A Comparative Analysis of Questions in American, Singaporean, and Turkish Mathematics Textbooks Based on the Topics Covered in 8th Grade in Turkey

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Abstract

This study offers a comparative analysis of questions found in Turkish, Singaporean, and American mathematics textbooks and workbooks based on topics covered in the 8th grade mathematics curriculum in Turkey. To this end, the study utilizes the 3-dimensional framework developed by Li. When the questions in the textbooks and workbooks representative of those used in the United States, Singapore, and Turkey were analyzed with respect to their mathematical features, the percentage of questions that require multiple computation procedures were found to be 90%, 96%, and 85% respectively. When the questions were analyzed with respect to their contextual features, it was observed that questions categorized as purely mathematical in context made up 72%, 76%, and 61% of the questions in the books. When the questions were compared with respect to their response type, a sub-category of performance requirements, it was found that 83%, 85%, and 66% of the questions respectively required only numerical answers. In the representative books from the US, when questions were categorized with respect to their cognitive requirements, a sub-category of performance requirements, it was determined that conceptual understanding, procedural practice, problem solving, and special requirements constituted 9%, 81%, 9%, and 1% of the questions. These percentages were determined to be 7%, 83%, 9%, and 1% for the Singaporean books, and 21%, 67%, 11%, and 1% for the Turkish books. Even though the percentage of questions that required problem solving was higher in the Turkish books than in those of the other two nations, the number of such problems in the books was less (US 259, Singapore 246, Turkey 144).

Key Words

Li's Dimensions of Problem Requirements, Mathematics Textbooks, Middle School Mathematics, National Comparisons, 8th Grade.

As a result of reform movements in mathematics education around the world, Turkey felt the need to revise its educational goals and prepare new curricula (Toptaş, Elkatmış, & Karaca, 2012). In the academic year 2006-07, a new mathematics curriculum for the 6th, 7th, and 8th grades was prepared, and starting with the 6th grade mathematics textbook in 2006, a new textbook for each grade was written and put to implementation. The project was finalized by the academic year 2008-09 (Eğitim Reformu Girişimi [ERG], 2005). Textbooks are considered to be the most important
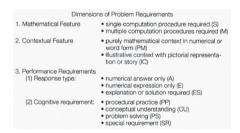
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component of a reformed curriculum, because they are a reflection of the curriculum for the teachers, students, and parents (Valverde, Bianchi, Wolfe, Schmidt, & Houang, 2002). Which textbooks are used is a good indicator of a curriculum, and analysis of the textbooks explores how well the intended curriculum is implemented (Remillard, 2000).

Of all learning materials, textbooks offer the most learning opportunities (Garner, 1992). In order to best measure students' learning opportunities, Törnroos (2005) assessed the mathematical topics included in Trends in Mathematics and Science Study (TIMSS 1999) using three categories. First, the learning opportunity in the content of each chapter was assessed using the content titles in the textbooks. Second, learning opportunities offered by teachers, and third, the content of the textbooks were analyzed with regard to how the material was presented. The result of this study indicated that textbooks are the best source for providing learning opportunities, as well as the best indicator for measuring the learning opportunities provided. Learning opportunities is an important factor in explaining differences in students' performances (Schimdt et al., 2001).

The finding that textbooks are a good source in establishing learning opportunities resulted in an increase in the number of studies focusing on textbook analyses of different nations after the 1990's. Foxman's (1999) research indicated that students using the mathematics textbook in class were more successful in TIMSS than their counterparts who had not. Similarly, Yeap's (2005) study established that textbooks played a vital role in the mathematics achievement of Singaporean students. For this reason, many nations strove to obtain minimum standards in the quality of their textbooks. In order to determine the potential effect of textbooks and pedagogical approaches on the mathematics achievement of students, the textbooks of many nations such as the US, Singapore, China, and Japan were analyzed (Fuson, Stigler, & Bartsch, 1988; Li, 2000; Mayer, Sims, & Tajika, 1995; Schmidt, McKnight, & Raizen, 1997). For instance, in his study comparing American and Japanese 1st and 2nd grade mathematics textbooks, Stevenson (1985) stated that the questions in the American textbooks were less challenging than their Japanese counterparts. In another study where Stevenson collaborated with Bartsch (1992), the content of mathematics textbooks used in the US and Japan was analyzed, and it was found that

