Experiences of analysis ToolPak in Matrix Algebra

I Maryati*, T S Sumartini, M A Noordyana, D Sofyan and S S Madio

Mathematics Education Program of Institut Pendidikan Indonesia (IPI), Jl. Terusan Pahlawan 32, Garut 44151, Indonesia.

*maryati_iyam@yahoo.co.id

Abstract. Analysis toolpak is very useful for a problem related with matrix material the purpose of this research article is to analyze the effectiveness of using the ToolPak analysis on matrix algebra. The method of this study is an experimental method with quasi-experimental design. The sample in this study took 27 students at the first years of the one at a private college in Indonesia. The results of processing data show that the value tcount equal to 9.207 and then the value (2-tailed) equal to 0.000 smaller than alpha 0.05 so that Ho is rejected. As the implication from this study the use of effective ToolPak analysis to improve students mathematical reasoning abilities in matrix algebraic material

1. Introduction

In the material of matrix algebra there is one of the laws of arithmetic operations in real numbers which does not apply in the matrix i.e. commutative law for multiplication. Any real number a and b, always applies ab = ba, but for matrices, AB and BA are not always equal. Equality does not occur because: 1) the first possibility, the results of times AB can be defined, but BA cannot be defined; 2) second possibility, AB and BA can be defined, but have different orders; 3) the third possibility is AB ≠ BA, although AB and BA can be defined and have the same order. In learning matrix algebra, memorizing formulas is not an appropriate method, but it requires a good understanding of the symbols, formulas, concepts, definitions and accuracy of the analysis. In addition, there is learning motivation that serves as a business driver in achieving achievement [1].

Based on the data values of linear algebra courses in the previous three consecutive years showed an average value of 2.5. included in the less category. In understanding this matrix algebra material there are several factors that cause low scores in this course. [2] Factors that are less able to start learning with a focus, lack of interest in Linear Algebra courses and unfavorable class conditions are factors that belong to the appropriate category to be the cause of difficulties for students to explore their initial knowledge. This factor is the cause for almost half of the students. Based on the results of the interview, it can be seen that factors that are less able to start learning focus on being a causative factor for students who have low category learning achievement. This giving motivation to the author to change the learning method used.

Learning that is in accordance with constructivist views is learning that helps students build concepts with their own abilities through the process of internalization so that the concepts are rebuilt into new concepts [3]. A constructivist learning environment assumes that it can make active students build their own understanding, so that knowledge is not only an external copy, nor is knowledge of passive absorption or limited transfer of simple knowledge from educators to students [4]. The ability to understand the concepts of students will be very good when using a constructivist-oriented learning
approach [5]. By considering constructivism learning, the learning used is the application of toolpak analysis methods. The purpose of this study is to determine the effectiveness of applying toolpak analysis methods in matrix material.

Every computer with a windows-based operating system is familiar with Microsoft (MS) Office, which includes MS word, MS Excel, MS access, and MS PowerPoint. Specifically, for MS Excel, besides being used in simple data processing, it can also be used for linear program problems such as two matrix multiplication, matrix determinant, matrix inverse, and linear equation system, namely toolpak analysis [6]. As for the application of the toolpak analysis method to the matrix material are as follows: a) Open your MS Office Excel application, may be 2007, 2010, 2013 or above; b) In Office 2007: click the Windows sign on the left screen. In Office 2010: click the file menu; c) Then you click Options; d) Select Add-Ins In the list, Select Inactive Applications Add-Ins; e) Select Analysis ToolPak and under the dropdown option, select Excel Add-Ins; f) Go button, please and click and then you click OK. These steps can be seen in the following figure:

Figure 1. Steps for activating toolpak analysis.

For example in solving the multiplication of two matrices is as follows: a) enter the element of matrix A in cell A1 to C2 and element B in cells E1 to F3; b) suppose we put the matrix multiplication on A5 cell then type in cell A5 = MMULT (A1: C2; E1: F3) then enter; c) to find out another value, then in A5 cell do: d) highlight cells A5 to B6; e) press the [F2] key; f) press the key combination [ctrl] + [shift] + [Enter]. These steps can be seen in the following figure:

Figure 2. The multiplication of two matrices.

