The reality of employing the mathematics lab and its relationship to developing geometrical proof skills among high school students

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Gehan Ahmed Alshafey , Sara Saad Aldosary

1- Associate Professor of curriculum dept College of Science & Humanities-Jubail, Imam Abdulrahman bin Faisal University, KSA
2- Master researcher of curriculum and Teaching Methods , College of Science & Humanities-Jubail, Imam Abdulrahman bin Faisal University, KSA

Correspondence: Gehan Ahmed Alshafey, College of Science & Humanities-Jubail, Imam Abdulrahman bin Faisal University, Dammam, KSA,. Tel: +966-54-745-8918 E-mail:gamohamed@iau.edu.sa

Abstract:

The study aimed to reveal the reality of employing the mathematics laboratory and its relation to the development of geometrical proof skills among high school students. Descriptive and semi-experimental methods were used to answer the research questions, and the study conducted a questionnaire administered to the secondary school teachers aimed at revealing the reality of employing the mathematics laboratory from their point of view and a list of geometrical proof skills necessary for high school students. A random sample was selected and represented by the research community that includes female teachers and female students in the secondary stage in Jubail city. The research sample consisted of (12 teachers and 58 students) divided into two groups, the first group included 28 students who studied geometrical proof by employing the mathematics laboratory, and the second group included 29 students who studied geometrical proof without employing the mathematics lab. The results showed that the reality of employing the mathematics laboratory from the point of view of the secondary school teachers in Jubail city was generally moderate, as there are statistically significant differences at the level of (0.01) of the means of scores between the first group and the second group in the skill of inferring relationships and the skill of the evaluation of proof due to the employment of the mathematics laboratory.

Keywords: Mathematics Lab, Geometrical Proof, Secondary School.

1. Introduction

In the current time there is a great scientific progress in all fields, and with the development of technology expanded knowledge where its multiplicity and diversity forms and became easy to obtain, and no longer human need to emphasize that one of the most prominent features of this era is the scientific acceleration and that the age of technology and information has become a real and tangible reality, so the best way to keep up with this scientific development is education and its curricula, which make it imperative for specialists in this field to develop their methods and look for new methods. That enhances the students' motivation of studying and achievements and develops their higher thinking skills. (Abdul Latif, 2010)

Mathematics, as one of the fields of knowledge, has a major and effective role in the scientific progress of civilization throughout the ages, where the progress of most other sciences depends on mathematics, especially in the era of the complex technological explosion that has become the language of the era in which we live. (Abu Soria, 2016). Nafez (2017) noted that mathematics was and still the major of science and is worthwhile because it is a major part of thinking and constitutes an aspect of our culture and has gained the confidence and certainty

of most scientists for its accuracy and firmness. Mathematics is one of the basic subjects that must be acquired its concepts and skills, because of its importance and ability to develop different thinking skills, so it became necessary for education to work to raise the level of responsibility of the learner to achieve better mathematical education and create a generation of thinkers and producers to be able to meet the demands of the future efficiently. (Al-Kubaisi & Abdullah, 2018)

The study of al-Assi (2018) and Al-Magamsi (2016) agreed on the importance of mathematics as one of the main pillars of the curriculum and is an important element in the preparation of the individual for life. (Al-Ghamdi, 2018) indicated that the progress of nations is no longer measured to the extent that education in both mathematics and science has been measured. Kingdom Saudi Arabia is clearly interested in teaching mathematics with the guidance of the High Honorable No. M/7544B and the date of 22/10/1427 H 13/10/2016 that the Ministry of Education implements the project of developing mathematics curricula in cooperation with a global publisher specializing in the production of educational materials (Ministry of Education, 2012).

The Ministry of Education, supported by the Government of the Kingdom of Saudi Arabia, adopted a decision to develop mathematics curricula and teaching methods. The Ministry of Education has also made great efforts in implementing this decision by preparing a project to develop mathematics curricula with the participation of specialized international companies with great experience in education. Al-Hamidi (2007) points out that the mathematics development project includes three dimensions: building curricula developed in mathematics according to international standards, professional development of ministry and teacher officials, as well as supporting teaching and learning processes and addressing the measures that have been made to ensure the quality of the development of educational materials.

