found that Grade 6, 7, and 8 students perceived that small group instruction was not valued highly by mathematics teachers. In another study Dede (2006) reported similar results. The utility of small group instruction however, directly influences long-term retention of mathematical concepts (Urion & Davidson, 1992), improves students' mathematics achievement (Springer, Stanne, & Donovan, 1999), and maximizes students' interest towards mathematics (Davidson, 1971).

Finally, the sixth component is *Consolidating*. This component focuses on *consolidating* during mathematics learning, such as using concrete materials to understand mathematics and hands on activities. Results of the current study indicated that the valuing of consolidating in mathematics was very positive for Grade 5 students while positive for Grade 9 students. Turkish primary mathematics school programs also emphasize that "students should be asked to make comparisons between concepts and rules and to solve problems that can make connections between concrete and abstract representations" (MEB, 2005). Dede (2007), determined that Turkish students in Grades 6-8 use their teaching materials "once or twice a month" while high school students use "one or two times during the semester" in mathematics learning. Similarly, the results of the Dede (2005; 2006) studies with Turkish primary school mathematics teachers also showed that the teachers use very little teaching materials such as recording devices, slides, worksheets, training tapes, educational films and cartoons in their lessons while they use too much writing on their classroom boards, auxiliary resources, textbooks, and photocopying machines. Teaching materials such as, concrete materials to understand mathematics and hands on activities, influence what learners will learn and how teachers will teach (Maclellan, 1997).

The present study has demonstrated how survey data on students' valuing can be further interrogated and analysed quantitatively to explore the influence of grade level on Turkish students' mathematics learning values. The WIFI questionnaire enables us to conduct studies with large samples, and analyse and interpret the collected quantitative data statistically so that meaningful cross-cultural comparisons are possible. Being able to use the valuing discourses to explain observed differences between groups of students, opens up other fronts of possibilities of addressing these differences, in terms of values modification, negotiation, and alignment. Mathematics educators could use the findings to enrich their understanding of what their students' values in mathematics learning, and to use this knowledge to better plan and deliver mathematics teaching experiences in school.

Students learn more effectively in environments, which align with their preferences. These preferences vary with year level and as it has been shown in this study, students in different grades demonstrate various levels of valuing in their mathematics learning. What is valued in a certain community is not necessarily valued in another. It is important for teachers to be aware of such differences and to plan their lessons in ways where there is shared valuing of mathematics and its pedagogy between teachers and students. As mentioned above, previous studies with Turkish students have indicated that there were disparities between students' and teachers' values. Further research is required in this area. Future research should be conducted investigating the reasons why Turkish mathematics teachers are not teaching in accordance with principles mandated by the MEB.

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