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TECHNICAL FACULTY
"MIHAJLO PUPIN"
ZRENJANIN

ITROCONFERENCE 13

INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT

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PROCEEDINGS

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Editor in Cheaf - President of OC ITRO 2022:
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Proceedings editor:
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Technical design:
Snežana Jokić, Ph. D, Assistant Professor
Maja Gaborov MSc, Assistant
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INTRODUCTION

This Proceedings comprises papers from the International conference on Information technology and development of education that is held on line on November 25th 2022. The International conference on Information technology and development of education has had a goal to contribute to the development of education in Serbia and in the region, as well as, to gather experts in natural and technical sciences' teaching fields. The expected scientific-skilled analysis of the accomplishment in the field of the contemporary information and communication technologies, as well as analysis of state, needs and tendencies in education all around the world and in our country have been realized. The authors and the participants of the Conference have dealt with the following thematic areas: - Theoretical and methodological questions of contemporary pedagogy - Personalization and learning styles - Social networks and their influence on education - Children security and safety on the Internet - Curriculum of contemporary teaching - Methodical questions of natural and technical sciences subject teaching - Lifelong learning and teachers' professional training - E-learning - Education management - Development and influence of IT on teaching - Information communication infrastructure in teaching process All submitted papers have been reviewed.

The papers presented on the Conference and published in this Proceedings can be useful for teacher while learning and teaching in the fields of IT, informatics, technics and other teaching subjects and activities. At the end of the conference, and based on the papers of our participants, we conclude that the main focus points of this moment in education. Contribution to science and teaching development in this region and wider has been achieved in this way.

The ITRO Organizing Committee would like to thank the authors of papers, reviewers and participants in the Conference who have contributed to its tradition and successful realization.

Chairman of the Organizing Committee
Ph.D Dragana Glušac

IN MEMORIAM PROFESSOR DIJANA KARUOVIĆ 1978-2022.

We especially want to pay tribute to our late colleague professor Dijana Karuović PhD, as one of the founders of the ITRO conference.

To all of us who knew her, professor Dijana Karuović will be a symbol of professional attitude towards work, dedication and loyalty to the institution to which she belonged. Behind HER remain her wonderful children, her many scientific works, her goodness and her love.

We are grateful to have known her.

Also, we will always remember our dear colleague professor Ivan Tasić, PhD, who passed away in 2019.

Our team thus suffered an irreparable loss, and their names will forever remain on the pages of the conference proceedings.

Professor Dijana Karuović and professor Ivan Tasić

CONTENTS

INVITED LECTURE

SCIENTIFIC PAPERS

Analysis of Student Achievements in Teaching Matrix Using Geogebra Software

E. Karamazova Gelova and M. Kocaleva Vitanova
Faculty of computer science, University Goce Delchev, Shtip, North Macedonia
elena.gelova@ugd.edu.mk, mirjana.kocaleva@ugd.edu.mk

Abstract - The achievement of students after completion of teaching process in each subject is what is quite important for both professors and students. This research deals with the analysis of students' achievements for the topic matrices, in a "traditional" way and teaching enriched with free software. The introduction of software in the teaching process as "modernized" approach to teaching aims to increase student activity, to raise the teaching process to a higher level, to raise a student's achievements and to motivate students to learn more independently.

I. Introduction

The interest in studying at technical faculties has tended to decline in recent years. It is a result of the general opinion that studying at a technical faculty is not easy. To change the current situation, analyzes must be made for the way in which the teaching process will be carried out to find a solution for greater motivation for learning, achieving better results and increasing the number of students at the mentioned faculties. This paper is also derived from the idea of finding the most appropriate way to perform teaching to achieve better results in mathematics subjects. Here, we investigate the results achieved by students for the topic matrices before and after used free education software. The aim of this paper is to compare the results of students for the topic matrices after classical teaching and after teaching with free education software. The students are from the Faculty of natural and technical science at Goce Delchev University - Stip. In this paper the results of the students' achievements will be listed so that the results of the students achieved during classical learning will be shown first, and then the results of the students after learning with software. Between the results of the two tests several solved examples of matrices using Geogebra will be listed. Also, applets have been created for some of them, for which links are given, with which help students can solve similar tasks. Also, for some calculations required in the given examples, commands are given which is used to obtain the solutions. In the end a conclusion from the results of both tests will be drawn.

