The Comparative Analyzes of the Student’s Performance about Matrix in Student Selection Exam (ÖSS) and the Approved Lecture Books of Ministry for the National Education (MEB)

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Abstract

The purpose of this study is to investigate the solving performance of students in the questions of Student Selection Exam (ÖSS) and the Approved Lecture Books of Ministry for the National Education (MEB). The study used both qualitative and quantitative methods. Sample of the research is 20 students from 2 different classrooms in 11\textsuperscript{th} grade of the 2011-2012 academic years in Adile Mermerci Anatolian High School. To get the information to determine the performance of students for the research, matrix questions gathered from ÖSS and MEB approved course books. The research has been made in order to prove whether the questions in ÖSS exam and the questions in MEB approved books are coherent or not. Students are asked to answer 14 questions. The data was analyzed by researchers jointly. The students have difficulties or couldn’t even answer the questions of the topics of matrix questions related with logarithm and solving the equations. It had been seen that the questions in MEB books, are similar with the questions that had been published in the ÖSS Exam.

Keywords: Student Selection Examination (ÖSS), The Ministry of National Education (MEB) books, concept of matrix, mathematics education

1. Introduction

Though math lesson is sensed as a hard-understanding lesson by students, this situation is not acceptable for all subjects and terms as well as it is not on the same level. Some subjects are qualified more difficult by students compared to others. The researches which determines the subjects which are found difficult and which are found

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easy by the students; are considered important in order to give directions and guidance for education planners and teachers (Gürbüz, Toprak, Yapıcı, & Doğan, 2011).

Since Linear algebra course is one of the most important subjects of mathematics, which are the basis of abstract algebra, students are required to learn them at a higher level (Ozdag & Aygör, 2011). Conceptual examples and exploratory introductions are what enable abstract understanding of linear algebra. Instead of giving concrete examples, we need to expose the basic structure and the concepts of Linear Algebra from within and build on them. To communicate the essence of Linear Algebra is quite easy. Linear Algebra can speak strongly and clearly to our students; we just need to let the forces within Linear Algebra guide us. We can develop both ‘concepts’ and ‘applications’ and then bridge the gap, say, between abstract linear transformations and concrete network flow problems by using ‘computations’. Such an approach makes the course vibrant and viable. Some of the concepts and some of the applications will take time to comprehend. But they will be understood (Uhlig, 2003). Harel (1994), who has studied the difficulties that students experience in interpreting the linear algebra and associating it with their former mathematics education, indicates that both the educational background and the readiness of a student play a crucial role in the learning process. When the secondary education level linear algebra studies are reviewed, Erçerman (2008) has found that in terms of cognitive and practical information, the linear algebra knowledge is inconsistent, incoherent and missing in most of the students. He also noted that practical information consist the major part of this knowledge. Öktac (2008) states that linear algebra is not treated as important as it should be in secondary education programs and that it is only studied in a short time with less content compared to the other topics in mathematics. Besides, he/she also emphasizes that it is very important to lay the foundations of the concepts of linear algebra- of whose comprehension necessitates abstraction- at the stage of secondary education and that this should be one of the main targets of mathematics program (Aydın, Delice, Kardeş, 2011). Even though its education is carried out in these secondary education schools in a limited way, there are still some challenges in the comprehension of basic linear algebra notions. Students are inclined to understand a linear algebra notion by its prototype examples rather than its general definition. Therefore their knowledge remains at the practical level (Erçerman 2008).

Matrices are a major issue in the primary education second tier 3rd class math program. There are difficulties experienced in learning and teaching of this subject. It is observed that matrix subject is handled very abstract in schools and some learning difficulties appear caused of this situation. Harel focused on the reasons of learning difficulties of students about basic concepts of linear algebra and how a way should be followed to resolve this situation, in a research he made in 1989. It is expressed that’s the first reason of these difficulties is that the terms are abstract, the second is that application areas are unusual for students and the third is that most of the students don’t know proof methods yet.

