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The efficacy of the CABRI 3D program in increasing academic achievement in mathematics of middle students in Arar City

فاعلية برنامج CABRI 3D في تنمية قدرات التفكير لدى مقرر الرياضيات لطلاب المرحلة المتوسطة بمدينة عرعر

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Abstract

The present research aimed to investigate the efficacy of the CABRI 3D Program in increasing the academic achievement in mathematics of middle school students in Arar city, Northern Border Region. Through its general objective, the study sought to answer the following key question: Are there statistical differences in the academic achievement in mathematics of the members of the study sample as a result of the implementation of the CABRI 3D Program? Methodology and research methods. The study sample consisted of (70) junior high school students in public schools in Arar city. The sample was distributed randomly between a first control group of (36) students and a second test group of (34) students, who learned using the CABRI 3D Program. After conducting the study, all arithmetic means were extracted, along with the standard deviations of the overall scores of the individuals in the sample, Results, and scientific novelty. The results of the study indicated that the students in the test group on whom the CABRI 3D Program was implemented had better direct and deferred academic achievement than the students in the control group who learned in the traditional way.

Keywords: CABRI 3D Program; Teaching Mathematics; Intermediate Education; Retention of Course Content.

المستخلص

هدفت هذه الدراسة لقياس فاعلية استخدام برنامج CABRI 3D في زيادة التحصيل العلمي لمقرر الرياضيات، لطلاب المرحلة المتوسطة بمدينة عرعر بمنطقة الحدود الشمالية، حيث سعت الدراسة من خلال الهدف العام إلى الإجابة عن التساؤل الرئيس التالي: هل توجد فروق إحصائية في التحصيل العلمي لأفراد عينة الدراسة لتعليم مقرر الرياضيات من خلال تطبيق برنامج CABRI 3D لتعليم الرياضيات، وتكونت عينة الدراسة من (70) طالباً من المرحلة المتوسطة بمدارس التعليم العام الحكومي بمدينة عرعر، حيث تم توزيع العينة بطريقة عشوائية إلى مجموعة ضابطة مكونة من (36) طالباً، والمجموعة الثانية تجريبية تعلمت باستخدام برنامج CABRI 3D، مكونة من (34) طالباً، وبعد تطبيق الدراسة، تم استخراج كافة المتوسطات الحسابية وكذلك الانحرافات المعيارية للعلامات الكلية لأفراد العينة، حيث أشارت نتائج الدراسة إلى أن طلاب المجموعة التجريبية الذين تم تطبيق برنامج الحاسوب CABRI 3D عليهم، كان تحصيلهم الدراسي المباشر والمؤجل أفضل من طلبة المجموعة الضابطة الذين تعلموا بالطريقة التقليدية، كما أوصت الدراسة بضرورة تعميم برنامج الحاسوب CABRI 3D، على تدريس مقرر الرياضيات لطلاب المرحلة المتوسطة، مع إجراء المزيد من الدراسات التي تدرس أثر استخدام وتطبيق برنامج CABRI 3D، في تعليم الرياضيات من أجل زيادة التحصيل الدراسي لكافة طلاب المراحل التعليمية (الابتدائية، الثانوية)، وضرورة تدريب أعضاء الهيئة التدريسية بالتعليم العام، لتخصص الرياضيات على استخدام برنامج CABRI 3D، وضرورة توظيف البرنامج لكافة التطبيقات الهندسية في تعليم مقرر الرياضيات.

الكلمات المفتاحية: برنامج CABRI 3D، تعليم الرياضيات؛ التعليم المتوسط؛ التحصيل الدراسي.