in the Japanese textbooks, many concepts were introduced several years earlier than those in the American ones. Stevenson, Stigler, Lee, and Lucker (1982) analyzed mathematics textbooks utilized in Japan, Taiwan, and the US to find when a concept was introduced, and the level of skills expected in a particular grade in different countries. In a similar study, Lo, Cai, and Watanabe (2001) compared mathematics textbooks used in China, Taiwan, Japan, and the US with respect to the overall appearance of the textbooks, as well as the questions and solutions they contained. The result of this comparison indicated that questions in the Chinese, Taiwanese, and Japanese textbooks had much more complex and difficult questions than those in the American books. A study comparing the treatment of addition and subtraction of fractions in the textbooks used in Southern Cyprus, Ireland, and Taiwan was published by Charalambous, Delaney, Seán, Hsu, and Mesa (2010). The authors argued that in order to understand the differences in the teaching and achievement of different nations, their textbooks should be analyzed. In a study completed by Mayer et al. in 1995, Japanese and American textbooks were compared based on their approaches to teaching problem-solving, and it was found that Japanese books emphasize problem-solving more than their American counterparts. Beckmann's 2004 study showed that Singaporean textbooks were the reason for the success of 8th grade Singaporean students in TIMSS.

In a paper published in 2000, Li developed a framework called "dimensions of problem requirements" in order to analyze mathematics questions in textbooks. This framework analyzes questions from three dimensions and is explained below (Li, 2000, p. 237):

Li's (2000) framework was the main methodology used in numerous studies, such as Arnold and Son's (2011), where response types and cognitive demands were categorized using Li's (2000) as well as Son and Senk's (2010) methods. In 2003, Cheung utilized Li's framework to compare questions in

the algebra chapters of two mathematics textbooks used in Hong Kong, one which was written for mathematics program of 1985 and the other for that of 2001. İncikabı and Tjoe's (2012) study compared questions related to ratio and proportion in American and Turkish mathematics textbooks with respect to mathematical features, contextual features, and performance requirements. The method used was similar to Li's (2000) in many respects, with the addition of a technology component for those questions that required its use. Conklin (2004) compared German, American, and Japanese mathematics textbooks with respect to their size, weight, structural organization, page length, and question characteristics. Li's framework was utilized for the analyses of the contextual features, response types, and cognitive demands. Hu's (2011) analysis of the response types and performance requirements of questions also employed Li's dimensions of problem requirements.

As is the case in other countries, studies focusing on mathematics textbooks in Turkey have increased over the years; however, these studies were mostly at the national level, based on the feedback of teachers, students (Arslan & Özpınar, 2009; A. Çakır, 2006; İ. Çakır, 2009; Işık, 2008). In a 2006 study, Delil analyzed geometry questions in the 6th, 7th, and 8th grade textbooks based on the cognitive requirements used in TIMSS 1999. The study found that although applying a known procedure constituted only 24% of TIMSS geometry questions, 50% of the questions in the textbook fell into this category, and whereas 30% of TIMSS questions required reasoning skills, only 10% of the textbook questions required it. Another study by Erbaş and Alacacı (2009) compared mathematics textbooks and workbooks used in the US, Singapore, and Turkey. According to the findings of this study, in the Turkish books, there was one type of question limited to the understanding of a concept, and multiple solutions were not offered. In contrast, Singaporean and American textbooks tried to develop various mathematical skills related to the concept. Moreover, in the Singaporean textbooks, problems of a wide range of difficulty and increasing complexity were offered, helping students internalize concepts.

There is no study in the literature comparing the 8th grade mathematics textbooks of Turkey with those in nations that take the lead in TIMSS and *Programme for International Student Assessment (P*ISA); however, numerous such studies exist for other countries (Charalambous et al., 2010; Fuson

et al., 1988; Haggarty & Pepin, 2002; Li, 2000; Mayer et al., 1995; Schmidt et al., 1997). The current study aims to be a continuation of the Erbaş and Alacacı (2009) study, thus its purpose is to analyze the overall picture of how middle school mathematics textbooks compared to those of nations that score higher than Turkey in global comparisons such as TIMSS and PISA (Eğitimi Araştırma Geliştirme Dairesi Başkanlığı [EARGED], 2003). One country that was chosen for this comparison was Singapore, a country that ranks in the top five in TIMSS and PISA. The other was the US, a country whose reform in education has affected many others, and which ranks about average in global comparisons. Authors of the present study believe that such an evaluation will help in the writing of mathematics textbooks that are up to par in the future. Li's (2000) three-dimensional framework will be used to compare the questions found in Turkey's 8th grade textbook and workbook with questions in books from the US and Singapore, in order to answer the following research questions:

1. a) Which topics are found across the 8th grade text books of the US, Singapore, and Turkey?

1. b) When are topics that are covered in the Turkish 8th grade textbook but not in the American or Singaporean textbooks taught in these countries?