Textbook is one of the important tools which is easy to use, accessible from all students, information is given directly, can be used continuously, can be referenced any time and can be replaced of verbal education’s interruptions. A well-prepared textbook pays dividends both teachers and students as well as it guides education and learning events (Semerci 2004). One of the major utilities of mathematic textbooks is giving helpful advises to teachers about content and perspective of the mathematic information which is going to be taught to the various student groups, teaching mathematic methods and in how much time to teach the subjects. In this case, teachers use textbooks while they prepare lesson contents, in-class activities and home works (Freeman & Porter, 1989; Ben-Peretz, 1990; Sosniak & Perlman, 1990; Apple, 1992; Russell, Schifter, Bastable, Yaffee, Lester, & Cohen, 1995; Schmidt, McKnight, & Raizen, 1997; Haggarty & Pepin, 2001; Nicol & Crespo, 2006) (Şağlam & Alacaci 2012).

In our country, central examinations are done in various education levels to choose and locate students who want to continue the next educational institution. These examinations are intended to measure of student success, talent or expected readiness level on the next level and these examinations are mostly qualified as selection exam. The majority of central examinations in Turkey are carried out of Student Selection and Placement Center (ÖSYM) (Deniz & Kellecioğlu 2005). In the research which Karaağaç and Threlfall made in 2004, it’s seen that because of the solution which used to solve the question is excluded from the evaluation and only marking the right answer makes point, it’s important to solve the question in the minimum time more than solving solution. And this situation directs students to look for the shortest and most practical method. Situation of practical solving solutions to be a primary; causes not to prefer requirements of long but conceptual learning and comprehend ordinary. Even, this situation makes dilemmas even
for the private course teachers who use some methods reluctantly which mean nothing in math teaching but in order to use the time, it makes students useful; they said (Baştürk 2011). Baştürk in its research named “Preparing to the university exam process’ negative reflection on students’ math learning” in 2011, it’s advised; Though University Exam is an exam that students join at the last grade in high school or after graduation, because of the hard challenge, preparing of the exam starts in the lower grades. Hereby, students encounter lots of practical methods without having a good mathematical background. So, high school teachers should not hurry about giving short and practical methods before students adopt the long method.

2. Method

2.1 Research Group

Two different 11th grades which each class consists of 20 students who take education in Adile Mermerci Anatolian High School in 2011-2012 academic years comprise the sampling of the research. In this research, compatibility of examples and exercises in the 11th grade Math textbook approved by MEB and matrix questions which are asked in the university exam is examined. For this reason, in total 14 questions, which are 8 multiple-choice questions from OSS exams and 6 classical questions from National Education 11th grade mathematic textbook, have been selected. Before application of the prepared questions, approvals are taken of these 2 classes’ mathematic teachers and expert in mathematic teaching, about purpose suitability. In the preparation process of the examination, firstly the gains about matrices on the mathematics curriculum and math textbooks are analyzed. The aim of the classical examination application is to observe where do students make mistakes and in which subject do they have lack of knowledge. Because of students are familiar to the test technique, even they don’t know how to solve the question, they can find the right answer by following the options. Examination time is specified as 50 minutes.

2.2. Data Collections Tools and Data Analysis

The examination which is prepared from us is applied to the all students in the sample in 2011-2012 academic years spring term. After the examination, all students’ solutions have been analyzed and 3 students from each class have been chosen and an interview has been made. The reason of choosing these students is their success levels, mistakes they have done and different resolve solutions. Interviews took approximately 10 minutes. The aim of the interviews to search reasons of the mistakes they have made in the exam and why are they more successful in tests though they are wanted to solve the questions which are similar to each other, both in test and classical methods. Therefore, during the interview, by asking students “What do you think about OSS exam?”, “What are the problems you encounter while resolving the questions?”, “Which one was the most difficult among these questions for you? Why?”, “Is matrix subject handled enough in the school?”, “Does low amount of matrix questions in the OSS exam influence you to focus this subject?” the difficulties that students encounter are specified while students are solving such problems. Students’ solutions are evaluated as True/False because of these were test questions. Then, by an interview with students, by taking opinions of students, a quantitatively data analysis is made.