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Introduction

Due to the technological progress in various fields, the use of computer software to support education has become a necessity of modern education (Momani, 2013). The use of computer applications and software is not limited to one area per se. Rather; they have been used in various fields (Stultz, 2013). This study seeks to use one of the computer applications and software, namely the CABRI 3D Program, in the field of education, particularly on the middle school mathematics curriculum, when students are involved in technologies that move away from traditional education (Karakus, 2018), which relies on rote learning, thus enhancing the level of academic achievement. Indeed, the CABRI 3D Program is effective in helping students increase their academic capabilities, retain information, as well as develop their ability to gather, use and present information creatively, thus enhancing the student's self-confidence in what he/she produces and presents to others (Abu Sarah, 2018).

The CABRI 3D Program is a mathematics program. Specifically, it draws three-dimensional models (geometry of space) (Abdullah, 2015), through which one can benefit from the program in all primary, intermediate and secondary and even university stages of education (Al-Shammari, 2018). Indeed, by using this program, we can manipulate three-dimensional objects, drawing most types of models with curved surfaces, such as a ball, cone, cylinder, and multi-sided shapes such as a pyramid, cube and prism (Bani Yassin, 2013). What distinguishes the program is the ability to move and rotate the shape and change the angle of view to examine it from all directions (Bütün & Karakus, 2021).

Study Problem and Questions

The study problem is that it seeks to determine one of the key scientific aspects by applying a computer program to increase the academic achievement in mathematics course of students, as there are no previous studies on this field, specifically middle school students in the Northern Borders Region. In addition, the application of the CABRI 3D Program is considered an important field for measuring the academic achievement of students who use it to study mathematics. For this reason, the study sought to measure the effect of using the CABRI 3D Program on increasing academic achievement by answering the following key question:

- Are there statistically significant differences in the academic achievement in mathematics attributable to the use of the CABRI 3D Program between the members of the study's test group and the members receiving traditional education?

Significance of the Study

Since mathematics coursework is related to public life, many researchers were keen to study its aspects, and determine whether there was a need for such a study at all stages of education. Indeed, it is conducted on the middle school stage, due to the ability of the computer software learning strategy to make the learner active, effective, and able to access all information while acquiring facts, skills, and processes, and due to the lack of local studies on the subject of the study. Therefore, there is a clear and real need to investigate the impact of using the CABRI 3D software application on increasing the academic achievement of middle school students in Arar city.

Study Objectives

The study specifically aims to:

- Measure the effect of implementing the CABRI 3D Program on increasing the academic achievement in mathematics of middle school students in the schools of Arar city in the Northern Borders Region.
- Reach firm results on extracting statistical results about the extent of the impact of implementing the program, and disseminating the results to all middle schools in the Northern Borders Region.

Scope of the Study

The study focused on studying the impact of implementing the CABRI 3D Program on increasing academic achievement. Indeed, a sample of (70) (male and female) middle school students was selected from two

largely similar schools in Arar city, and the study was conducted during the first semester of the 2021-2022 academic year.

Study Terminology

1.5.1 Teaching Using the CABRI 3D Program: A set of procedures presented by the educational program to the learner for the purpose of explaining the geometry unit, particularly geometry of space and its application (Okumus & Hollebrands, 2016).

1.5.2 Academic Achievement: The progress made by the student in achieving the objectives of the subject studied, which is measured by the grade he/she earns on the achievement test (Abu Lum, 2003).

Theoretical Framework

Using computers in the educational process

In light of the great knowledge revolution that has taken place in our age, computers had to be used in order to make it easier for those working in this field to store information, then retrieve it easily at any time. In addition, computers are relatively cheap given the significant benefits that one derives from using them, particularly in the field of education. All of the foregoing supported the trend towards increasing the quality of education provided to students and breaking the routine of daily education based on the method of rote learning (Al-Balawi, 2015). The computer has been a great tool for both teachers and students, in terms of the quality, enjoyment, and efficiency of the educational process using various computer programs. Computer use has resulted in increased academic and cognitive achievement among the students. In addition, computer software is easy to use for all age groups Accascina & Rogora, 2006).