Taking the topics covered in the Turkish 8th grade mathematics textbook approved by the Turkish Ministry of Education as a basis:

2. a) How do the questions pertaining to these topics compare in the American, Singaporean, and Turkish books with respect to their mathematical features?

2. b) How do the questions pertaining to these topics in each content area compare in the American, Singaporean, and Turkish books with respect to their mathematical features?

3. a) How do the questions pertaining to these topics compare in the American, Singaporean, and Turkish books with respect to their contextual features?

3. b) How do the questions pertaining to these topics in each content area compare in the American, Singaporean, and Turkish books with respect to their contextual features?

4. a) How do the questions pertaining to these topics compare in the American, Singaporean, and Turkish books with respect to their response type, a sub-category of performance features?

4. b) How do the questions pertaining to these topics in each content area compare in the American, Singaporean, and Turkish books with respect to their response type, a sub-category of performance features?

5. a) How do the questions pertaining to these topics compare in the American, Singaporean, and Turkish books with respect to their cognitive requirements, a sub-category of performance features?

5. b) How do the questions pertaining to these topics in each content area compare in the American, Singaporean, and Turkish books with respect to their cognitive requirements, a sub-category of performance features?

Method

This is a qualitative study, where the questions in the textbooks and accompanying workbooks (if available) that are representative of those used in the US, Singapore, and Turkey are analyzed according to Li's framework. The reason Li's (2000) framework was used is because it was designed specifically to analyze mathematics questions in textbooks.

1. Mathematical features:
   · Single procedure (S)
   · Multiple procedure (M)

2. Contextual features:
   · Purely mathematical context in numerical or word form (PM)
   · Illustrative context with pictorial representation or story (IS)

3. Performance requirements:

a) Response type:
   · Numerical answer only (NA)
   · Numerical expression only (NE)
   · Explanation or solution required (ES)

b) Cognitive requirements:
   · Procedural practice (PP)
   · Conceptual understanding (CU)
   · Problem solving (PS)
   · Special requirements (SR)

A study conducted by Adaptive Curriculum in 2010 in 100 school districts in the US indicated that the 8th grade mathematics textbook most widely used was *Mathematics: Applications & Concepts* by Rhonda Bailey, Roger Day, Patricia Frey, Arthur Howard, Deborah Hutchens, Kay McClain, Beatrice Moore, Jack Ott, Ronald Pelfrey, Jack Price, Kathleen Vielhaber, and Teri Willard (Glencoe). For this reason, the present study used the same book. In Singapore, all textbooks need to be approved by Singapore's Ministry of Education before they can be adopted. As a representative of math textbooks and workbooks in Singapore, the New Syllabus series was chosen. For Turkey, the 2010 reprint of the textbook and workbook first published and approved in 2008 by the Ministry of Education was chosen. For this study, all questions in the textbooks and workbooks' learning activities and worked-out examples, except those used at the introduction of the topic, were coded. For those topics found in the 8th grade books in Turkey, but not in those of the US and Singapore, 6th to 9th grade textbooks were surveyed. The books surveyed are given in Table 1.

Table 1.
Text Books Used in the Study

Grade	US	Singapore	Turkey
6	Mathematics: Applications & Concepts Glencoe, 2006, Mcgraw-Hill	New Syllabus 1, 2010, Shinglee	
7	Mathematics: Applications & Concepts Glencoe, 2006, Mcgraw-Hill	New Syllabus 2, 2010, Shinglee	
8	Mathematics: Applications & Concepts Glencoe, 2006, Mcgraw-Hill	New Syllabus 3, 2010, Shinglee	Ministry of Education, 2010
9	Algebra 1 Glencoe, 2006, Mcgraw-Hill	New Syllabus 4, 2010, Shinglee	

To answer the second part of the fifth research question, the questions in the textbooks and workbooks were coded according to Li's framework. Before the coding was started, a workshop was given to the two coders, both of whom are mathematics teachers, by a faculty member working in this area. During this workshop, questions were coded and the codings were discussed. Later, the two coders coded all the questions independently, and results were compared. In any category where the reliability was less than 90%, the questions that were coded differently were discussed and coded again. Reliability was calculated based on the last coding. The reliability calculated for each category

was found to be 94% for mathematical features, 98% for contextual features, 96% for response type, a sub-category of performance requirements, and 97% for cognitive requirements, a sub-category of performance requirements.

Results

The first part of the first research question asked about topics that were found across the 8th grade textbooks of all three countries. These topics were "Exponents and Operations with Exponents," "Relationships Formed by the Sides of a Triangle," "Slope," "Inequalities," and "Ratios in a Right Triangle;" however, the coverage of some of these topics ranged between 7th to 9th grades in the US and 6th to 8th grades in Singapore (Table 2).