3. Findings

The findings of this study have been evaluated both qualitative and quantitative. Because of there are two kind of question type as Classical and Test, no point is given to the key of the situation. The answers of the students in according to classroom; are grouped only in the form of right and wrong solution and after converting to the table, are analyzed qualitative. As it is seen in the table below, students in both classes are more successful in test questions.

| Table 1. According to the classes, the number of correct and incorrect answers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|   | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | K1 | K2 | K3 | K4 | K5 | K6 |
| Class A | D | 19 | 16 | 18 | 16 | 18 | 13 | 14 | 8 | 7 | 6 | 1 | 8 | 2 |
|         | Y | 1  | 4  | 2  | 4  | 2  | 7  | 6  | 7 | 12 | 13 | 14 | 19 | 12 | 18 |
As it is seen in the table below, students had difficulties in the resolve of the 4th and 6th classical questions. The reason of the difficulties students encounter is that matrix questions contain logarithms and equation solving issues.

Table 2. The number of correct and incorrect answers and their percentage

| Questions | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | K1 | K2 | K3 | K4 | K5 | K6 |
|-----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Correct Answer | F | 37 | 33 | 33 | 33 | 35 | 28 | 30 | 27 | 15 | 12 | 12 | 3 | 15 | 3 |
| Incorrect Answer | Y | 92,5 | 82,5 | 82,5 | 82,5 | 87,5 | 70 | 75 | 67,5 | 37,5 | 30 | 30 | 7,5 | 37,5 | 7,5 |
|               | F | 3 | 7 | 7 | 7 | 5 | 12 | 10 | 13 | 25 | 28 | 28 | 37 | 25 | 37 |
|               | Y | 7,5 | 17,5 | 17,5 | 17,5 | 12,5 | 30 | 25 | 32,5 | 62,5 | 70 | 70 | 92,5 | 62,5 | 92,5 |

It’s decided to the reliability and the validity of the prepared questions according to the opinions and critiques of the experts. For data acquisition of this research, the questions below have been given to the students. %80 of the students has answered correct to the first 8 questions because they are prepared in test technique. Rest of the students left the questions blank. The next 6 questions are prepared for students to solve in classical method. It’s specified the success of the students in these questions is %25. The answers which some of the students responded to the classical questions are listed below without any change after scan.

3.1 Problem used in research

In this study, subjects were given the following questions to obtain data. The participants were asked to answer 14 questions: 8 multiple-choice questions from OSS exam and 6 classical questions from MEB books.

3.1.1 Multiple-choice questions

1) Consider the equation \[
\begin{bmatrix}
3x + y \\
-2x + 2
\end{bmatrix} + \begin{bmatrix}
-2x + y \\
x + y
\end{bmatrix} = \begin{bmatrix} 5 \\ 3 \end{bmatrix}.
\]
What are the \(x\) and \(y\) values which provides the equality? (1972 ÖSS)

A) \(x = -1, y = 2\) \hspace{1cm} B) \(x = 2, y = 1\) \hspace{1cm} C) \(x = 1, y = 2\) \hspace{1cm} D) \(x = -1, y = -2\) \hspace{1cm} E) \(x = 2, y = 2\)

2) According to that, \[
\begin{bmatrix}
-1 \\ 3 \\
2 \\
6
\end{bmatrix} \begin{bmatrix}
x \\
\frac{1}{6}
\end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}.
\]
What is the \(xy\) multiplication? (1988 OSS)

A) \(-1/24\) \hspace{1cm} B) \(-1/18\) \hspace{1cm} C) \(-1/16\) \hspace{1cm} D) \(-1/12\) \hspace{1cm} E) \(-1/6\)

3) Determine those value of \(a\) for which the matrix \[
\begin{bmatrix}
1 & 3 & 5 \\
3 & 0 & 7 \\
1 & 3 & a - 9
\end{bmatrix}
\]
is not invertible. (1996 ÖYS)