Motivations for using computers in the educational process

The use of computers in education is considered an efficient and highly effective method. It can help in the development of education by introducing countless study methods. It can also help students develop many skills that will help them in their careers (Ardıç, & Isleyen, 2017). Below are the most prominent motivations for using computers in education, which include improving efficiency thus allowing the use of computers in education to develop innovative teaching plans, which help keep students engaged. They also help promote the capability of individualized learning. This is in addition to the ease of extracting new information. Moreover, computer learning can increase students' sense of comfort and connection as they get closer to pursuing their careers (Güven, 2008). All of this increases efficiency in the educational system, thus helping both the student and the teacher. Indeed, students can now have their lessons when it suits them. The use of computers in education has also helped teachers save time when planning lessons, assessing students, correcting homework, providing feedback, and performing administrative and other paperwork (Qarawani, 2012).

This is in addition to the improvement in the skills that help when using computers in education to refine and develop the students' skills through the computer techniques and programs that are used and interacted with during the study stages. Indeed, the development of skills is often related to the field of programming and computer techniques, whereby computer use increases students' confidence in their ability to learn to use new tools that will support their learning in many fields (Mowafi, 2013).

Obstacles to the use of computers in education

However, many obstacles red the use of computers in the educational field. These obstacles vary from one area to another (Stultz, 2013), depending on the conditions of the educational area. They can be summarized as follows: The high cost of purchasing computers and using the Internet in schools, particularly in developing countries, as well as the mentality of some teachers, who believe that lectures and rote memorization are the best methods of learning the academic subject and curriculum to be taught to students. The spread of viruses on the internet and fear of their consequences are also a hindrance (Sharman & Amal, 2015), as well as the financial aspect if the computers are damaged due to infection by a virus. Moreover, sitting in front of a computer screen for a long time may affect the physical and mental health of its users.

The CABRI 3D Program

It is a mathematics program used specifically to draw three-dimensional 3D models (geometry of space) (Harasiya, 2008). We can benefit from the program at all academic stages: Primary, intermediate, secondary, and even university studies. Indeed, through the use of this program, we are now able to manipulate three-dimensional objects; draw most shapes with curved surfaces, such as a ball, cone, cylinder, and multi-sided shapes such as a pyramid, cube, and prism; move and rotate the shape; and change the viewing angle to examine them from all directions as though you were holding that shape with your hand (Guven et al, 2009).

The CABRI Program technology was designed in the research laboratories of the French National Center for Scientific Research and the Joseph Fourier University in Grenoble. The project began in 1985 (Khalil, 2006) when Jean-Marie Laborde began making learning two-dimensional geometry easier and more interesting (Okumus & Hollebrands, 2016).

The Program is specialized in teaching geometry. It is the first accredited software produced from a series of dynamic or moving geometry software and is considered the most common and widely used. This program is capable of making radical changes in the field of teaching geometry and mathematical proofs due to its enormous potential. The CABRI 3D program provides the student with a geometry environment through which he/she can create geometric shapes, and perform various measurements enabling him/her to obtain a continuous series of measurements or shapes without the need for reconstruction or measurement each time (Al-Shammari, 2018). It also enables the student to see mathematics as a moving system and helps him/her to get infinite examples of the drawn shape instead of a single static mental image. The student can view the geometric shapes as models that he/she views from all sides and thus become more familiar with the visual issues. This is done in a very short period of time as compared to the time the student would need to identify some of these examples using paper-based methods (Bani Yassin, 2013). The program also has great potential for teaching, learning, and strengthening the student's ability to visualize and model physical structures and movement (Momani, 2013). There are three tasks that strengthen the link between the visual and geometric methods in the program, namely:

- Moving from the verbal description of the geometric shape to draw.
- Explaining the drawing method using geometric concepts, which correspond to the transition from drawing to verbal description.
- Copying the drawing or converting the drawings using geometry.