Table 2.
Topics Found in the American, Singaporean, and Turkish 8th Grade Mathematics Text Books

Topics	US	Singapore	Turkey
Exponents and Operations with Exponents	7-8-9	8	8
Relationships Formed by the Sides of a Triangle	8	6, 8	8
Slope	8	8	8
Inequalities	8	8	8
Ratios in a Right Triangle	8	8	8

The second part of the first research question asked when the topics covered in Turkey's 8th grade textbooks are taught with the same depth in the US and Singapore. To answer this question, the objectives of the mathematics program of these countries were analyzed, and the results are given in Table 3.

The first part of the second research question investigates the mathematical features of questions in the textbooks and workbooks of the US, Singapore, and Turkey, based on the topics covered in the Turkish 8th grade textbooks. Questions were categorized into two groups, namely, those requiring a single procedure in their solution and those requiring multiple procedures. There are a total of 2,736 questions in the American books, 2,669 questions in the Singaporean books, and 1,367 questions in the Turkish books. Of those, 2,454 (90%) of the questions in the American books, 2,560 (96%) of the questions in the Singaporean books, and 1,163 (85%) of the questions in the Turkish books require multiple procedures. The distribution of these questions in the textbooks and workbooks is given in Table 4.

Table 3.
The Grades At Which Topics Covered in the 8th Grade Textbook in Turkey Are Covered in the US and Singapore

Topics	US	Singapore	Turkey
Numbers			
Exponents and Operations with Exponents	**7-8-9**	**8**	**8**
Square Roots and Operation with Square Roots	7-8-9	6	8
Real Numbers	8	6	8
Geometry and Measurement			
Reflection, Translation, and Rotation	8	-	8
Fractals	-	-	8
Relationships Formed by the Sides of a Triangle	**8**	**6, 8**	**8**
Congruence and Similarity of Triangles	7-9	8	8
Prisms, Surface Area, and Volume of Prisms	8	6	8
Surface Area and Volume of Pyramids, Cones, and Spheres	8	7	8
Projection and Polyhedra	-	-	8
Perspective Drawing	-	-	8
Polyhedra and Its Cross Sections	-	-	8
Geometric Objects and Symmetry	8	-	8
Ratios in a Right Triangle	**8**	**8**	**8**
Slope	**8**	**8**	**8**
Algebra			
Number Sequences	7-8	6	8
Pythagorean Theorem	7-8-9	7	8
Identities and Factors	8	7	8
Rational Expressions	9	7	8
Inequalities	**8**	**8**	**8**
System of Equations	9	7	8
Statistics, Probability, and Data Analysis			
Combination	8	-	8
Probability and Event Types	8	9	8
Histogram	8	-	8
Standard Deviation	-	9	8

*Topics written in bold are those mutually included in the 8th grade text books of the three countries.

Table 4.
Mathematical Features (Number of Procedures Required) of Questions in the Representative Textbooks and Workbooks from the US, Singapore, and Turkey

Country	Number of Procedures Required (Percentage)	
	Single	Multiple
US Textbooks	217 (%10)	1882 (%90)
US Workbooks	65 (%10)	572 (%90)
US Total	**282 (%10)**	**2454 (%90)**
Singapore Textbooks	73 (%4)	1758 (%96)
Singapore Workbooks	36 (%4)	802 (%96)
Singapore Total	**109 (%4)**	**2560 (%96)**
Turkish Textbook	95 (%15)	544 (%85)
Turkish Workbook	109 (%15)	619 (%85)
Turkish Total	**204 (%15)**	**1163 (%85)**

The second part of the second research question investigates how the mathematical requirements

of the questions in (2a) were distributed across content in the American, Singaporean, and Turkish books. The questions were categorized into four content areas, namely, numbers, geometry and measurement, algebra, and statistics, probability, and data analysis. A summary of these results is given in Table 5.

The second part of the third research question investigates how the contextual requirements of the questions in (3a) are distributed across the four content areas in the American, Singaporean, and Turkish books. A summary of these results is given in Table 7.