The educational software that we decided to use is Geogebra. Everything we need to know about Geogebra software can be found in [9] and [10]. Here we can find more mathematics problems solved using Geogebra software from different mathematical topics.

Free softwar Geogebra in [5] is use for visually presenting the shape of which are calculate the volume. In that way the students can calculate the volume of the shapes and at the same time, they can present the shape visually and see what they calculate. The topic of [4] is to use computers in the lesson of Calculating the surface of a flat figure – the application of definite integral. The purpose of [4] is to master the same school program in two different methods: the first is the traditional method and the second is using computers, or more precisely, the Geogebra software. In [3] author shows how in a simple and interesting way the function flow in the Geogebra program package is examined.

Application of modern digital technologies in teaching has changed teaching methods. [1] is based on forming a teaching model in order to improve the level of ICT knowledge and skills of students applicable in the area of technical sciences. The purpose of [2] was to master the same school program in two different methods: the first was the traditional method and the second was using computers, or more precisely, the Geogebra software. The aim of the testing conducted after teaching the above-mentioned unit was to show the effect of using computers in teaching.

There is more research in which the main goal is to see the importance of ICT in the teaching process in mathematical subjects. Like that, paper [6] is the research in which there are two groups of students, from two Universities: Mother Teresa Skopje and Goce Delchev Stip. In the paper are process mathematical content in two different ways (some with Geogebra and on a computer, and others without visualization and Geogebra). Then the testing is done, the results is compared, and a conclusion is drawn.

Many high school teachers face questions from their students about the applicability of mathematical contents. For that reason, in paper [7] authors try to answer students question related to linear programming problems and solved them using Geogebra. The article [8] describes the observations of the experimental teaching conducted in the high school in Košice, where Geogebra was used. Geogebra was used for the first time in students' lives for solving a linear optimization word problem.

II. MAIN RESULTS

Matrix is a topic that is very important for students of technical faculties because its application is large. The importance of its application in most areas of technology and engineering, as well as other disciplines of mathematics on the one hand, the growing tendency of the number of weaker students from year to year on the other hand were reasons to find a solution to increase the motivation to learn. We decided to achieve our goal by introducing the Geogebra software in the study of some matehematics topic. We decide that to be topic matrices. To see how much the Geogebra software will help us in achieving our goal, we will analyze the student's achievement after classical learning of the given topic and learning with software. The results of the testing will be presented, and the conclusion will be drawn.

First, after studying the topic of matrices in a traditional way, we did a test on a group of 23 students from the Faculty of natural and technical sciences to see if the results were satisfactory. The test consisted of 6 tasks. Tasks are shown below:

1.Calculate 2A-3B if

$$A=\begin{pmatrix}1 & -1 & 2\\ 3 & 0 & 1\\ -1 & 4 & 1\end{pmatrix}, B=\begin{pmatrix}0 & 1 & 0\\ 0 & 0 & -1\\ 0 & -1 & 0\end{pmatrix}$$

2. Calculate 2AB+C if

$$A=\begin{pmatrix}5 & -2\\ -3 & 1\\ 2 & 0\\ 0 & 4\end{pmatrix}, B=\begin{pmatrix}3 & 4 & -1\\ 0 & 2 & 0\end{pmatrix}$$

–

$$C=\begin{pmatrix}0 & -1 & 2\\ 2 & 0 & 1\\ 2 & -2 & 3\\ 0 & 8 & 0\end{pmatrix}$$

3. Calculate $(AB)^T$ and B^TA^T if

$$A=\begin{pmatrix}1 & 0 & 1\\ 0 & 0 & 2\end{pmatrix}, B=\begin{pmatrix}2 & 1\\ 0 & 0\\ -1 & 1\end{pmatrix}$$. What do you conclude?

