PRESERVICE SECONDARY MATHEMATICS TEACHERS' COMPARATIVE ANALYSES OF TURKISH AND AMERICAN HIGH SCHOOL GEOMETRY TEXTBOOK

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Abstract

The purpose of this study is to investigate the preservice mathematics teachers' comparative analyses of Turkish and American geometry textbook. This study explores issues emerging from a teacher education activity from a course called "Textbook Analyses in Mathematics Education" in which preservice mathematics teachers were invited to analyze selected sections of different mathematics instructional materials (i.e. US textbook, Turkish textbook). Findings of study showed that comparative analyses open up new windows into teaching and learning mathematics for preservice teachers. Textbook writers should consider the international curriculum materials.

Keywords: Textbook Analyses in Mathematics Education, Comparative analyses of geometry textbook

LİSE MATEMATİK ÖĞRETMEN ADAYLARININ TÜRK VE AMERİKAN LİSE GEOMETRİ KİTAPLARINI KARŞILAŞTIRMALI OLARAK ANALİZİ

Özet

Bu çalışmanın amacı, lise matematik öğretmen adaylarının Türk ve Amerikan geometri kitaplarının karşılaştırmalı analizi hakkındadır. Bu çalışma "Konu Alanı Ders Kitabı İncelemesi" dersinde yapılan aktiviteden (Türk ve Amerikan kitaplarının karşılaştırmalı analizi) ortaya çıkan analiz sonuçlarını incelemektedir. Bu çalışma göstermiştir ki karşılaştırmalı analiz öğretmen adayları için matematik öğreniminde ve öğretiminde yeni bakış açıları oluşturmuştur. Matematik kitaplarının yazarları da uluslararası kitapları kaynak olarak göz önünde bulundurmalıdırlar.

*Anahtar **Kelimeler:** Konu Alanı Ders Kitabı İncelemesi, Geometri kitaplarının karşılaştırmalı analizi*

Introduction:

For many years now the International Association for the Evaluation of Educational Achievement (IEA) has conducted several international comparative studies of the mathematics and science performance of students around the world. Third International Mathematics and Science Study-Repeat (TIMSS-R) was conducted in 1999, in which Turkish students scored below the international average at all five content areas (fraction and number sense- measurement- data representation, analysis, probability- geometry and algebra). Table 1 shows the Turkish and US students scores on all five content areas. In geometry content area both countries students' scored below the international average. However, Turkish students' scores were significantly lower than international average whereas US students' scores were not.

Table 1. Students Scores on Five Content Areas

Content Areas	Students' Scores Turkish/US	International Average
Fraction and Number Sense	430/509	487
Measurement	436/482	487
Data Representation, Analysis, Probability	446/506	487
Geometry	428/473	487
Algebra	402/506	487

Table 2 shows the highest scores and students' nationality in five content areas. Singaporean students scored the highest on both fraction & number sense and measurement content areas. Korean, Japanese and Chinese students scored the highest data representation, analysis, probability; geometry and algebra respectively.

Table 2. Top Scores and Country on Five Content Areas

Content Areas	Country	Scores
Fraction and Number Sense	Singapore	608
Measurement	Singapore	599
Data Representation, Analysis, Probability	Korea	576
Geometry	Japan	575
Algebra	Chinese Taipei	586

What are the reasons behind mathematical success of these countries? Where does this high achievement come from? Do the Turkish textbooks resemble textbooks used in countries where students perform well on international mathematics assessment? What kind of instructional strategies do Turkish mathematics textbook emphasizes?

Pepin Haggarty and Keynes (2001) explains that "In order refine our understandings of the teaching and learning cultures of mathematics classroom in different counties, we need to refine our understandings of teachers, the learners, the materials used for learning and the interaction between them" (p.158)

Fujita and Jones (2003) analyzed and compared the Japanese and Scottish geometry textbooks. Their analyses revealed that in the Scottish textbook geometrical facts always came first in Scottish textbook, whereas in Japanese textbook the geometrical facts comes studied in the lesson often shown after students fully understand them. Furthermore Fujita and Jones (2003) concluded that deductive reasoning and proof evident in both Scottish and Japanese textbook with own strengths and weaknesses.