If D = B x A then the matrix D will have a 3x3 order. Using the same steps is obtained, the results can be seen in the following figure:
From the above example inductively, it is proven that two matrices do not apply commutatively. In determining the matrix determinant, suppose that the M matrix has the order ixi (square matrix), then the determinant of a 2x2, or 3x3 matrix is relatively easy. But what if looking for a determinant of more than 3x3, of course requires accuracy and a long time. [7] the calculation is actually 4! = 24 elementary times results marked and the 10x0 determinant will involve calculating 10! = 3,628,800 elementary times marked. From this it is difficult to find the matrix determinant. For example, looking for matrix determinants using syntax = MDETERM (matrix M). As for the steps as follows: a) Enter the matrix element M in cell A8 with the following syntax: = MDETERM ({1,2,3,4; 8,7,6,5; 9,10,11,12; 16,15,14,13} ); b) Press the [Enter] key, then the result of the determinant of the matrix M is 0. The results can be seen in the following figure:

Whereas for matrix inverses, a square matrix (order nxn) will have an inverse if the matrix determinant is not equal to zero. The inverse of matrix A is written A\(^{-1}\) so that it applies \( A \cdot A^{-1} = A^{-1} \cdot A = I \) (with I = Identity matrix). For the matrix M above does not have an inverse because the determinant is zero. For looking inverse matriks using syntax analysis toolpak as for the steps as follows: a) Enter matrix A elements in cells A 11 to cell D14; b) Suppose that it will place the inverse matrix in cell A16, then in cell A16 type = MINVERS (A11: D! 4) then Enter; c) To find out another value, then highlight cells A16 to D19, press the [F2] key, then press the key combination [Ctrl] + [Shift] + [Enter]. The results can be seen in the following figure:
Figure 5. Inverse matrices.

To test the correctness of the value of $A^{-1}$ above can be checked by multiplying the matrix $A$. if it produces an identity matrix then the result of matrix $A^{-1}$ is correct. To find a solution to a system of linear equations, we usually use the method of elimination, substitution, a mixture of elimination and substitution, and Gauss elimination (Elementary Line operation). in general, linear equations are written as follows:

$$AX = C$$

then to produce the value of $X$ is done step:

$$AX = C$$
$$A^{-1}.AX = A^{-1}C$$
$$IX = A^{-1}C$$

So that

$$X = A^{-1}C$$

In the use of toolpak analysis methods, the solution of a system of linear equations is done by multiplying the matrix inverses of the linear equation coefficient matrix with its constant matrix [8].

Relevant research, namely in studying matrix material requires a constructivist learning model [9]. The identity matrix or multiples are special things of the ellipse that have a positive definite matrix in a circle [10]. Factors that cause difficulties for students in conducting investigations to find their own concepts are: a). Less familiar with learning that emphasizes construction own knowledge; b). The Linear Algebra Module which does not lead to the discovery of concepts; c). Lack of adequate learning resources [11].

System problems in linear equations are often found in science problems knowledge and technology, such as the numerical solution of differential equations ordinary, partial differential, network analysis and so on. Big size and numbers involved in the matrix are often obstacles in resolving analytically. Numerical solutions are one alternative that can do. In developing numerically, algorithms are built with concepts algebra, to be able to be used in solving systems of linear equations general. In this paper we discuss how to construct algorithms from algebraic forms linear to numerical calculations [12].

2. Method

Research data were obtained from 27 students of first-years in academic year 2016/2017 from technology and informatics education department of Institut Pendidikan Indonesia. The population of this research is all first-level students of the Institut Pendidikan Indonesia. The research method used quantitative method [13], and quasi experiment design. T test is applied to test hypotheses in one
treatment study. the use of the t test was also conducted to determine whether the average results of the research conducted had met certain criteria or not [14].

3. Result and discussion
Based on the results if the value data shows the results of the algebra matrix learning using the toolpak method it is effective to be applied in the classroom. The results of the data processing are shown in the following table:

| Table 1. One-sample test. |
|-------------------------|
| N  | Mean | Std. Deviation | Std. Error Mean |
|----|------|----------------|-----------------|
| Toolpak methods | 27  | 3.7326         | .55455          | .10672 |

| Table 2. One-sample test. |
|-------------------------|
| Test Value = 2.75 |
| t  | df  | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference |
|----|-----|-----------------|-----------------|---------------------------------|
| Toolpak Methods | 9.207 | 26             | .000           | .98259                      | .7632 to 1.2020 |

From the first output it can be seen that the number of student data is 27 people with a mean = 3,733, and standard deviation = 0,107. Test criteria used if the significance value is more than alpha then the null hypothesis is accepted [15].