Table 5.
Mathematical Features (Number of Procedures Required) of Questions in the Representative Textbooks and Workbooks from the US, Singapore, and Turkey With Respect to Content Areas

Countries	Numbers		Geometry and Measurement		Algebra		Statistics and Probability	
	Number of Procedures Required							
	Single	Multi	Single	Multi	Single	Multi	Single	Multi
US Textbooks	94 (%18)	430 (%82)	51 (%8)	579 (%92)	34 (%5)	651 (%95)	38 (%15)	222 (%85)
US Workbooks	0	185(%100)	39 (%19)	167 (%81)	16 (%9)	167 (%91)	10 (%16)	53 (%84)
US Total	**94 (%13)**	**615 (%87)**	**90 (%11)**	**746 (%89)**	**50 (%6)**	**818 (%94)**	**48 (%15)**	**275 (%85)**
Singapore Textbooks	14 (%6)	221 (%94)	43 (%8)	478 (%92)	11 (%1)	978 (%99)	5 (%6)	81 (%94)
Singapore Workbooks	7 (%2)	419 (%98)	0	64 (%100)	29 (%10)	275 (%90)	0	44 (%100)
Singapore Total	**21 (%3)**	**640 (%97)**	**43 (%7)**	**542 (%93)**	**40 (%3)**	**1253(%97)**	**5 (%4)**	**125 (%96)**
Turkish Textbook	62 (%35)	117 (%65)	21 (%9)	225 (%91)	10 (%6)	148 (%94)	2 (%4)	54 (%96)
Turkish Workbook	58 (%27)	154 (%73)	25 (%9)	256 (%91)	25 (%9)	151 (%91)	1 (%2)	58 (%98)
Turkish Total	**120 (%31)**	**271 (%69)**	**46 (%9)**	**481 (%91)**	**35 (%10)**	**299 (%90)**	**3 (%3)**	**112 (%97)**

The first part of the third research question investigates the contextual features of questions in the textbooks and workbooks from the US, Singapore, and Turkey based on the topics covered in the Turkish 8th grade textbooks. Questions were categorized into two groups, namely, those having a purely mathematical context and those having an illustrative or story context. It was found that 1,963 of the 2,736 questions (72%) in the American books, 2,403 of the 2,669 questions (77%) in the Singaporean books, and 834 of the 1,367 questions (61%) in the Turkish books had a purely mathematical context. The distribution of these questions in the textbooks and workbooks is given in Table 6.

Table 6.
Contextual Features (Pure/Illustration or Story) of Questions in the Representative Textbooks and Workbooks from the US, Singapore, and Turkey

Country	Contextual Features (Percentages)	
	Pure Mathematics	Illustrative Context or Story
US Textbooks	1456 (%69)	643 (%31)
US Workbooks	507 (%80)	130 (%20)
US Total	**1963 (%72)**	**773 (%28)**
Singapore Textbooks	1348 (%74)	483 (%26)
Singapore Workbooks	695 (%83)	143 (%17)
Singapore Total	**2043 (%77)**	**626 (%23)**
Turkish Textbook	381 (%60)	258 (%40)
Turkish Workbook	453 (%62)	275 (%38)
Turkish Total	**834 (%61)**	**533 (%39)**

The first part of the fourth research question investigates the response type, a sub-category of performance requirements, of questions in the textbooks and workbooks from the US, Singapore, and Turkey based on the topics covered in the Turkish 8th grade text books. Questions were categorized into four groups, namely, those requiring a numerical answer only, those requiring a numerical expression only, and those requiring either an explanation or a solution. It was found that of the 2,736 questions in the American books, 2,264 (83%) of them required numerical answers only, 471(17%) required an explanation or solution, and two required a numerical expression only. In the Singaporean books, of the 2,669 questions, 2,165 (81%) required a numerical answer only, 504 (19%) required an explanation or solution, and two required a numerical expression only. In the Turkish books, there were 1,367 questions, of which 897 (65%) required a numerical answer only, 448 (33%) required an explanation or solution, and 22 (2%) required numerical expressions. As can be seen from the example below, although Turkey had a higher percentage of questions requiring an explanation or solution, these explanations did not focus on higher-level thinking skills used towards the solution, but merely on the answer itself. The distribution of these questions in the textbooks and workbooks is given in Table 8.

Table 7.

Contextual Features (Pure/Illustration or Story) in the Representative Textbooks and Workbooks from the US, Singapore, and Turkey With Respect to Content Areas