1.1 Problem of the Study:

The National Council of American Teachers of Mathematics (NCTM) (2000) issued a document of principles and standards for school mathematics containing six principles and ten criteria, five standards for content and the other for processes. It identified what the student expects to learn from mathematics at different levels of study. Geometry was one of the standards of content and the problem solving and proof was two standards of operations, which confirm that one of the most important objectives of learning mathematics is to develop the ability of problem solving and geometrical skills proof to help them to face problems in life. (Ghariba, 2010) (Abu Soria, 2016:2)

The National Council of Teachers of Mathematics (NCTM) (2000) also assured that modern contemporary trends in mathematics education and learning are achieving the standards of processes that are considered to be one of the basic requirements for mathematics education. recent studies also focused on the study of mathematics standards and stressed the need for their availability in the curriculum, including the study of Al-Assi (2018), Tamimi (2017) and of Al-Obaidan (2014). Adnan (2015) and Issawi (2009) emphasize that the educational stages are mainly aimed at acquiring and developing thinking skills, especially logical thinking, which is the kind of thinking that mathematics is suitable for developing, due to its special nature and skills of geometrical proof at different levels.

Also Fawzi (2018) stated that despite the great progress reached by specialists in the field of mathematics curriculum development, there are still many difficulties facing teachers, such as choosing the appropriate methods and strategies to learn mathematical and geometrical skills, low levels of the student in those skills and the inability to translate these skills and use them in scientific life, which is contrary to the main objectives of learning mathematics.

The research in the appropriate teaching methods of the subjects, has occupied the mind of educators, especially after the experiments and research proved that the traditional method is no longer suitable for such an advanced age, and mathematics like the rest of the subjects has appropriate teaching methods and its four functions (calculation, geometry, algebra, mathematical analysis). Various methods are suitable for one branch

or subject without the other, but some of those methods have become necessary of mathematical culture especially in this era, which helps to develop the ability to think mathematically, drafting assignments, collecting data and presenting discussions supporting .(Abu Zeina and Ababna 2007) So Hamada (2013) emphasized that the development of thinking skills of different types is a major goal for teaching mathematics at all educational levels, and educators seek to employ laboratories, programs and strategies to develop thinking among learners.

Mathematical proof is one of the manifestations of the higher levels of thinking in mathematics learning (Al-Saadi, 2000). It is a pattern of logical thinking that deals with establishing the validity of theories and results, and solving the geometric problems, a series of mental activities and logically sequential actions carried out by the learner. Hamada (2013). According to Habib (2012), the evidence depends on the types and forms of knowledge employed by the learner in situations that lead to the conclusion of new relationships that help the learner to have logical proofs that can be verified. Many studies have been conducted on the development of geometrical proof skills, including The Study of Shorouk Ibrahim (2018), Faiza Ahmed (2013), Abu Hashim (2012), Al-Tawil (2011), Ghariba (2010), Shoihi (2009), and Maher Saleh (2008)

Al-Saadi (2000) stated that math teachers for the higher grades play an important role in helping students develop thinking, as well as students need to know the proof. It also indicated that the student finds it difficult to study geometry and is unable to solve their exercises, which may be due to the method used during teaching. Khalafallah (2013), which dealt with general geometrical education and analysis, indicated that there are difficulties in students' understanding of the nature of geometry, and that laboratory teaching is one of the teaching strategies that has proved successful in teaching mathematics. Also Abu Soria (2016) emphasized that mathematics contains the most abstract subjects and it is important to provide mathematical content using educational techniques, models and examples and link it to daily life in an educational learning environment that achieves the student's positive interaction with the content provided and works to establish mathematical concepts in their minds then enable them to practically apply new skills.

Al-Khdidi (2015) stated that the math lab is an appropriate educational method that helps to develop different thinking skills and helps to reach a lot of goals where laboratory activities can help in learning, remembering, understanding facts and applying skills. Al-Ethawi and Al-Khdidi also added that laboratory teaching is based on self-assistance and is called upon by modern learning theories in an educational basis represented by experimental educational studies that have proved successful in achieving the desired goals, which made the laboratory method a major among the different methods of teaching mathematics.

