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The Effect of Teaching Mathematics Using Scratch Software on the Achievement of 6th grade students in Kuwait

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Abstract

This study aims at investigating the effect of teaching mathematics using the Scratch Software on achievement of middle-school 6th grade students in Kuwait. To achieve this used objective, the researcher uses the Quasi-experimental Design. This study provides a sample consisting of 30 students of the middle-school 6th graders, and distributed over two sections in Fatima bint Abdil-Malik bin Marwan in Kuwait. They were divided randomly into two groups: an experimental group taught by the use of Scratch Software, and a control group based on the standard approach. The study conducted an achievement test in Math and extracting its psychometric characteristics (validity & reliability). The results reveal that there is a significant statistical difference in the Significance Level ($\alpha = 0.05$) in the achievement in favor of the experimental group. According to the results of the study, the researcher recommends employing the Scratch Software in teaching Mathematics and incorporate its Software within the training programs of Math teachers in the educational institutions.

Keywords: *Scratch Software, achievement, middle-school sixth-graders, Kuwait.*

Introduction

Mathematics is considered an experimental subject required to be taught through engaging many senses that contribute to simplification and comprehension. Math provides solutions to many problems and challenges which face mankind. Therefore, teaching and learning mathematics receives great attention in all educational systems. Also, the acceleration of the cognitive and the technological development contributes to providing an interactive educational environment which suits the needs of the teachers and help them in developing their skills in dealing with the variables of this era. Al-Halfawi (2011) states that the rapid growth of the technologies of the internet shows a necessary need for adopting modern educational systems for the enhancement of education through implementing technology in the process of teaching and learning. Karawani (2012) adds that technology has broadly influenced the traditional methodologies in increasing the efficiency of the higher education in all its disciplines including mathematics and developing student-centered teaching strategies.

The student-centered teaching strategies influences the student's motivation in learning and the amount of knowledge, skills, and values acquired from learning. Calder (2014) believes that using internet has implement a new model in the field of education which calls for abandoning the traditional methodologies and adopts instead the methodologies

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of electronic learning (e-learning). Hubackova (2015) confirms that the technological advancement has support the emerging of various educational patterns which surpass time, place, the financial capacities, and the individual differences in skills and needs. For this reason, the e-learning is considered a necessary requirement in the present days. The rapid development of the systems of information & technology has led to achieving large scale of advancement in creating multi-media including programs and has contributed to developing new methods of learning and teaching resulting in the enhancement of the educational objectives and outcomes.

The educational institutions have been searching for adopting multi-media in education, as it constitutes as an element of logical-type of thinking which stands as one of the primary skills called now "the twenty-first century skills". As an attempt to elevate attention toward Software, much effort has been executed in developing the instruments and activities for the students, and Scratch Software was among the outcomes of these efforts. This Software provides great room for creativity and ability to solve and tackle problems, as it is a free-to-use graphic Software language and designed for facilitating and supporting the technological competence. One of its objectives is providing "modifiability" through which beginner programmers are able to collect, de-code, and re-collect the units of coding structures to build whatever they desire. Scratch also aims at elevating creativity and motivating while using computers. (Jenedi, Naqib, & Abduallah, 2018). Su, Shao, & Zhao (2021) have emphasized that Scratch is a type of visual Software used in a large scale in teaching children in elementary schools, as it supports building a digital world for children to design, develop, and conduct teaching courses which targeting their creative thinking.

Implementing Scratch in classroom lessons has been greatly welcomed and appreciated among students as well as teachers who experienced the fun and simplicity of its use. As a result, it supports their interactive participation reflecting the improvement of their achievement level. Following this direction, the educational studies conducted on Software generally tend to investigate its contributions accomplished in the learning process, and they also emphasized that Scratch supports the development of analytical thinking, logical growth, and mathematical thinking. Evidently, the students who receive instructions for Software in an early age has broader mathematical knowledge and better skills in solving problems, while not to mention the contribution of Scratch in learning Software and algorithms and being reflective of the development of their intellectual skills and acquiring different and various concepts (Ali & Saltan, 2015), (Calder, 2019), (Shafer, 2018).

Supporting the participation of students is also considered as a consistent outcome, as it is the case of facilitating the approach of solving problems which mostly integrate mathematical thinking. This can be supported when students work in a Scratch environment on the one hand. On the other hand, education largely contributes through game activities in Scratch in the academic accomplishments in plane geometry as opposed to the traditional approach. In a Scratch environment, the Software structures are more material-based (visual) and their results can be observed physically in an objective environment as an illustration for positive contribution in the skills of mathematical thinking among students.