Kauffman(2002) conducted a study to investigate the use of curriculum materials by four second-year elementary school teachers, two using a traditional math textbook and two using a reform math textbook. He found that mathematics curriculum materials, particularly textbooks, are central to work of all four teachers. Kauffman (2002) found that all four teachers use of curriculum materials were varied depending on; teachers perception of the effectiveness of instructional materials, ease of use of textbooks and teachers feel of freedom what to teach and how to teach it.

As Stigler and Hiebert(1999) points out "One of the advantages of comparing activities across cultures is that we can see things we might never have noticed had we looked within our own culture." (p.55). Such activities also have significant potentials for both prospective and practicing mathematics teachers' to improve teaching.

Analyses of instructional materials provide great learning opportunities for preservice teachers. This opportunities are new content and pedagogical understanding (Ball 1988; 1996; Ball & Cohen, 1996; Lloyd & Behm 2005;Remillard 1999; 2000; Reys, Reys, , Chávez, 2004;Stigler & Hiebert, 1999). Lloyd and Behm (2005) further suggest three reasons that analyses of instructional materials activity have unique values; (1)Teachers get familiar with reform oriented curriculum materials such as representations of new content and activities. Furthermore, comparisons between various curricular materials may shed light into teacher decisions about the relative educational value of the different curricular design.(2)Analysis of instructional materials from the two windows (teacher and students) may help preservice teachers to develop pedagogical content knowledge.(3) Finally, it helps teachers to questions their tacit held beliefs about teaching.

What are the roles of textbook?

First it determines how the teacher sequences the materials. It also determines the content. Third role of the textbooks is to provide teachers with activities and instructional ideas for engaging the topics is presented(Davis & Krajcik , 2005; Remillard 1999:2000).Textbook serve as set of lesson plans for the teacher, complete with sample problems, diagrams work out examples and homework assignments. (Reys et al. , p.63)

Reys, Reys and Chavez (2004) raises some important question related to mathematics textbooks: What types of activities does the textbook provide? Are students challenged to think and develop understanding, or are they simply shown how to work some exercises and then asked to practice procedures? Will these activities engage students in mathematical thinking and activity?

Is there a focus on mathematical thinking and problem solving? Are students expected to explain "why"? Does the textbook encourage students to explore "what if" questions and to offer and test conjectures?(p.69) Reys et al. (2004) critiques the American Textbooks "Textbooks in the United States typically present mathematical ideas as facts to memorize rather than as meaningful relationships."

According to Haggarty and Pepin (2002) "Teachers act as mediators of the text: they decide which textbook to use; when and where the textbook is to be used; which sections of the textbook to use; the sequencing of topics in the textbook; the ways in which pupils engage with the text; the level and type of teacher intervention between pupil and text; and so on" (p. 572). Davis and Krajcik(2005) discuss that "Educative curriculum materials should help to increase teachers' knowledge in specifics instances of instructional decision making but also help them develop more general knowledge that they can apply flexibly in new situations" (p.3).Haggarty and Pepin (2002) analyzed French, German and English mathematics textbook. In their analyses, they found that students in different countries are offered different mathematics and learning opportunities which influenced by teachers and textbooks.

Methods and Participants:

Participants were recruited from a course called "Textbook Analyses in Mathematics Education". There were 18 preservice teachers in this course, at a major state university in Istanbul, Turkey. During the 7th week of the class preservice teachers were given copies of selected American curriculum materials. The Turkish curriculum materials were not given, they were free to choose, however, the Turkish curriculum materials they choose must be approved from the Ministry of National Education. The 8th week of the class preservice teachers was given 10 questions to guide in their comparative analysis. The question set used in this study was taken from the previous study done by Lloyd and Behm (2005).

Two set of curricular materials:

US textbook used in this study was Discovering Geometry by Michael Serra. Focus of the study was Chapter 9: Pythagorean Theorem.