A) 15 \hspace{1cm} B) 14 \hspace{1cm} C) 11 \hspace{1cm} D) 6 \hspace{1cm} E) 5

4) Consider the matrices \(A = \begin{bmatrix}
1 & 4 \\
-5 & 2
\end{bmatrix}\) and \(B = \begin{bmatrix}
2 & 3 & 4 \\
0 & -2 & 1
\end{bmatrix}\). Compute the \((AB)^T\) (1998ÖYS)
5) Consider the matrices \( A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \) and \( B = \begin{bmatrix} x \\ y \end{bmatrix} \). Find the matrix \( B \) such that \( AB = A - B \) (1995 ÖYS)

6) Determine the value of \( x \) such that \( \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & 3 \\ 0 & 1 & z \end{bmatrix} = \begin{bmatrix} 5 \\ 3 \\ 2 \end{bmatrix} \) (2009 MAT-2)

7) Consider the matrix \( A = \begin{bmatrix} 2 & 4 \\ 1 & 3 \end{bmatrix} \). Let \( A^T \) transpose of matrix \( A \) and \( A^{-1} \) invers of matrix \( A \) be. Find \( A^T A^{-1} \) (2010 LYS1)

8) Determine the value of \( x + y \) such that \( \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} \) (2011 LYS1)

3.1.2 Classical questions

1) Use the matrices \( A = \begin{bmatrix} 2 & -1 \\ -3 & 4 \end{bmatrix} \) and \( B = \begin{bmatrix} 5 & 1 \\ 2 & 0 \end{bmatrix} \). Find \( 2A + 3B \)

Answer of Student A to the 1st question:

\[
\begin{bmatrix} 2 & -1 \\ -3 & 4 \end{bmatrix} \text{ ve } \begin{bmatrix} 5 & 1 \\ 2 & 0 \end{bmatrix} \text{ olduğuna göre } 2A + 3B \text{ matrisini bulunuz.}
\]

\[
\begin{bmatrix} 4 & -2 \\ -3 & 4 \end{bmatrix} + \begin{bmatrix} 15 & 3 \\ 2 & 0 \end{bmatrix} = \begin{bmatrix} 19 & 1 \\ -1 & 4 \end{bmatrix}
\]

In the sum of matrix question that students generally solve easily, Student A; by considering the multiplication of scalar with matrix as multiplication of scalar with determinant, multiplied only first row elements with constants. Though Student A knows sum of matrix, doesn’t know multiplication of scalar with matrix. It’s seen that student is not successful also on the other questions when its exam sheet is examined. When the reason is asked him, he said: “Subjects of matrix is handled very fast in the school. Because of there are only 2 questions in the university exam, our teacher didn’t pay too much attention on this subject, so I didn’t solve enough questions because of I don’t consider this subject important”.

2) Let \( A = \begin{bmatrix} 3 & -1 \\ 4 & 2 \end{bmatrix} \) and \( B = \begin{bmatrix} 1 & 1 \\ 2 & 3 \end{bmatrix} \). Find matrix \( (AB)^T \)
Answer of Student B to the 2nd question:

2) \[ A = \begin{bmatrix} 3 & -1 \\ -2 & 4 \end{bmatrix} \text{ ve } B = \begin{bmatrix} 1 & 1 \\ -2 & 3 \end{bmatrix} \text{ olduğuna göre } (AB)^T \text{ matrisini bulunuz.} \]

\[ \begin{pmatrix} 3 & -1 \\ 4 & 2 \end{pmatrix} \begin{pmatrix} 1 & 1 \\ -2 & 3 \end{pmatrix} = \begin{pmatrix} 3 & -1 \\ 8 & 6 \end{pmatrix} \]

\[ \begin{pmatrix} 3 & -1 \\ 8 & 6 \end{pmatrix}^T = \begin{pmatrix} 3 & 8 \\ -1 & 6 \end{pmatrix} \]

Student B, by considering matrix multiplication as sum of matrix and multiplied with the corresponding entries of the matrices. Although he knows the matrix transpose, he found the wrong value because of made wrong multiplication. In the interview made with Student B, he said “Our teacher handles the lesson for university exam. University exam’s questions are multiple-choice but in classical exams which is wanted to solve questions with classical method. I’m having difficulties to resolve questions in such exams because of I’m used to tests”. When his opinion about university exam is asked, he said “If this exam never exists, if anybody could enter any branch of the universities, it would be better but the biggest advantage of the exam is that it is test”.