Akpinar & Altun (2014) states that the employment of Scratch Software or other types of Software should not be limited to college education, but it rather includes elementary and high school. Similarly, integrating a curriculum based on this program and design should support developing the skills of analytical thinking and spatial reasoning of students and solving-problem skills. Accordingly, the current study addresses the effect of Scratch Software in the achievement of 6th graders in mathematics in Kuwait.

The Problem of the Study

Mathematics is considered a difficult and undesirable subject for most students despite its significance in almost all professions, especially the scientific and technological ones. Katmada, Mavridis, & Tsiatsos (2014) indicate that students face many difficulties in learning mathematics.

In Kuwait, the International Trends Study (The Trends in International Mathematics and Science Study. TIMSS, 2019) revealed a huge gap between the ability of students in learning the basic principles of sciences and mathematics and their abilities in applying knowledge. These results are attributed to teaching methodologies followed in teaching the subjects of sciences and mathematics in most of schools in Kuwait. Although Kuwait Schools provide computers and high-speed internet modems, no development has been achieved in elevating the achievement level of students due to persistence of teaching in employing the traditional strategies.

Since the researcher works as a teacher, the results of this study have touched the practical reality, which enable this current study to break the rhythm of the traditional strategies while touching the modern spirit for upgrading the achievement level of the subject of math for female students in the primary stage, and thus, the enhancement of the outcomes of education, and in addition to providing an active educational environment that change the stereotypical image of mathematics and make more entertaining and attractive.

Therefore, this study addresses narrowing this gap in the literature of this subject. Particularly, the study issue focuses on answering the following question “what is the effect of teaching mathematics using Scratch in the achievement of 6th grade female students in Kuwait”.

The Research Questions

- Does using Scratch Software in teaching mathematics enhance the level of achievement of school students, particularly 6th graders in Kuwait.
- Does Scratch Software prove an engaging and practical instrument in education?

The Study Objective

- The study investigates the effect of the use of Scratch Software on the achievement of 6th graders in the subject of mathematics in Kuwait.

The Study Significance

The significance of this study is clarified according to the following:

Theoretical significance: Through enhancing the knowledge using the educational program based on e-learning (Scratch Software) in the process of learning and education and link it to the improvement of the elements of mathematical knowledge (skills, generalizations, algorithms, and solving the mathematical argument) contributing to the field of teaching and learning mathematics. Girgis (2017) indicated that teaching Software support the development of creativity, skills, and transforming an imitative generation to creative and innovative one, and positively influence their achievement in the mathematics subject in the future, and their approaches toward Software generally.

Studying the effect of programs (ex: Scratch Software) is considered one of the issues through which it is possible to build on the modern strategies in education for students in their primary educational stages. It is a worthwhile issue in this study, and it keeps up to date with recent developments of this age in the educational and the digital learning systems and its influence on education generally and on mathematics specifically.

While the applied significance of this study provides a new teaching methodology for math teachers compatible with the intellectual and technological development to elevate

the performance level of students in the subject of mathematics. Moreover, the objectives are expected to offer benefit for officials in charge of preparing the curriculums of mathematics in the ministry of higher education to provide the necessary programs to enhance the mathematical achievement, and to incorporate Software languages in the education of mathematics. This study may also present useful information for researchers in this field, teachers in different disciplines, and students in all educational stages, due to the significance of digital programs in enhancing the level of mathematical achievement of the students. While it sheds light on the concept of plane geometry in mathematics as it is perceived as a subject characterized with difficulty and challenge for the students in the primary stage, also try to employing what has been reached out of the results in elevating the mathematical achievement, and particularly the primary school stage.

Terminological and Procedural Definitions of this Study

Scratch Software: is an easy, simple Software environment potentially usable by specialists and non-specialists such as teachers and children through the basics instead of using the Software coding. It is also possible for users to produce interactive stories, add dimensions, and special effects through inserting animation, pictures, or sounds, as it helps students in comprehending ideas as the educational material is presented with exciting and interesting styles. For this reason, some consider it an educational game which supports the learning process, facilitates building concepts, draws the attention of the students, and expands their experiences such as finding solutions to their problems. (Calder, 2019:60).

Scratch enables its users to insert pictures, video sounds, and other multi-media, which allows them to acquire opportunity in embodying their ideas in the form of animation, interactive stories, or even musical and artistic games, and others among these technological innovations.

Scratch Software is identified procedurally as a visual Software language which relies on the building blocks of the ready-made lists and dropping them in the workspace of the Software instead of writing down the instructions of the program for teaching beginners the basics of logical thinking in learning mathematics. Educational Achievement: “The amount acquired by the student of forms of knowledge, information, skills, and academic experiences in the content of the different educational subjects”. (al-Jamal Warkha, 2015, 160).