4. Find the inverse of $A=\begin{pmatrix}0 & 1 & -2\\ -1 & 2 & 3\\ 0 & 2 & -1\end{pmatrix}$.

5. Calculate A^3, if $A=\begin{pmatrix}1 & -2 & 0\\ 3 & -1 & 2\\ 0 & 4 & -3\end{pmatrix}$.

6. Find the rank of the matrix $\begin{pmatrix}0 & 1 & 3 & 0 & 1\\ 1 & 1 & 5 & -1 & 0\\ -2 & 0 & -2 & 3 & 1\end{pmatrix}$.

Each test task carries 5 points.

Information about the group of tested students is given in the following table

Table 1. Information about students

Variables		N
Group		23
Age	18-21	20
	other	3
Gender	F	15
	M	8

The results of the testing after the lessons conducted in the traditional way in which the topic matrices was studied are:

Table 2. Students' achievements after learning in the traditional way

Number of students	23
Number of students who scored over 15 points	12

Number of students who scored below 15 points	11	
student achievements	Tasks	Number of students who solved it completely correct
	1	20
	2	15
	3	11
	4	10
	5	17
	6	2

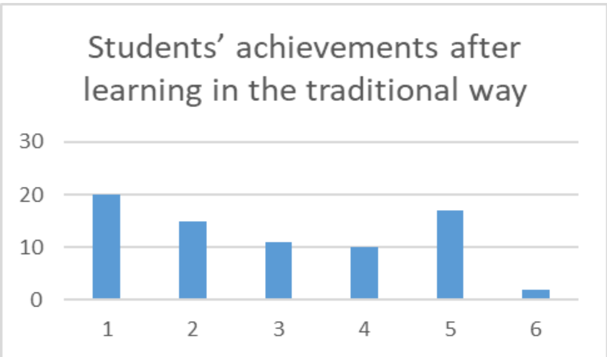


Figure 1. Result of testing after learning in the traditional way

Since the topic is very important for the students of the technical faculties, and the results were not the satisfactory, we decided to introduce changes. The changes were aimed at re-studying the topic with the application of ICT. The educational software which we decided to use was Geogebra, primarily because it is free and on the other hand it is easy to use.

In that way, in the following we will state how in Geogebra we can calculate the sum of matrices, the product of matrices, the determinant of a matrix, the inverse of a given matrix and the transpose and rank of a given one. For some calculations, we will also put links to applets that we are created in Geogebra to help students to learn.

Solve the problems with the help of Geogebra software:

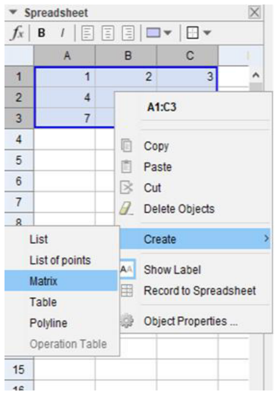
Example 1. Calculate A+B and B+A if it is possible for the following matrixes:

a) $A=\begin{pmatrix}1&2&3\\4&5&6\\7&8&9\end{pmatrix}, B=\begin{pmatrix}3&4&5\\1&9&5\\4&7&9\end{pmatrix}$

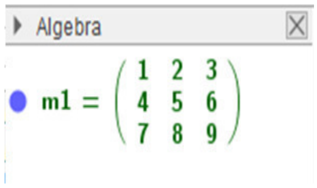
b) $A=\begin{pmatrix}1\\4\\7\end{pmatrix}, B=\begin{pmatrix}1&-1&0\end{pmatrix}.$

Solution. a) In Geogebra we write the elements of the first matrix, in the previously given sum in the same order as in the matrix, in the table which we get by selecting View → Spreadsheet. We select the cells and right click on them.

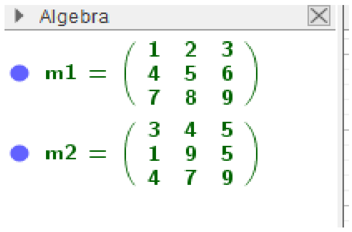
Then we choose Create →Matrix.