3) Let \[ A = \begin{bmatrix} 2 & 3 \\ 5 & 6 \end{bmatrix} \]. Find the matrix \((A^2)^T\)

Answer of Student C to the 3rd question:

3. \[ A = \begin{bmatrix} 2 & 3 \\ 5 & 6 \end{bmatrix} \text{ matrisi veriliyor. Buna göre } (A^2)^T \text{ matrisi bulunuz.} \]

\[ A^2 = \begin{bmatrix} 4 & 9 \\ 25 & 36 \end{bmatrix} \]

\[ (A^2)^T = \begin{bmatrix} 4 & 25 \\ 9 & 36 \end{bmatrix} \]

While Student C calculating \(A^2A^2\) matrix, instead of calculate \(A.A\) matrix, he took square of each \(a_{ij} \) \((i,j = 1,2)\) element. Though he knows the transpose, the answer is wrong. In the interview done with Student C, he said “I could find the correct answer if the exam would be test, I like test questions a lot. My biggest dream is that complete liquidation of the university exam, exam stress makes us terrible”.

4) If the matrices \[ A = \begin{bmatrix} \log_{2}x & 1 \\ 0 & \frac{1}{64} \end{bmatrix} \text{ and } B = \begin{bmatrix} 3 & 3a+1 \\ \log_{5}y & 2^{b-1} \end{bmatrix} \text{ are equal, find } a^x + b^y. \]

Answer of Student D to the 4th question.

4. \[ A = \begin{bmatrix} \log_{2}x & 1 \\ 0 & \frac{1}{64} \end{bmatrix} \text{ ve } B = \begin{bmatrix} 3 & 3a+1 \\ \log_{5}y & 2^{b-1} \end{bmatrix} \text{ matrisleri eşit ise } a^x + b^y \text{ yi bulunuz.} \]

\[ \log_{2}x = 3 \\
\log_{5}y = 0 \\
2^{b-1} = 6 \\
b = \frac{7}{2} \]
Student D although he answered other questions right, he answered the matrix question wrong which is also logarithm included. This is caused of the lack of information in logarithm. He couldn’t answer this question right although he knows matrix equality. As it is seen in the tables above, students are unsuccessful most in this question. In the interview done with the student, he said “Logarithm in the matrix made me hard to solve, though I know the matrix subject, I couldn’t find the right answer, whereas matrix is my favorite subject, I wish there could be more questions from this subject in university exam”. When he is asked about university exam he said “University exam stays at the center of our lives. Because of the future concern, I became unable to do the things that I am actually able to. Being test of exam comforts me. I solve the questions from the options in multiple-choice questions, and sometimes when I solve the question wrong, if the value in found isn’t existed in the options, I understand that I solved wrong and I have chance to correct. But in the classical exams, we can’t know is our answer correct or not”.

5) Determine the value of $x + y + z$ such that
\[
\begin{bmatrix}
  x & 6 \\
  3 & -2y
\end{bmatrix} + \begin{bmatrix}
  y & 1 \\
  z & x
\end{bmatrix} = \begin{bmatrix}
  4 & 7 \\
  6 & 1
\end{bmatrix}
\]

Answer of Student E to the 5th question:

\[
\begin{align*}
  x + y &= 4 \\
  3z &= 6 \rightarrow z = 2 \\
  -2y + x &= 1 \\
  -x + y &= -4 \\
  -3y &= -3 \rightarrow y = 1
\end{align*}
\]

\[x + y + z = 6\]

5.) \( \begin{bmatrix}
  x \\
  3
\end{bmatrix} + \begin{bmatrix}
  6 \\
  -2y
\end{bmatrix} = \begin{bmatrix}
  4 \\
  6
\end{bmatrix} \) olduğuna göre $x + y + z$ kaçtır?