Achievement in Mathematics: is the achievement accomplishment of Mathematics in the concepts, facts, and mathematical skills acquired by the student in the classroom in the prescribed subject (al-Radadi, 2007), and in the current study, the achievement is determined by the acquired grade in the plane geometry test.

Subject of Mathematics: the subject of mathematics for middle-school 6th graders accredited by the ministry of higher education in Kuwait, formed as a geometry unit.

Study Limitations

1. Location limitations: the current study was limited to middle-school female 6th grade students at Fatima bint Abdil-Malik bin Marwan in Kuwait City.

2. Time limitations: the current study was conducted in the first semester 2021/2022.

3. Subject limitations: the current study was limited to Scratch Software and the plane geometry unit in the intermediate 6th grade math book.

Theoretical Framework & Previous Studies

This chapter includes the theoretical frame and previous studies regarding the issue of the current study addressed through investigating the Arabic and foreign data platforms, as it is presented in detail below.

Theoretical Framework

As there have been rapid growth in the systems of information and technology of the internet, there were quite much advancement in the industry of multi-media and internet including software and educational games. Scratch is considered one of the used software in the educational learning process.

When the digital technologies are used in an appropriate fashion, they provide opportunities to create, explore, and organize date or the mathematical phenomena in ways which might support the mathematical thinking, while allowing the recipient in learning to perceive them from the specific to the general. While coding enables learning to be through repetitive process of participation and thinking, and along with the increasing participation with the code and the outputs generated by the coding language. It is also possible for the programmer to try out something and specify the effects of the new coding in a relative speed, allowing one to generalize the special characteristics of the coding and edit their perspective. Through the visual environment in Scratch for instance, where there is a screen of each coding and the output next to each other, one is able to identify these relations much easier (Calder, 2018). The following shows theoretically the variables of this study:

First: Scratch Software

Programming is considered one of the essential means which teach the student the basic skills, most importantly problem-solving skill. However, the many complications within coding languages were earlier generally a setback before merging this material in the lower levels, and consequentially, a setback for gaining benefit during the educational learning process. Nonetheless, along with the emergence of Scratch, it has managed to erase the obstacles between the students and the concept of programming through overcoming the complications of codes and compensate them with animation and extracts of the software, opening before them the door for creativity all the way through.

Scratch Software enable young children to learn in a simple fashion and compatible with their growth stage, while contributing to better securing their education, as opposed to other programs characterized with complexity. Lifelong Kindergarten has developed Scratch in the multi-media lab at MIT. The main goal is to strengthen and support creativity, as well as develop innovation by children, and also for adults who do not know anything about software. This program enables its users to create their games and their interactive stories through a quite easy and simple programming language. (Abdil-Aziz, Abdil-Majid, & Halima, 2019).

Another advantage of the features of Scratch is that the software is free-to-use from its recourse and use animation instead of complicated codes usually adopted in other software programs. This language is more like a game than a programming language (Aqil & Al-Umrani, 2018: 22). Scratch Software is a design programming for educational environment dependent on sounds, images, and texts in which one can build bodies or extracts within the software instead of writing a complicated coding language. (El Sourani & Ihmaid, 2019: 90).

The significance of Scratch is conceived on minimizing the difficulties shown within programming languages, and which make most people reluctant to use despite its importance. Scratch works on the development of the aspects of creativity and innovation among the young people, and encourage them to design their own projects, and perform them on the ground, without having the technical side as an obstacle for them. In

addition, the early and simplified learning of this type of programming prepares students in high schools to understand programming, specifically object-oriented programming, as most of them face difficulties in understanding its features. (Mohammed & Saleh, 2020).

On the other hand, Scratch helps learners to acquire basic programming concepts such as conditions and repetitions, as well as the most complicated concepts including objects and blocks, and in addition to crucial mathematical ideas and concepts such as the system of coordination, variables, and random numbers. All of such is managed in an entertaining and motivating learning style. Moreover, Scratch help learners acquire life-long basic skills such as analysis, communication, cooperation, and learning, which are necessary for future success and for adaptation with the demands of the knowledge economy. (Ihmaid, M. K., 2017).

The Components of Scratch Software

Scratch components are distinguished from other types of programming as mentioned in the following fashion (Raja & Nagasubramani, 2018): the upper bar, Scratch screen, commands screen, objects screen, and the window backgrounds. The upper bard contains several options including a file, an "open" option, which one can click on for showing up the old projects performed on this program, the "new" option, which is used for creating a new project, and there is "save" option. The user can also record video clips relevant to the project and saving the files, and there is also "undo" option in the editing list in the upper bard used for undoing the mistakes made.