Countries	Numbers		Geometry		Algebra		Statistics and Probability	
	Contextual Features							
	Pure Math.	*Illustrative or Story*	*Pure Math.*	*Illustrative or Story*	*Pure Math.*	*Illustrative or Story*	*Pure Math.*	*Illustrative or Story*
US Textbooks	481 (%92)	43 (%8)	280 (%44)	350(%56)	546 (%80)	139(%20)	149 (%57)	111(%43)
US Workbooks	176 (%95)	9 (%5)	115 (%56)	91 (%44)	176 (%96)	7 (%4)	40 (%63)	23 (%37)
US Total	**657 (%93)**	**52 (%7)**	**395 (%47)**	**441(%53)**	**722 (%83)**	**146(%17)**	**189 (%59)**	**134(%41)**
Singapore Textbooks	222 (%94)	13 (%6)	185 (%36)	336(%64)	900 (%91)	89 (%9)	41 (%48)	45 (%52)
Singapore Workbooks	380 (%89)	46 (%11)	29 (%45)	35 (%55)	282 (%93)	22 (%7)	4 (%9)	40 (%91)
Singapore Total	**602 (%91)**	**59 (%9)**	**214 (%37)**	**371(%63)**	**1182(%91)**	**111 (%9)**	**45 (%35)**	**85 (%65)**
Turkish Textbook	170 (%95)	9 (%5)	98 (%40)	148(%60)	96 (%61)	62 (%39)	17 (%30)	39 (%70)
Turkish Workbook	192 (%91)	20 (%9)	97 (%35)	184(%65)	134 (%76)	42 (%24)	30 (%51)	29 (%49)
Turkish Total	**362 (%93)**	**29 (%7)**	**195 (%37)**	**332(%63)**	**230 (%69)**	**104(%31)**	**47 (%41)**	**68 (%59)**

Table 8.

Response Type (a Sub-Category of Performance Requirements) of Questions in the Representative Textbooks and Workbooks from the US, Singapore, and Turkey

Countries	Number of Questions According to Response Type *(Percentages)*		
	Numerical Answer Only	*Explanation or Solution*	*Numerical Expression Only*
US Textbooks	1702 (%81)	396 (%19)	1 (%0)
US Workbooks	562 (%88)	75 (%12)	1 (%0)
US Total	**2264 (%83)**	**471 (%17)**	**1 (%0)**
Singapore Textbooks	1452 (%79)	379 (%21)	1 (%0)
Singapore Workbooks	713 (%85)	125 (%15)	1 (%0)
Singapore Total	**2165 (%81)**	**504 (%19)**	**1 (%0)**
Turkish Textbook	418 (%66)	213 (%33)	8 (%1)
Turkish Workbook	479 (%66)	235 (%32)	14 (%2)
Turkish Total	**897 (%65)**	**448 (%33)**	**22 (%2)**

Example

Explain if the numbers given below are a perfect square.

  a) 230   b) 156   c) 196   d) 0

The second part of the fourth research question investigates how the response type (a sub-category of performance requirements) of the questions in (4a) is distributed across the four content areas in the American, Singaporean, and Turkish books. A summary of these results is given in Table 9.

The first part of the fifth research question investigates the cognitive requirements (a sub-category of the performance requirements) of the questions in the textbooks and workbooks from the US, Singapore, and Turkey, based on the topics covered in the 8th grade Turkish textbooks. Questions were categorized into four groups, namely, those requiring conceptual understanding, those requiring procedural practice, those requiring problem solving, and those having special requirements.

It was found that of the 2,736 questions in the American books, 241 (9%) of them required conceptual understanding, 2,215 (81%) required procedural practice, 260 (9%) required problem solving, and 20 (1%) had special requirements. In the Singaporean books, of the 2,669 questions, 187 (7%) required conceptual understanding, 2,200 (83%) required procedural practice, 246 (9%) required problem solving, and 36 (1%) had special requirements. In the Turkish books, there were 1,367 questions, of which 291 (21%) required conceptual understanding, 918 (67%) required procedural practice, 144 (11%) required problem solving, and 14 (1%) had special requirements. The distribution of these questions in the textbooks and workbooks is given in Table 10.

The second part of the fifth research question investigates how the cognitive requirements (a sub-category of the performance requirements) of the questions in (5a) were distributed across the four content areas in the American, Singaporean, and Turkish books. A summary of these results is given in Table 11.

Table 9.
Response Type (a Sub-Category of Performance Requirements) of Questions in Representative Textbooks and Workbooks from the US, Singapore, and Turkey With Respect to Content Areas