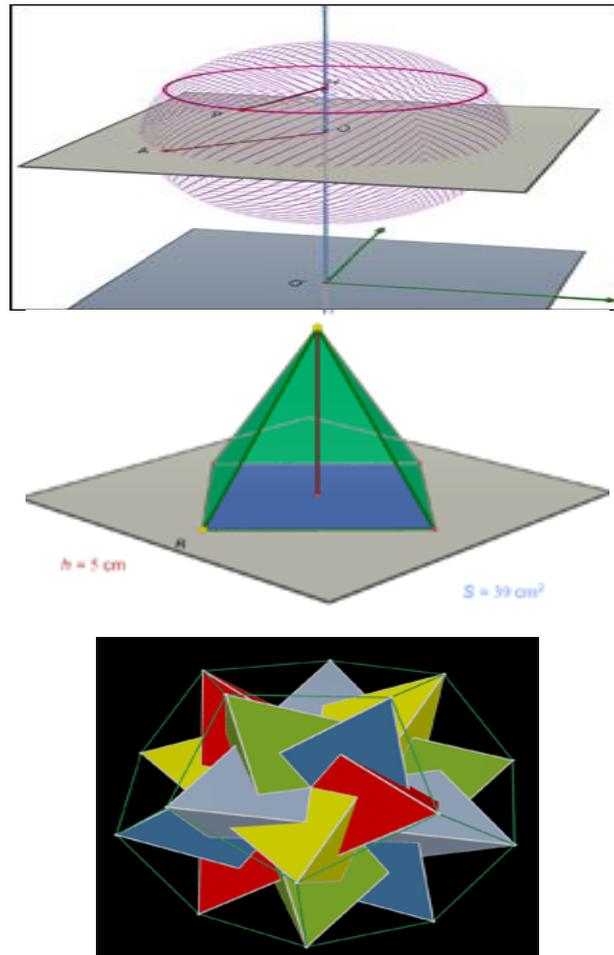
The potentials of this program can be summarized as follows (Kepceoglu, 2018):

- It permits the construction of points, lines, triangles, polygons, circles, solids, and other basic elements.
- It allows for retraction, zooming in, zooming out, and rotation of geometric objects around specific axes or specific points as well as reflection and symmetry.
- It allows for easy creation of conic sections, including ellipses, hyperbolas, and parabolas.
- [It offers] the possibility of specifying a measurement for lengths and angles and calculating the perimeter, area, and volume of shapes.
- Finding the operations on vectors.
- It handles with both Cartesian and polar coordinates.
- It displays equations for lines and segments, as well as the coordinates of points.
- It allows the teacher to create lists of tools if he/she wants to focus only on the activities of a specific lesson.
- It tests geometric properties to test hypotheses based on Euclid's five postulates.
- [It] hides the items used in construction to tidy up your desktop.
- It highlights objects through the use of colors.
- It defines the geometric location on an ongoing basis.
- It enables the student to visualize the dynamic characteristics of the shapes through movement.

Basic and Flat Geometric Shapes in the CABRI 3D Program

The CAPRI 3D program is characterized by drawing shapes in the second dimension, but the geometric shapes in the second dimension look different from their natural form (Hussein, 2017), because the program

is designed for three-dimensional shapes, but it allows them to be made in the second dimension. The program also executes some basic and flat geometric shapes such as a circle (oval shape), polygon, sphere, cone, prism (3D), pyramid, and cylinder (Kepceoglu, 2018).



(These graphs and figures have been manifested by the author and under his authorship)

Literature review

(Al-Mahrazi & Al-Darwani, 2016): This study aimed to identify the effect of teaching solid geometry using the CABRI 3D Program on the geometric thinking and spatial awareness of eleventh-grade students in the capital city of Sanaa. To achieve this, a teacher's guide for teaching solid geometry using the program was developed. This was done by formulating the solid geometry measurement unit using the program. The study sample consisted of (89) eleventh-grade students who were selected at random and divided into two groups: (44) students representing the test group and (45) students representing the control group. The test group was taught the solid geometry course using the CABRI 3D Program, while their classmates in the control group were taught the same course without using the program. At the end of the trial, the levels of both groups were measured according to the geometric thinking scale after verifying its reliability and validity. The ready scale was also used to measure the spatial awareness of the topics after verifying their suitability to the Yemeni environment and its measurement characteristics. The data was statistically calculated using the SPSS Program used by the Anova researchers to provide the degree of variance as well as t-test. The results showed that teaching of solid geometry using the CABRI 3D Program developed the students' geometric thinking and spatial awareness.