Scratch Screen is the main screen of the program which contains a picture of a cat, and it is characterized with a white color, and the user may add their projects on that screen. The project is operated through pressing the button on the green flag, and then, combined with clicking on the red button.

The "commands" screen on the right of the Scratch screen includes several instruments used for movement, operations, and others, and it enables the user to show all the commands in the screen. The screen contains categories which each has its own color.

The objects screen is found in the bottom of the Scratch screen, and the user may add through this screen characters and animals intended to use within the project. The user may perform launching a name for each character and for each animal, and he may also perform any editing desired to be done on those names. Moreover, the objects screen includes a brush to be used in painting a new object or a character. The user may catch any picture and upload on the program through the available "camera" option in the screen.

The background window has several backgrounds as the user chooses one of them to be the background for the characters and the special objects in their project. It is available for the user to download a background among the existing ones on his device, or painting a new background.

Second: Achievement

The Achievement is defined as the scientific effort made by the student in the different learning situations for the purpose of improving the acquisition level of sciences, skills, and information in a specific scholastic field (Lynn & Kelly, 2001). Al-'Isawi and others (2006) define it as the accomplishment level or the skillfulness of the school work measured by the teacher according to the assigned tests based on the total measurement of grades gained by the student at the end of the school year, whether after passing or failing at the tests. Adeyinka, Adedeji & Olufemi, 2011) also defines school achievement as the sum of standards or measurements for assessing the scale of the effect of the learning tasks and the ability as well as the efficiency of the student to benefit from them, and thus, going through categorizing and ordering the students academically to higher, intermediate, and lower levels.

The researcher of this study perceives what the students acquires in terms of information, sciences, directions, values, and skills expressed by them as the sum of grades achieved in tests which determine the success or failure of the relevant educational material.

The achievement is considered of a complex nature as it is affected by a set of factors determining the achievement level of the student, which are the following: the individual factors, factors related to school, factors relevant to the family and social environment, and factors have to do with one's companions (Shafiq, Chaudhry, Farooq & Berhanu, 2011).

Previous Studies

Through the author's review of the studies relevant, she has not found a study addressing the current issue addressed here specifically. However, some studies relevant to one of its variables, as previous studies have shown relevant to the issue of the study reached through scanning the Arabic and foreigner data system, as will be presented in this study.

Al-Othman & Al-Mwash (2020) conducted a study aimed at investigating the effect of teaching programming using Scratch on the self-motivation for learning programming for students in the primary stage in Riyadh. The sample of the study consists of 25 students in the primary fourth grade. Both researchers follow the semi-experimental approach. The measurement of motivation for learning the software was applied in-person upon the sample, and then, programming lessons were conducted using Scratch for a semester, and then the measurement was applied again remotely. The results of the study show statistical differences in favor of the remote application, which means there is improvement in the self-motivation among students for learning programming using Scratch Software. Results have indicated that the self-motivation improvement rate in total is 22.8%.

El Sourani & Ihmaid (2019) conducted a study investigating the interaction of using the Scratch applications in developing and maintaining the English vocabulary of 6th grade students along with the self-interaction in Gaza for the purpose of investigating the role in Scratch applications in developing and maintaining English vocabulary and the self-motivation for interaction among 6th grade students. For achieving the objective of the study, both researchers adopted the experimental approach, as the achievement tests was conducted on the study sample consisting of 44 6th grade students after they were divided into two groups: control and experimental. The study results show that there are statistical differences in developing learning skills of the English vocabulary between the two groups in favor of the experimental group taught using the Scratch Software.

Lin, Chen, & Nien (2014) conducted a study to address the effect of electronic learning on the achievement of the accounting subject as well as motivation. The study applied a semi-experimental design divided into an experimental group and a control group. Such an effect was assessed through an in-person test as well as remotely. For achieving the goal of the study, the semi-experimental group adopted the strategy of electronic learning, while the control group studied in the standard method. After a period of six weeks, the effectiveness of learning was tested through the experimental group, and the results consisted of two parts: first, the strategy of electronic learning did not differ from the standard learning method in terms of achievement in accounting for the new students in the college. Second, the strategy of electronic learning was superior to the standard learning style in terms of learning motivation.

Kalelioglu & Gulbahar (2014) conducted a study aimed at testing the effect of Scratch Software on problem-solving skills among fifth-grade students at the primary stage. The study was performed with a sequential illustrative design of the blended ways through the participation of 49 students in primary school, The results showed the absence of an evidential statistical effect of the Scratch Programming in problem-solving skills by the

students of the primary schools. Also, there only trivial increase in the average factor of "self-confidence in their ability of solving problem".