While at the second output the Test Value = 2.75 with the value tcount = 9,207; value (2-tailed) = 0,000. while the hypothesis testing criteria is if the value (2-tailed) > α then H0 is accepted. because the value (2-tailed) = 0,000 < α then Ho is rejected, meaning that learning with the toolpak analysis method is effectively used in matrices algebra courses.

4. Conclusion
There are several advantages in the solution that involve problems in the matrix, specifically the multiplication of two matrices, matrix determinants, matrix inverses, and linear equation systems using the toolpak analysis method, namely a) varied matrix orders; b) the results of calculations are more accurate; and c) speed up the results obtained. The results of this study are in accordance with the objectives of using Microsoft Excel[16]. Based on the results of data processing shows that the use of toolpak analysis method is effective because the alternative hypotheses formulated are acceptable, namely the use of the toolpak analysis method is said to be effective if the average student test score is 75% in the good category.

References
[1] N Hidayati and J O W Soemanto 2017 Peningkatan Motivasi Belajar Mahasiswa Terhadap Prestasi Belajar Aljabar Matriks 6(1) 28–32.
[2] N Wasito and F A Kurniawan 2018 Mata Kuliah Aljabar Linier J. Pendidikan, M. Indonesia 47–51.
[3] Mucholid 2015 Penerapan Pendekatan Konstruktivisme dalam Pembelajaran Matematika untuk Meningkatkan Prestasi Belajar Materi Persamaan Linier Dua Variabel Siswa Kelas VIII-D SMP Negeri 1 Pogalan Kabupaten Trenggalek Semester I Tahun 2013/2014 JUPEDASMEN 1(3) 75-80.
[4] R. dan Scaife 2012 Sustaining Constructive Learning Environment: The Role of Multi sources
Regulation. *Procedia-Social Behav. Sci.* 35 180 – 186.

[5] N et al. 2009 Pengembangan Perangkat Pembelajaran Berorientasi Konstruktivisme untuk Mengajarkan Konsep Perbandingan Trigonometri Siswa Kelas X SMA *J. Pendidik. Mat.* 3(2) 57-72.

[6] R Sundayana 2017 *Media Pembelajaran Matematika (untuk guru, calon guru, orang tua, dan para pencinta matematika).* Bandung: Alfabeta.

[7] H Anton 1995 *Aljabar Linear Elemeter. (Terjemahan: Pantur Silaban) edisi ke lima.* Jakarta: Erlangga.

[8] C Meyer 2000 *Matrix Analysis and Applied Linear Algebra.* Society for Industrial and Applied Mathematics.

[9] M Zainudin 2017 Studi Eksploratif Kualitas Bukti Matematis pada Soal Aritmatika Matriks Berbasis Motivation to Reasoning Tasks *JIPM (Jurnal Ilm. Pendidik. Mat.)* 4(1) 26.

[10] R Sagara 2015 Sebuah Telaah Elips dan Lingkaran Melalui Sebuah Pendekatan Aljabar Matriks *Cauchy.*, 1(2) 85.

[11] M West 2016 The International Journal Of Humanities & Social Studies The Influence of Technical Challenges on the Integration of ICT into the Teaching of Mathematics in Secondary 4(11) 65–72.

[12] B A Sulistyono 2017 Mengembangkan Penyelesaian Numerik Pada Sistem Persamaan Linier Dengan Konsep Aljabar *JIPM (Jurnal Ilm. Pendidik. Mat.)* , 3(2) 382–389.

[13] J W Creswell 2012 *Research Design Pendekatan Kualitatif, Kuantitatifs dan Mixed Pustaka Siswa:* Yogyakarta.

[14] R Sundayana 2017 *Statistika Penelitian Pendidikan.* Bandung: Alfabeta.

[15] Nawari 2010 *Analisis Statistik dengan MS Excel 2007 dan SPSS 17.* Jakarta: Elex Media.

[16] B Permana 2000 *Microsoft Excel 2000.* Jakarta: Elex Media Komputindo.