A matrix will be created in the algebra window:

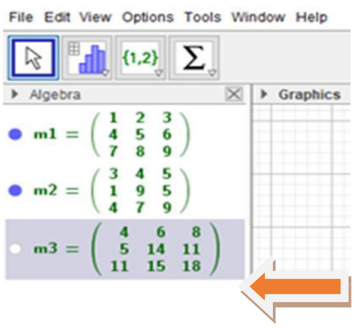


We can see that the matrix has been given the tag m1. We create the matrix B in the same way. That matrix also appears in the algebraic window with tag m2:



In the input field we enter:

Then we press Enter from the keyboard and the result appears in the algebraic window



To find B+A in the input field we enter m2+m1 and we get the same result.

b) In the same way as example 1 a) we enter the matrices into Geogebra. For the result from adding A+B and B+A we get in the algebra window

$$m1 = \begin{pmatrix} 1 \\ 4 \\ 7 \end{pmatrix}$$

$$m2 = \begin{pmatrix} 1 & (1) & 0 \end{pmatrix}$$

l1 = {}

from which we can see that the sum A+B cannot be found. Also and the sum B+A.

Example 2. For matrices in example 1 find products AB and BA if it is possible.

Solution: a) To find product AB in the input field we enter Input: m1*m2 and in the algebra windows we get matrix m4 which is the resulting matrix:

$$m4 = \begin{pmatrix} 17 & 43 & 42 \\ 41 & 103 & 99 \\ 65 & 163 & 156 \end{pmatrix}$$

Product BA we calculate so in the input field we enter m2*m1 and we get matrix m5

$$m5 = \begin{pmatrix} 54 & 66 & 78 \\ 72 & 87 & 102 \\ 95 & 115 & 135 \end{pmatrix}$$

b) In the same way as a) for the product AB we get matrix m3 in Geogebra

$$m3 = \begin{pmatrix} 1 & (1) & 0 \\ 4 & (4) & 0 \\ 7 & (7) & 0 \end{pmatrix}$$

And for product BA matrix m4:

$$m4 = \begin{pmatrix} (3) \end{pmatrix}$$

Example 3. To multiply the matrix $\begin{pmatrix} 2 & 3 & 4 & 5 \\ -1 & 2 & 5 & 9 \end{pmatrix}$ by ½.

Solution: In the input field in a new Geogebra window, we enter the given matrix, which is taged automatically with m1, then we enter

Input: 1/2m1

and in the algebraic window the matrix m2=(1/2)m1 is obtained:

Algebra

$$m1 = \begin{pmatrix} 2 & 3 & 4 & 5 \\ (1) & 2 & 5 & 9 \end{pmatrix}$$

$$m2 = \begin{pmatrix} 1 & 1.5 & 2 & 2.5 \\ (0.5) & 1 & 2.5 & 4.5 \end{pmatrix}$$

Example 4. Find the inverse matrix of $\begin{pmatrix} 3 & 4 & 5 \\ 1 & 9 & 5 \\ 4 & 7 & 9 \end{pmatrix}$.

Solution. We are working in the previous Geogebra window in which the matrix given in this example was entered and was tag with m2. To find the inverse of m2 in the input field we enter:

Input: Invert(m2)

At the same time, in the algebraic window, we get the matrix l1 which is the inverse of m2.

$$l1 = \begin{pmatrix} 1.24 & (0.03) & (0.68) \\ 0.3 & 0.19 & (0.27) \\ (0.78) & (0.14) & 0.62 \end{pmatrix}$$

With https://www.geogebra.org/m/bnfqen2r an applet is given which students can be used to calculate the inverse of a 3x3 matrix. Command that is use in Geogebra for find inverse matrix is *Invert(<Matrix>).*

Example 5. Find the transpose matrix of $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$.

Solution. In the input field we enter

Input: Transpose(m1)

because the given matric in this example get automatically tag m1 after entering it in the spreadsheet. In the algebra windows we get matrix m6:

$$m6 = \begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{pmatrix}$$

which is transpose of $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$.

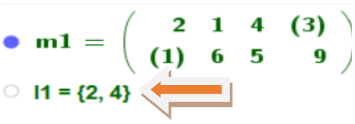
So, the command that is use for finding transpose matrix is *Transpose(<Matrix>)*.