(Hussein, 2017) This research aimed to explore the efficacy of dynamic geometry (CABRI 3D) programs in teaching geometry of space in high school in the areas of geometric thinking and attitude towards mathematics. The research used the quasi-experimental method with a sample of (50) male and female high school students distributed equally between the test group and the control group. The test group learned

using CABRI 3D, and the control group learned using the normal teaching strategies with the pre-test - post-test (Van Hiele test, the placement on the mathematics scale, attainment test), The results showed that the sample was at the third level of the Van Hiele scale and that there was efficacy with the CABRI 3D Program in teaching geometry of space in high school, while there was no efficacy in geometry of space, geometric thinking and attitudes towards mathematics.

(Hartatiana & Nurlaelah, 2018) The study aimed to measure students' abilities that can facilitate their understanding of geometry concepts, namely the ability to think spatially. Spatial thinking ability can be defined as an ability that involves a person's cognitive processing to provide and process spatial shapes as well as the relationship and forms of the shape. The research seeks to discover the difference in the spatial thinking ability of students who have been given model extraction activities using CABRI 3D (MEAC) and those who have been given model extraction activities using only (MEA) to use a quasi-experimental design in this research, which included a sample of 143 high school students. The study found that students who were given model extraction activities using CABRI 3D had better spatial thinking ability than those who were given model extraction activities. The research also suggests that mathematics teachers implement the instructions using model extraction with CABRI 3D.

(Okumus & Hollebrands, 2016) The study was issued by the North America Branch of the International Group for the Psychology of Mathematics Education, via a paper presented at the Annual Meeting of the North America Branch of the International Group for the Psychology of Mathematics Education (38, Tucson, Arizona, November 3-6, 2016). The methods in which two high school students formed three-dimensional objects were analyzed from the rotation of two-dimensional shapes. The students participated in a task-based interview using paper and pencil. The results indicated that they had difficulty using paper and the pen to rotate the two-dimensional shapes and form three-dimensional objects. The difficulty in thinking about rotation arose in a two-dimensional context. Although the use of processors helped them think about three-dimensional problems, they still had difficulty representing the three-dimensional objects correctly. However, the students were able to link the courses applied to the two-dimensional shape to the three-dimensional object produced using the CABRI 3D software.

Methodology

Study Population and Sample

The study population consisted of a regular random sample of middle school students in public schools in Arar city. The sample consisted of 70 male and female students, with (34) students in the control group and (36) students in the test group.

Study Methodology and Tools

The researcher applied the criteria of the experimental method, which relies on a systematic method used by the researcher to study specific facts through experimentation, interpretation, control, and prediction of the future outcome. The researcher used two tools for the study, namely:

The CABRI 3D software.

The Attainment Test: After analyzing the content of the mathematics unit, an achievement test for geometry skills was built, and the validity of the test was approved through the researcher's work to build the test and through what was presented to the arbitrators. The test was applied in its final form to find stability using the test-retest method, and the Pearson correlation coefficient was extracted. Its value was (0.87), which is an appropriate value to begin conducting the study.

Statistical Processing

After applying and implementing the study procedures, the arithmetic means, standard deviations, and percentages of the total scores of the study sample members were extracted.

Results and Discussion

The text of the key question of the study: Are there statistically significant differences in the academic achievement of the members of the test group and the members of the traditional teaching group in the subject of mathematics, due to the method of learning through the application of the CABRI 3D program? To answer this question, the arithmetic means and standard deviations of the test group’s post-test were calculated, according to Table No. (1).