Erol & Çırak (2021) specifies the effectiveness of "Scratch" on problem-solving skills of the students at secondary schools. This study carried out its work for 14 weeks, depending on a course for "the technologies of information and software" for two hours a week. 14 secondary-school students attended the course as being the experimental group, while 16 students of the secondary school as the control group. The control group studied according to the activities included within the school book for designing games, while the experimental one did their study using Scratch. The study results showed that the activities for designing games using Scratch increased the problem-solving skills of the participants. In this context, it is possible to use game-designing activities using programming instruments with children to help them in acquiring problem-solving skills at an early stage.

Ali & Saltan (2015) addressed identifying the effects of using Scratch Program in information technologies courses for the sixth grade for developing algorithmic and problem-solving skills in Turkey. The study used a semi-experimental approach. A group of 65 6th-grade students participated in the study at a high school. An algorithm-developing test and a problem-solving questionnaire were used. The students of the control group learned the algorithms as shown in the model, where the students of the experimental group learned the algorithms using Scratch. The results revealed that there were no differences of statistical significance between the control group and the experimental group in terms of developing algorithm and problem-solving skills.

Rodriquez-Martinez, González-Calero, & Sáez-López (2020) conducted a semi-experimental study investigating the effect of Scratch in acquiring mathematical concepts and in developing mathematical thinking among 6th grade students. The experiment consisted of two different stages: a programming stage related to teaching through Scratch and it concentrates acquiring the basic concepts of the mathematical thinking, and a mathematical stage directed exactly toward the solution. Among the mathematical tasks in particular, the mathematical stage focused on the problems of mathematical concepts whose solution included using the least common multiple and the least common denominator. For evaluating the objectives of the study, the results of the tests were compared before and after the teaching process, whether in the mathematical thinking or the mathematical standards. The results indicated that Scratch can be used for developing the mathematical ideas of the students and calculative thinking.

Feedback on Previous Studies

The current study agrees with previous studies through the employment of Scratch Software in learning, while it differs from them in terms of the dependent variable as well as the sample. The current study investigated the effect of using Scratch Software on the achievement within teaching of plane geometry. The target of the study was 6th grade female students at middle school in Kuwait. It shows agreement with the study of Rodríguez-Martínez, González-Calero, & Sáez-López (2020) in the sample, while it shows difference in methodology as well as the dependent variable. As previous studies have been presented, few studies seem to address the effect of teaching mathematics using Scratch on the achievement of 6th grade female students in Kuwait State. The researcher has not found studies which target teaching panel geometry using Scratch. Therefore, this study might be one of the first studies handling the effect of teaching mathematics using Scratch on the achievement of 6th grade students about mathematics, and it might be solely exclusive on addressing this aspect.

The researcher has made use of the previous studies in revealing the gap within the literature of this topic, the core of the issue of study, identifying the mechanism of choosing the appropriate approach, the choice of appropriate instruments, and the methods of choosing the study sample.

Methodology & Procedures

Chapter 3 includes outline of the participants, the study instrument, and the necessary procedures to achieve credibility and stability of the results of the study in terms of its dependent and independent variables, the statistical processing, and the study procedures.

The Study Methodology

Answering the question of the study, the researcher uses a semi-experimental (the experimental and the control groups in-person and remotely), as to discover the effect of teaching mathematics using Scratch on the achievement of 6th grades in Kuwait.

Sample of the Study

The participants are elementary 6th female graders at Fatima bint Abd al-Malik bin Marwan in Kuwait. The school test was conducted as two sections among four sections were chosen adopting the simple random method, and one of the two sections was chosen to be the experimental group by the simple random method. While the other section was considered the control group. The number of participants of the experimental group were 15 female students, who were taught the unit of panel geometry using the Scratch, while the control group were 15 students, taught the unit of panel geometry using the standard method.

The Parity of the Study Groups

The parity of the study groups (experimental and control) was tested on the in-person performance of the achievement test in math, and using (t-test) exam for the independent samples, as it is shown in the following table:

Table (1) The results of the (t-test) exam for revealing the parity of the study two groups in the in-person performance of the achievement test in mathematics

	group	**Num.**	**Average**	**Standard Deviation**	**"T" Value**	**Freedom Degrees**	**Statistical Significance**
In-person performance	experimental	15	10.200	1.971	-1.293	28	.207
	control	15	11.000	1.363			

Table (1) reveals that there is no statistical significance of the average performance of the two groups of the study in the in-person performance. This result confirms the parity of the two groups statistically before processing.

The Study Instrument

The study develops an achievement test for measuring achievement in the panel geometry unit. The test consists of 30 paragraphs as multiple-choice in appendix (1), as the student chooses an option out of 4 as the correct answer.