Student E made an operational mistake by multiplying $a_{21}$ and $b_{21}$ elements while making sum of the matrix. Similar operational mistakes are seen also on other students. With this research, it’s determined that students make a lot of operational mistake in matrix questions. In an interview which is had with Student E, Student E said “I make a lot of operational mistake. Therefore my performance decreases. My wrong answer isn’t caused of my lack of knowledge. If it had been test, I would answer it correct by giving values”. In addition, Student E said “The Matrix Subject is handled fastly and superficially in schools. Only the question types which might be in the university exam are solved. I hate just to solve questions by focusing on the examination. We are making calculations by rote without learning the matter, whereas the aim should be learning the matter”.

6) Given the matrices $A = \begin{bmatrix}
  1 & -2 & -1 \\
  3 & 1 & -2 \\
  2 & -3 & 4
\end{bmatrix}$, $B = \begin{bmatrix}
  3 \\
  -5 \\
  4
\end{bmatrix}$ Write equation $AX = B$ as a linear system and solve the linear system.

Answer of Student F to the 6th question:
It’s seen that Student F is having difficulties to solve three equations with three unknowns. Student F couldn’t answer the question because he doesn’t know how to solve equation though he knows multiplication in matrices subject. When the exam sheets of the other students are examined, it’s seen that most of the students have no idea about this question. This question is left blank from most of the students. In the interview which is done with Student F, he said “I don’t know how to solve linear system with matrices, so I tried to solve equation with elimination method, but I did wrong. I don’t think there will be resolve of the equation systems in the university exams. That’s why I didn’t stand on the issue; I’m more successful on solving test questions. If this question would be a test question, I would solve it %100 correct”.

4. Conclusions and Recommendations

At the end of the research, it’s seen that students are more successful in the exam given as a test. As can be seen in the tables, it’s seen that students are not successful in classical exams and especially lowest success is in the 4th and 6th questions. 4th question is found difficult by the students, because matrix operations included logarithm concept. This type of questions generally gives fright to the students. The student also needs knowledge of logarithms to solve the question. Some of the students couldn’t solve the question because of the lack of logarithm information although they have matrix information; some of them couldn’t because of the lack of matrix information although they have logarithm information. In the 6th question, there are three equations with three unknowns. The students used to solve two equations with two unknowns using elimination method, so they tried to solve with same method, but they didn’t succeed to find result. That shows that they don’t know to solve equation systems with the matrices. Students are used to reach to the result in the test questions by putting values given in the options instead of unknowns. At the same time, students can easily reach the result using the same method in the linear system questions. Therefore, they couldn’t solve it with classical method. Besides, it’s seen that the success of the students was also low in the 6th and 8th questions from test questions. When these questions are examined, it’s seen these are equation system questions. We can say that generally students are having trouble to solve equation system questions. In addition, it’s seen they are successful in test questions especially highest success is on the 1st and 5th questions.

In the research that Baštürk has done in 2011, it’s seen that they used to methods, which are short and practical for
resolve, it in the high schools that motivation of preparation to the exam is high. These methods don’t require much mathematical talent; they are just based on the remembrance of the memorized rule. Therefore, the mistakes are made because of not remembering the rules or remember them wrong. These students don’t have control possibilities of the resolve process, when memorized rule isn’t remembered or remembered wrong, they don’t have any option than leave it blank or make mistake. Besides, these practical resolve methods causes more mistakes to the students who don’t have a math background. Although the teachers from A and B high schools taught both methods, Most of the students who are enroll that school didn’t use of long method and also they said they forget the long method. If the teachers rush for giving the practical methods before teaching the mathematic rules well it will be impossible for students to learn the mathematical methods.

In the result of the research it’s seen that students try to solve the problems with logic of the test solving and had difficulties to solve classical questions. The problems that students encounter are operational mistake, to be nearer to logic of the test solving, lack of knowledge and misconceptions. In the interviews which are done with the students, the cause of their unsuccess is specified as not being used to solve questions in classical method because they prepare a multiple-choice examination and by this reason they make a lot of mistakes.

In mathematic lesson, it is more appropriate that teachers should teach the subject in a long way instead of using shortcuts. It is important for teacher stand on such questions like “Why” or “What” in order to try to explain the question to the student and also in the exams the students should explain the question while answering it in order to learn it better. Though multiple-choice exam is preferred in the entrance of many educational institutions; this doesn’t provide the retention of information.

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