Withhttps://www.geogebra.org/upload/633546b449cd9/?lang=mk an applet is given that can be used by students for calculate the sum and the product of two 3x3 matrices and the transpose of a 3x3 matrix.

Example 6. Find the number of rows and columns of the matrix $\begin{pmatrix} 2 & 1 & 4 & -3 \\ -1 & 6 & 5 & 9 \end{pmatrix}$.

Solution. In the input field of a new Geogebra window, we first enter the given matrix, which is automatically taged with m1, then we enter the command *Dimension(m1)*:

and in the Algebraic windows we get



Just below of the matrix m1 in the algebraic window we get the number of rows and columns of the matrix m1.

Example 7. Find the determinant of the matrix $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$.

Solution. We find the determinant of a matrix with the command *Determinant(Matrix).* We write the command in the input field using the keyboard. So, for matrix m1 in the input field we enter

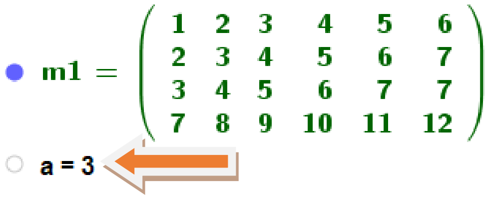
And in algebra windows we get

which means the value of the determinant is zero.

Example 8. Find the rank of the matrix

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 2 & 3 & 4 & 5 & 6 & 7 \\ 3 & 4 & 5 & 6 & 7 & 7 \\ 7 & 8 & 9 & 10 & 11 & 12 \end{pmatrix}.$$

Solution. Rank of the matrix in Geogebra we can find with the command *MatrixRank(<Matrix>).* So we enter the given matrix in spreedsheet and then in input field we enter MatrixRank(m1) becouse the entered matrix got tag m1 and we get in Algebraic windows:



Rank of the 4x6 matrix can be find with applet given with https://www.geogebra.org/m/daxep5wu .

After the classes in which tasks were solved with the help of Geogebra, listed above and in which to the students were sent links from the applets also listed above and many others created by us, we again conducted testing on the same group of 23 students. In the new test, the students had to solve the similar tasks as in the first test but now with the help of Geogebra. Solving time in the first test was 90 minutes, and in the second 60 minutes. Results of the second test are given in table 3:

Table 3. Students' achievements after learning with Geogebra

Number of students	23	
Number of students who scored over 15 points	21	
Number of students who scored below 15 points	2	
student achievements	Tasks	Number of students who solved it correctly
	1	23
	2	22
	3	20
	4	23
	5	21
	6	19

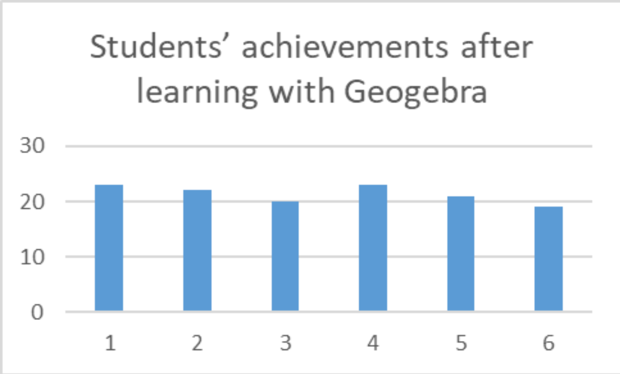


Figure 2. Results after learning with Geogebra

From table 3 and figure 2 we can see that the results are much better than the previous ones given in table 2 and figure 1. Students get better results after applying Geogebra software because the software helps them to get the correct solution in a very short time, the software helps them to check their obtained solution manually, to see what is the final solution and get a direction how to solve and what is most important with the application of the software are encouraged to solve independently.

III. CONCLUSION

From the table 2 and table 3 we can see that the application of ICT in the teaching of mathematics subjects is very important. The results confirm the general opinion that it is very important for students to have help in learning (in this case from the software). This is the only way they will get a greater desire to work, a greater interest in solving problems and thus achieve better results. How greater are the students' knowledge, the greater will be the chances that they will apply it in practice. From the table 2 and table 3 we can see also that the time required to solve is not so important when students know how to use and use software when solving.

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