Serra, M. (1997). *Discovering Geometry: An Inductive Approach* (2nd Ed.). Berkeley: Key Curriculum Press.

Turkish textbook: Preservice Secondary Mathematics Teachers were free to use any textbook section focusing on Pythagorean Theorem. The Turkish textbook must be approved by the Ministry of National Education.

Guided Comparison Questions

1. Upon first glance, what seems to be similar between the two sets of instructional materials? What seems to be different?
2. Look back at the similarities and differences you listed in question1.What do you think certain components of the instructional materials are different or similar? What is your opinion of the differences and similarities between the materials?
3. What do you like less or more about each set of instructional materials? Why?
4. Which set of instructional materials do you think is "better" for students. Explain your reasoning, making sure to describe what you mean by better.
5. From a teacher's point of view, which set of instructional materials do you like better? Which set of instructional materials do you think would be easier to use in the classroom? Explain.
6. Which set of instructional materials do you think is more commonly used in classroom? Why?
7. If you could make changes to any part of either of these materials, what would those changes be? Why?
8. What is your favorite component of these two sets of instructional materials? Explain your reasoning.
9. Go through each set of instructional materials again; Try to imagine yourself as a student working through each set. What do you think are the main ideas that you would get out of each set of materials? How are the main ideas similar and/or different between the two sets?

10. Overall, which set of instructional materials do you like better? If given the option to choose, which set of materials would you use in your classroom? Why? (pp. 60-61)

Research Questions:

Based on the preservice secondary mathematics teachers' responses to "Guided Comparison Questions" this study investigates the following questions:

1. What kinds of learning opportunities identified by preservice secondary mathematics teachers from the two set of instructional materials?

   Comparing learning opportunities presented in two different set of instructional materials might give teachers to widen their teaching mathematics.
2. What are preservice secondary mathematics teachers' identification of differences and similarities between Turkish and American Textbooks?
3. What are choices of preservice secondary mathematics teachers as textbooks between two set of instructional materials?

Interpreting the Teachers' Written Reports

In Turkish textbooks Pythagorean theorem was explained a page at most and given two examples after the proof of the theorem. In American Textbook Pythagorean Theorem was explained in 40 pages. Secondary preservice mathematics teachers' written reports were analyzed and divided into four main categories: historical connection, application problems, connection with other mathematical ideas, and finally assessment.

Historical Connections in American Textbook

In Turkish textbook there are not any historical anecdotes related to Pythagorean Theorem. In American textbook there were lots of information on historical background of Pythagorean Theorem and historical uses. Figure 1 show how ancient Egyptians used Pythagorean Theorem to find boundaries of their land after the flooding of Nile.

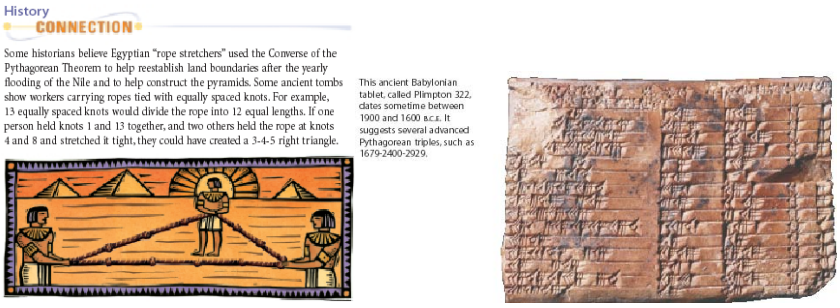


Figure 1: Historical Connection

Application Problems

In American Textbook there are application problems. These are effective for getting student attention and interest as well as conceptual understanding of the topic by providing real life examples and applications.

23. APPLICATION Felice wants to determine the diameter of a large heating duct. She places a carpenter's square up to the surface of the cylinder, and the length of each tangent segment is 10 inches.