The following steps and procedures were adopted in preparing the test:

1- Analyzing the content of the unit 4 (panel geometry) of the math textbook of middle 6th graders.

2- Determining the learning outcomes according to the three intellectual levels: knowledge (remembering), understanding and comprehension, and advance mental processes based on Bloom Classifications for the educational goals adopted to measure by the test.

3- Preparing a table of the test descriptions including the levels of the objectives, the percentage of each objective, and the learning outcomes as well as the relative scale of each, and the appendix (2) shows the table.

4- Formulating the test descriptions of the 30 paragraphs as multiple choice of four options, and one of them is the correct answer. The student receives one mark upon choosing the correct option, as the range of marks of this test is between 0-30, and the paragraphs were distributed on 8 paragraphs addressing remembering, 10 paragraphs of understanding and comprehension, and 12 paragraphs for the level of advance mental processes.

The Psychometric Characteristics of the Study Instrument

Face Validity

Significance and content comprehensiveness of the test were investigated by the researcher herself, and test questions, their formulation, and their relevance to the field, as the standards of the face validity were available within it.

The Validity of the Content

The test was given to a group of experienced expert judges in the field of the methodologies of teaching math, which are 10 in Appendix (3), as to achieve its suitability and compatibility to the objectives desired to achieve. The researcher worked on editing the formulation of some paragraphs after considering their opinions and suggestions. As a result, the test turned ready for application on the survey sample to check its psychometric characteristics, as the judges estimated its time for 40 minutes.

Test Reliability

Coder Richardson Equation (KR-20) 20 used to find the internal consistency of test, as it is an approach which adopts the other objectivist tests to check the reliability of test. The factor of reliability 0.86 indicates that the test has high rate of reliability and homogeny between the test and paragraphs.

Factors of Difficulty and Distinction

The factors of difficulty and distinction were calculated on the paragraphs of test, and through analyzing the responses of the individuals of the survey sample using SPSS Program. Table (2) shows the factors of difficulty and distinction for each paragraph of the test paragraphs.

Table (2) Factors of Difficulty & Distinction of the Paragraphs of the Achievement Test

Paragraph number	Distinction Factor	Difficulty Factor	Paragraph Number	Distinction Factor	Difficulty Factor
1	0.10	0.95	16	0.53	0.53
2	0.40	0.47	17	0.33	0.33
3	0.33	0.43	18*	0.07	0.07
4	0.40	0.50	19	0.47	0.47
5	0.07	0.30	20	0.33	0.33
6	0.11	0.18	21	0.47	0.47
7	0.40	0.33	22	0.47	0.47
8	0.35	0.53	23	0.33	0.33
9	0.33	0.50	24	0.47	0.47
10	0.13	0.33	25	0.53	0.53
11	0.40	0.47	26	0.40	0.40
12	0.33	0.30	27	0.14	0.14
13	0.47	0.63	28	0.09	13
14	0.33	0.37	29	0.40	14
15	0.40	0.47	30	0.14	15

Table (2) shows that the factors of distinction ranged between -0.07 and 0.53, and that factors of difficulty ranged between 0.10 and 0.63. According to what Oda (2014), the paragraph is considered useful to keep if the factor of distinction is 0.30 and is considered weak and to be removed if the factor of distinction is below 0.30. Oda also emphasizes

that the accepted range for the paragraph difficulty between 0.20-0.80, and the following removed paragraphs were: 1, 6, 27, 28, 30, so the test is formed in its final form with 25 paragraphs in Appendix (4). The researcher found that the time estimated by the judges was suitable and unnecessary to change.

Correcting the Test

The test was corrected after preparing the key answers by giving a mark for each paragraph, as the total marks of test are 25.

The Learning Scientific Material

The fourth unit (geometry) of the 6th grade textbook was chosen (the first part) for the experimental processing. The teacher guide was prepared to help the teacher to teach the included subjects of the unit using Scratch Software. To prepare the guide, the researcher following the next steps:

1. Reviewing the previous educational literature in identifying the most suitable method in building the teacher guide (the educational program) and going over some studies using Scratch Software in teaching different subjects.

2. Determining the general objectives for teaching the unit of geometry, and the special objectives for each lesson of the unit, adopting the teacher guide published by the Kuwaiti Ministry of higher education. The unit included the following lessons: measurement, classification, and drawing angles. Straight lines, adjacent angles, and neighboring angles, triangles classifications, drawing a triangle with its sides, total measurement of the triangle, polygons, total measurements of the quadrilateral angles, classification quadrilateral shapes, transformational geometry, line of symmetry, and drawing a circle.