Countries	Numbers			Geometry			Algebra			Statistics and probability		
	Response Types											
	Num. Answ.	Explain/ Solution.	Num. Exp.	Num. Answ.	Explain Soln.	Num. Exp.	Num. Answ.	Explain./ Solution	Num. Exp.	Num. Answ.	Explain/ Solution	Num Exp.
US Textb.	467 (%89)	57 (%11)	0	467 (%74)	162 (%26)	1 (%0)	558 (%81)	127 (%19)	0	210 (%81)	50 (%19)	0
US Workb.	185 (%100)	0	0	181 (%88)	25 (%12)	0	139 (%76)	44 (%24)	0	57 (%90)	6 (%10)	0
US Total	**652 (%92)**	**57 (%8)**	**0**	**648 (%78)**	**187 (%22)**	**1 (%0)**	**697 (%80)**	**171 (%20)**	**0**	**267 (%83)**	**56 (%17)**	**0**
Singapore Textb.	196 (%83)	39 (%17)	0	373 (%72)	148 (%28)	0	823 (%83)	166 (%17)	0	60 (%70)	26 (%30)	0
Singapore Workb.	365 (%86)	61 (%14)	0	44 (%69)	20 (%31)	0	261 (%86)	43 (%14)	0	43 (%98)	1 (%2)	0
Singapore Total	**561 (%85)**	**100 (%15)**	**0**	**417 (%71)**	**168 (%29)**	**0**	**1084 (%84)**	**209 (%16)**	**0**	**103 (%79)**	**27 (%21)**	**0**
Turkish Textb.	131 (%73)	45 (%25)	3 (%2)	132 (%54)	113 (%46)	1 (%0)	116 (%73)	38 (%24)	4 (%3)	39 (%70)	17 (%30)	0
Turkish Workb.	195 (%92)	11 (%5)	6 (%3)	148 (%53)	132 (%47)	1 (%0)	103 (%58)	66 (%38)	7 (%4)	33 (%56)	26 (%44)	0
Turkish Total	**326 (%84)**	**56 (%14)**	**9 (%2)**	**280 (%54)**	**245 (%46)**	**2 (%0)**	**219 (%66)**	**104 (%31)**	**11 (%3)**	**72 (%63)**	**43 (%37)**	**0**

Table 10.
Cognitive Requirements (a Sub-Category of Performance Requirements) of Questions in the Representative Textbooks and Workbooks from the US, Singapore, and Turkey

Country	Number of Questions with Respect to Cognitive Requirements			
	Procedural Practice	Contextual Understanding	Problem Solving	Special Requirements
US Textbooks	1643 (%79)	216 (%10)	220 (%10)	20 (%1)
US Workbooks	572 (%90)	25 (%4)	40 (%6)	0
US Total	**2215 (%81)**	**241 (%9)**	**260 (%9)**	**20 (%1)**
Singapore Textbooks	1478 (%80)	142 (%8)	195 (%11)	16 (%1)
Singapore Workbooks	722 (%87)	45 (%5)	51 (%6)	20 (%2)
Singapore Total	**2200 (%83)**	**187 (%7)**	**246 (%9)**	**36 (%1)**
Turkish Textbook	405 (%63)	157 (%25)	72 (%11)	5 (%1)
Turkish Workbook	513 (%71)	134 (%18)	72 (%10)	9 (%1)
Turkish Total	**918 (%67)**	**291 (%21)**	**144 (%11)**	**14 (%1)**

Discussion and Recommendations

This study analyzing the 8th grade textbooks and workbooks from the US, Singapore, and Turkey, found that the topics in the Turkish textbook overlapped more with those in the American books (85%) than those in the Singaporean books (30%), and that the overlap between the American and Singaporean books was even less (20%). Although national curricula are considered as one of the most influential factors contributing to a country's success in global comparisons such as TIMSS (Peak, 1996), this alone does not explain the ranking of these three countries in recent TIMSS. Both in TIMSS 2007 and PISA 2009, the US ranked above Turkey, even though its curriculum had less of an overlap with Singapore's. This study indicated that Singaporean students are introduced to mathematical concepts a year or two earlier than Turkish students. Stevenson and Bartsch (1992) attributed Japanese students' success over their American counterparts to having been introduced to topics in earlier grades. This feature seems to be an important characteristic of the education system of countries in the Far East such as Singapore and Japan.

In the American and Singaporean books, there were 2,736 and 2,669 questions respectively, though in Turkish books the number was considerably less (1,367). Fewer questions may result in fewer question types, especially a fewer number of high-level questions. Numerous studies on Turkish mathematics textbooks recommend increasing the number and difficulty level of the questions in the textbooks (Altun, Arslan, & Yazgan, 2004; Aydoğdu İskenderoğlu & Baki, 2011; Erbaş & Alacacı, 2009; Yüksel & Artut, 2010).