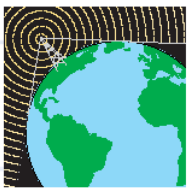
a. What is the diameter? Explain your reasoning.

b. Describe another way she can find the diameter of the duct.

Figure 2: Application Problem Example-1

Technology
CONNECTION

Radio and TV stations broadcast from high towers. Their signals are picked up by radios and TVs in homes within a certain radius. Because Earth is spherical, these signals don't get picked up beyond the point of tangency.



21. APPLICATION Read the Technology Connection above. What is the maximum broadcasting radius from a radio tower 1800 feet tall (approximately 0.34 mile)? The radius of Earth is approximately 3960 miles, and you can assume the ground around the tower is nearly flat. Round your answer to the nearest 10 miles.

22. A diver hooked to a 25-meter line is searching for the remains of a Spanish galleon in the Caribbean Sea. The sea is 20 meters deep and the bottom is flat. What is the area of circular region that the diver can explore?

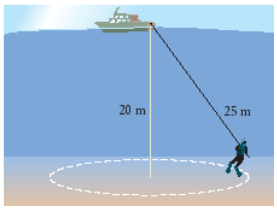


Figure 3- Application Problem Example-2

Connections with Other Topics (Distance formula and Circles)

Investigation 1
The Distance Formula

In Steps 1 and 2, find the length of each segment by using the segment as the hypotenuse of a right triangle. Simply count the squares on the horizontal and vertical legs, then use the Pythagorean Theorem to find the length of the hypotenuse.

Step 1 | Copy graphs a–d from the next page onto your own graph paper. Use each segment as the hypotenuse of a right triangle. Draw the legs along the grid lines. Find the length of each segment.

The Pythagorean Theorem

Although in Turkish textbook Pythagorean Theorem left alone, in American textbook connections has been made. Relationship with Pythagorean Theorem and distance between two points, and also relationship with Pythagorean Theorem and circle equation has been established.

With American Textbook compare to Turkish textbook Pythagorean Theorem could be thought more easily and effectively. Turkish textbooks are lack of real life examples, historical connections and related investigation projects. American textbooks are more student centered materials than the Turkish textbooks. A Preservice teacher' comment was "There are activities and assignments in American textbook that promotes learning by discovery".

Assessment

In Turkish textbook assessment was done only with questions at the end of the chapter. However, in American textbook along with the chapter questions, Portfolio assessment, journal writings, creativity ad presentation has been suggested as shown in Figure 5.

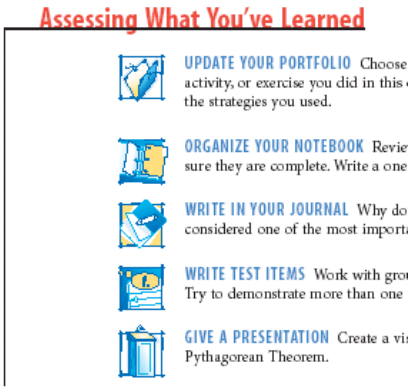


Figure 4. Alternative Assessments in American Geometry Textbook

Conclusions

Turkish students would be lost in formulas and equations without real life connections and projects. They will only memorize the formulas without conceptual understanding. Our curriculum materials should give students to explore and investigate mathematics from multiple windows. An interesting comment from a preservice teacher was "After examining US textbook I could not find any positive side on the Turkish Textbook". Unlike the Reys et al. (2004) critiques to the American Textbooks which was "Textbooks in the United States typically present mathematical ideas as facts to memorize rather than as meaningful relationships." Turkish preservice teachers found American textbook more fruitful in terms of promoting conceptual understanding.

When ones look at the reference section of latest Turkish textbooks, they used books as reference from 50s and 60s and also very few reference has been used. They were not any single international reference. International comparative studies such as TIMSS-r showed that we are at the bottom. Textbook writers should investigate what curriculum materials they are using. Preservice teachers identified that in US textbook students are given more chance to learn than the Turkish textbook. Preservice teachers were willing to use US textbook more than Turkish Textbooks as an instructional material.

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