Table 1.
Arithmetic Means and Standard Deviations of the Overall Scores of the Members of the Post-Test [As Compared to] the Students in the Test Group.

Strategy	Means out of (20)	Standard Deviation	(t) value	(f) value
The strategy of using the CABRI 3D Program on the students in the test group	15.12 Pre-test = 10.67	3.28 n= 22	0.269	1.220
The strategy of using the traditional method (control)	12.06 Pre-test = 9.77	3.97 N=18	0.763	1.06

(This Table has been manifested by the author and under his authorship)

It is noted from Table (1) that the arithmetic means of the overall score of the students in the test group on the post-test was 15.12 out of 20, i.e. 75.6%, with a standard deviation of 3.28 points. In contrast, the arithmetic mean of the overall score of the students in the control group on the same test was 12.06 out of 20, i.e. 60.3%, with a standard deviation of 3.97 points. This descriptive result means that there is a clear difference of 3.06 points, or 15.3%, between the mean overall scores of students on the post-test. This indicates that there is a processing effect on the academic attainment of the members of the study sample, and these differences favor the test group that used learning through the CABRI 3D program.

The results of the study indicated that the students in the test group on whom the CABRI 3D software was applied, had better direct and deferred academic achievement than the students in the control group who learned in the traditional way. In light of this result, it is possible to say that the learning strategy of implementing the CABRI 3D program outperformed the traditional method in terms of direct and deferred academic achievement by students on mathematics. The result can be attributed to the great ability of the CABRI 3D learning strategy to make students active and effective while acquiring skills and information in educational settings that provide engagement, competition, reinforcement and excitement. Indeed, CABRI 3D software takes into account the students’ capabilities, and enables them to learn according to their abilities, by having them choose the difficulty level and speed that suit them.

In addition, the CABRI 3D software includes a huge collection of drawings, shapes and colors in educational settings that enable significant academic achievement, and information retention, thus making them active and effective, and igniting the spirit of competition and persistence in them, which enables information retention for a longer period of time, contributes to successful learning, and increases the efficiency of academic achievement.

Conclusions

The study points towards confirming the conclusion of the study objectives according to the following:

The researcher concludes that there is a significant increase in the academic achievement of school students in Arar city, where the results of the direct study indicated that the students of the experimental group, which is the group to which the CABRI 3D computer program was applied, had better direct academic achievement than the students of the main control group who learned in the traditional way. Based on that, a direct conclusion can be reached that the use of the learning strategy through the application of the CABRI 3D program has effectively outperformed the traditional method through learning with the CABRI 3D computer program, and the researcher believes that this is directly due to the great ability of the program to provide students In the experimental group of educational skills and situations that have the ability to

achieve academic achievement, in addition to the competition, reinforcement and suspense, as the CABRI 3D computer program takes into account individual differences, students' abilities, and the level of educational difficulty. The program also facilitates the ability to present a variety of graphics, shapes, and colors in situations Multiple educational works that increase academic achievement and increase its effectiveness.

On the other hand, and based on the confirmed results of the study, it can be concluded that teaching can be generalized through the CABRI 3D computer program to all levels of education for students of general education in the northern border region in the Kingdom of Saudi Arabia, as the direct results of the study push towards confirming the role of the computer program in promoting Academic achievement, increasing the amount of information and its permanence among students, and thus the generalization of teaching through the program has a positive direction so that the rest of the students in the general education of the mathematics course can benefit from the capabilities of the CABRI 3D computer program widely and effectively.

Recommendations

In light of the study results, the investigator strongly recommends the following:

1. Using the CABRI 3D Program to teach the mathematics curriculum to middle school students.
2. Conducting further studies into the impact of using and applying the CABRI 3D Program on mathematics education in order to increase the retention by all students at the educational stages (primary and secondary).
3. Training the mathematics teaching staff in public schools to use the CABRI 3D Program, and using the program for all engineering applications when teaching the mathematics curriculum.

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