An analysis of the books revealed that in all three countries and in all content areas, the percentage of questions requiring multiple procedures was higher than those requiring single procedures, although the number of questions requiring a single procedure in their solutions was highest in Turkey's books. These findings are parallel to those found

Table 11.
Cognitive Requirements (a Sub-Category of Performance Requirements) of Questions in the Representative Textbooks and Workbooks from the US, Singapore, and Turkey With Respect to Content Areas

Country	Numbers				Geometry				Algebra				Statistics and Probability			
						Cognitive Requirements										
	PP	CU	PS	SR	PP	CU	PS	SR	PP	CU	PS	SR	PP	CU	PS	SR
US Textb.	469 %89	31 %6	24 %5	0	438 %69	117 %19	69 %11	6 %1	578 %85	37 %5	62 %9	8 %1	158 %61	31 %12	65 %25	6 %2
US Workb.	178 %96	0	7 %4	0	172 %83	6 %3	28 %14	0	167 %91	16 %9	0	0	55 %87	3 %5	5 %8	0
US Total	**647 %92**	**31 %4**	**31 %4**	**0**	**610 %73**	**123 %15**	**97 %11**	**6 %1**	**745 %86**	**53 %6**	**62 %7**	**8 %1**	**213 %65**	**34 %11**	**70 %22**	**6 %2**
Singap. Textb.	190 %81	36 %15	7 %3	2 %1	380 %76	64 %12	65 %12	12 %2	873 %88	36 %4	79 %8	1 %0	35 %41	6 %7	44 %51	1 %1
Singap. Workb.	394 %93	21 %5	2 %0	9 %2	39 %61	13 %20	5 %8	7 %11	284 %94	10 %3	6 %2	4 %1	5 %11	1 %2	38 %87	0
Singap. Total	**584 %88**	**57 %9**	**9 %1**	**11 %2**	**419 %72**	**77 %13**	**70 %12**	**19 %3**	**1157 %89**	**46 %4**	**85 %7**	**5 %0**	**40 %31**	**7 %5**	**82 %63**	**1 %1**
Turkish Textb.	136 %75	39 %22	1 %1	3 %2	129 %52	85 %35	30 %12	2 %1	121 %76	23 %15	14 %9	0	19 %34	10 %18	27 %48	0
Turkish Workb.	195 %92	9 %4	2 %1	6 %3	159 %56	97 %35	25 %9	0	142 %81	14 %8	20 %11	0	17 %29	14 %24	25 %42	3 %5
Turkish Total	**331 %85**	**48 %12**	**3 %1**	**9 %2**	**288 %55**	**182 %35**	**55 %10**	**2 %0**	**263 %79**	**37 %11**	**34 %10**	**0**	**36 %31**	**24 %21**	**52 %45**	**3 %3**

Note: PP: Procedural Practice, CU: Conceptual Understanding, PS: Problem Solving, SR: Special Requirements

by Erbaş and Alacacı (2009). When questions were analyzed with respect to their contextual features, the percentage of pure math problems was 76% in the Singaporean, 72% in the American, and 61% in the Turkish books. These results also support Erbaş and Alacacı's (2009) findings. Olkun and Aydoğdu (2003) cited insufficient quality of the visuals in the geometry content area in the books published by the Ministry of Education in Turkey as a reason for Turkish students doing poorly on these questions in TIMSS. Ng and Lee's (2009) research indicated that the visuals in the Singaporean books aided students in their solutions and strengthened their conceptual understanding. When questions were analyzed with respect to their required response type, it was observed that in all three countries' books, questions requiring a numerical answer only constituted the largest percentage of the questions. In the Turkish books, even though the percentage of questions requiring an explanation or solution was higher than in the books of the other two countries, the responses focused on the explanation of the answer rather than on the solution method. Erbaş and Alacacı (2009), Cai (2003), and Soylu and Aydın's (2006) results confirm this finding and contrast it to the focus of the questions in the Singaporean books on solution methods. When the questions were compared with respect to cognitive demands, it was found that in all the countries investigated, procedural practice took the lead. Li, Chen, and An (2009) indicated that in the Far Eastern countries, conceptual understanding is attained during the presentation of a topic, and as Hiebert and Carpenter (1992) argue, one needs to have a conceptual understanding, as well as the necessary skills for procedural practice, in order to be successful in mathematics.

The recommendations of this study are to increase both the number and variety of questions in the Turkish mathematics books, especially those with a high level of cognitive demand. In the American and Singaporean books, the questions were labeled as easy, mediocre, and difficult; such a categorization in the teacher's resource book used in Turkey would increase teachers' awareness as to the kind of questions they are assigning. In the Turkish textbooks, both the number and percentage of pure mathematics questions were less than those of the other two countries' books. Increasing the pure mathematics questions in Turkish books is also recommended. Alternative solution strategies that enhance students' repertoire and help them internalize concepts should be offered in Turkish textbooks. Finally, this study can be repeated utilizing the cognitive levels used in TIMSS or PISA.

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