The Validity of the Educational Program

The program has been represented to a group of expert judges in the curricula of mathematics and its styles of teaching by faculty members at several Jordanian and Kuwaiti universities, and by educational supervisors, programming experts, as well as 9 math teachers, to ensure the suitability and compatibility of the program to the objectives desired to achieve. According to all reviews made by all of them, some editing was made, and as a result, the program turned ready to application.

Independent Variables

The study included the following variables:

- The strategy of teaching has two components:

• Scratch Software

• The Standard Method

Dependent Variable

- The achievement in mathematics

The Statistical Processing:

To answer the question of the study and test its hypothesis, the mathematical averages for the performance of the female students of the two groups of the study, and while using One-way Ancova.

The Study Procedures

Achieving the objective of the study, the procedures have been conducted as follows:

• Preparing the scientific achievement test in its preliminary form and confirm its credibility.

- Adopting the official approvals according to the standards of the application of the study instrument
- Choosing the school in which the study was conducted, and choose two sections of the 6th-grade female students in middle school, and divide them randomly into two groups: experimental and control.
- Applying the instruments on a survey sample to confirm the credibility of the instruments and the scale of compatibility of the suggested time by the arbitrators, as the researcher found the suggested time suitable.
- Applying in-person test on both groups (experimental and control) to ensure their equivalence
- Applying the educational program according to the Scratch Software on the experimental group, and teach the control group through the standard method by the teacher herself.
- Applying the remote achievement test on the two groups after finishing the relevant unit for students
- Correcting test and assess grades, and then analyze the data statistically using SPSS

Study Results

This section includes results reached by the study within its main objective in identifying the effect of teaching mathematics using Scratch for the achievement of the sixth graders in Kuwait State comparing to the standard methodology. This objective is achieved after applying the study procedures, collecting data, and using the required statistical analysis. This is indicated within the main question of the study:

The study question: Are there evident statistical differences between the grades' averages of the experimental group and the control group in the remote application of the achievement test of math that can attributed to the teaching methodology whether using Scratch or the standard method?

Answering this question, the mathematical averages and standard deviations were extracted for the performance of the participants of the study in math according to the variable of the strategy of the study (Scratch Software, the standard method), as shown in the table (4).

Table (3) reveals that there is evident difference between the averages of the performance of the remotely experimental and control groups in the mathematical achievement in favor of the experimental group.

Table (3) Mathematical Averages and Standard Deviations of the In-person & Remote Performance of the Participants of the Study on the Mathematical Achievement according to the Variable of the Teaching Strategy.

Teaching Methodology	Number	In-person Measurement		Remote Measurement	
		Average	Standard Deviation	Average	Standard Deviation
Scratch Software	15	10.200	1.971	20.600	3.112
Standard Method	15	11.000	1.363	14.667	1.877
Total	**30**	**10.600**	**1.714**	**17.633**	**3.935**

To achieve the statistical evidence of the apparent difference in the performance of the participants of the remote study in the mathematical achievement after controlling the

effect of the in-person performance according to the teaching strategy, One-way Ancova was conducted, as shown in table (3).

Table (4) reveals that there is evidential difference statistically between the averages of the experimental and control groups attributed to the strategy of teaching. The value of squared Eta (.556) indicates that the strategy of teaching explains %56.6 of the performance variation of the math test, which reveals that there is evidential effect statistically of the variable of the teaching strategy in improving the achievement of math among 6th-grade students.

Table (4) Results of the Analysis of the Unilateral Variation of the Statistical Significance of the Apparent Difference in the Remote Performance of the Participants of the Study in Mathematics after Controlling the Effect of the In-person Performance according to the Teaching Strategy

Variation Recourse	Sum of Squares	Degrees of Freedom	Average of Sum of Squares	F Value	Significance Level	Eta η^2 Square
In-Person Measurement	16.844	1	16.844	2.706	.112	.091
Teaching Method	219.354	1	219.354	35.235	.000	.566
Mistake	168.090	27	6.226			
Total	9777.000	30				
Total Average	**448.967**	**29**				

Table (5) shows a comparison between the averages between the performance of the experimental and control groups in math according to the two mathematical averages, the standard deviation, and the standard mistake of the remote performance based on the teaching strategy before and after controlling the in-person performance differences.

Table (5) The Two Modified Mathematical Averages, the Standard Deviation, and the Standard Mistake of the Remote Performance according to the Teaching Strategy before & after Controlling the In-person Differences

The Group	**After Modification**		**Before Modification**	
	Average	**Mistake Deviation**	**Average**	**Standard Deviation**
Scratch Software	20.417	.654	20.600	3.112
Standard Method	14.850	.654	14.667	1.877

The results in table (5) indicate that the differences were in favor of the participants who studied the material through using Scratch Software comparing to the students who adopted the standard method. According to the One-way Anvoca, the educational program (Scratch) has an evidential effect statistically in enhancing the performance of the experimental group.

Accordingly, the Zero Theory is rejected, which states that: “there is no statistical evidence for the difference between the grades averages of the experimental and control groups in the remote application of the achievement test in mathematics as to be attributed to the teaching methodology (Scratch or the standard method). Therefore, the study adopts the alternative theory, which states that: “there is statistical evidence for the difference between the averages of the grades of the experimental and control groups in the remote application of the achievement test in math as to be attributed to the effect of the teaching methodology (Scratch or the standard method).

Discussion of Results and Recommendations

This chapter addresses the discussion of the results of study theoretically and in the light of previous studies. It also includes a collection of recommendations suggested based on the results of the study, and what follows discusses the study main question.

Discussion of the study main question: is there significant difference statistically between the grades' averages of the experimental and control groups in remote application of the achievement test in mathematics as to be attributed to the teaching methodology (Scratch Software or the standard method).

The study results show that there is significant difference statistically of the teaching method in the achievement of mathematics in favor of the experimental group. These results are due to the fact that Scratch does not limit itself in its education role in the recalling and recovering information, but it can rather encourage students on having conversation, writing, and linking what is learned with their prior experiences, and apply such skills in their daily lives. The programming uses Scratch which enables students to implement ideas, organize them logically and chronologically. Scratch also works on providing an interactive environment that triggers the motivation of the students for learning, and their desire in constant learning, and thus, reaching a high achievement.

Also, this result is attributed to the fact that using Scratch requires students to employ their five senses in the educational learning process, which has an intelligible positive effect on increasing attention, recognition, and conscious understanding of mathematics. As a result, this effect reflects on overall consciousness, achievement, and interaction with the educational material and lesson applied through Scratch.

This result reveals that using Scratch allows interactive participation of the students and exchange of opinions constructively through gaining the benefit of the abilities of the one group. The implementation of these abilities leads to their unity overall, so the one group can receive benefit out of it. Students tend to learn with much more than their peers who are taught in the traditional method. In addition, the nature of Scratch Software and its procedures constitute a reason for the motivation of the students in the subject of math, as it enforces upon each student to learn and use several skills such as listening, reading, observing, and creating ideas and discussions, which are poorly implemented in the traditional method (J Correa, Moreno-León & Calao, 2015).

Also, the digital revolution demands individuals to have the ability to constant self-learning, which is not triggered unless the individual is pushed with inner motivation enforced by the technological educational environment as it encourages one to constant learning. Scratch is considered one of the learning methods by which the individual is able to employ learning skills with high interaction, and therefore, contributing to one's growth behaviorally, intellectually, and psychologically and can support the process of comprehending the elements of the fourth industrial revolution (Lin, Chen, & Nien, 2014).

The result of the study agrees with Calao's and others (Calao et al., 2015), which concluded that using the software on the chapters of the math subject may enhance its teaching process in several subjects: (a) the operation of mathematical modeling, (b) thinking, (c) identifying & solving problems, (d) comparison, execution of procedures, and algorithms. Erol & Çırak (2021) found that the activities of designing games using Scratch enhanced problem-solving skills among participants.

Calder's study (2019) emphasizes the role of Scratch in developing problem-solving skill and building educational programs for 6th-grade students through their designing of some mathematical and geometric programs.

In return, the results of the current study does not agree with results of Ali & Saltan's (2015) which showed that there was no significantly statistical differences between the

control group and the experimental group in terms of the development of algorithmic-skills as well as mathematical problem-solving skills attributed to the role of using Scratch.

Recommendations and Suggestions

According to the results of this research, the main recommendation is provided as follows:

- Employing the use of Scratch in teaching math subject, as it has interactive effect on increasing the achievement.

While the suggestions of this research include the following:

- Implementing Scratch Software within the preparation programs of mathematics in the educational institutions, so the students are able to master its steps and application in the learning process.

- Conducting training courses for math teachers and explaining the mechanism of operating Scratch, so they can execute the modern teaching methods inside the classroom according to the proper steps. The ministry of higher education should encourage the conduct of such courses for the teachers to elevate their knowledge of the modern methods, strategies, and programs in teaching.

- Conducting more researches and studies on the interaction of Scratch Software upon the different learning stages and students from both sexes, and in different educational subjects compatible with the national and international standards. The results can be generalized to other educational stages and different age levels through encouraging researchers to conduct more studies on this issue.

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