The laboratory method is one of the modern strategies for teaching mathematics, transforming the role of the teacher from an active speaker to a facilitator and mentor of the teaching and learning process, and this is what modern education seeks. Minara (2016). Salama stated (2005) that teaching mathematics today requires a positive interaction from the learner in the educational situation. The student must work and discuss his teacher and colleagues and address mathematical concepts with modeling and realism.

There are several recent studies that have used the laboratory method in mathematics teaching, including Gaodat Saada (2016), Abu Soria (2016), Al-Maghamsi (2016), Al-Khadidi (2015), Al-Ethawi (2014), Abdul Razzaq (2013), Khalafullah (2013) and Tressa (2011). It was also recommended by the Al-Ethawi (2014) and Abu Soria (2016) to appropriately establish mathematics laboratories at all levels of education to improve the mathematical thinking of student, develop various mathematical skills and link mathematics to the student's daily life.

Despite this progress and recent studies, mathematics still faces many problems, most notably the low level of learners for the basic skills needed to learn mathematics.

It was found through the previous studies that there is a lack of skills of mathematical proof in general and geometrical proof skills where the problem of research was determined in the presence of a decrease in the level of performance of geometrical proof skills, which leads to the failure of the student in the order of ideas, leading to the lack of clarity of the idea of proof. Thus, the student fails to plan the proof as well as reach its idea, and

may be due to the teacher's use of traditional methods and strategies and the lack of the provision of the appropriate educational environment and geometrical tools. Therefore, the current study seeks to explore the reality of the employment of the mathematics laboratory and its relation to the development of geometrical proof skills in high school students.

1.2 Literature Review:

The review of literature includes a coverage of the research terms: the mathematics laboratory (its concept, its components and objectives, and the role of both the teacher and the learner during it), geometrical proof skills (its components and importance), and previous studies that dealt with the two concepts (the laboratory mathematics and geometrical proof skills).

1.2.1 Mathematics Lab:

Many definitions of the mathematics laboratory appeared, some specialists identified it as the place where a student studied mathematics, and there are those who knew it according to its different functions of the quality of the work within it, including: The definition of Bran, (1997:252) where the mathematics lab was known as "a special room containing manuals, computers, games and commercial books required to promote the development of perception in mathematics, and used by teachers in many ways; some teachers use it to teach a particular lesson or to complete a particular perception, and the laboratory has also been the site of a number of professional development programs" Al-Shebl, Mohammed, (1991:53) described it as "a place with hand tools and other equipment used by the student to experiment, search for mathematical concepts and reveal mathematical relationships, and the place may be the same classroom or a private room, depending on the conditions of the laboratory work practiced by the student." Afana et al., (2012), Khalafallah, (2013), and Al-Khdidi (2014) defined it as an environment in which students learn mathematics by recognizing concepts, discovering principles or applying mathematical abstractions in practical situations, by representing them with mathematical models, or practical activities such as games so that the student formulates abstract concepts and principles, and applies them by practical dealing with the concrete examples. Nabulsia, (2018:12) defined it as "a special room in the school dedicated and equipped to teach mathematics contains a computer, a display, models, measuring tools, educational tools, and office and geometrical tools so as to practice mathematics activities and develop geometrical skills and a tendency towards mathematics."

The genesis and development of the mathematics laboratory:

The idea of employing the mathematics lab belongs to the works of Piaget, Dinz, and Brunner, each of whom presented a modern theory of learning that differed from the theories that prevailed in educational psychology in the first half of the 20th century (Rehan, 2000). The mathematics laboratory is not new in mathematics education, so the follower of the genesis and development of the mathematics laboratory finds that some educators have used the mathematics laboratory since the nineteenth century. This is confirmed by Maddah about the statements of (Krulik & Wiese): “the beginning of the use of the mathematics laboratory in teaching was at the beginning of this century. Moor referred to it in his book on mathematics in America (1998). Some educators used the mathematics laboratory in individual teaching, which was then considered the best method of learning. The math lab could be used in the individual teaching process for the purpose of achieving individual and group teaching, as it allows flexibility for the student to use the lab individually or in small groups. (Maddah, 2001)

Nabulsia, (2018) added that the mathematics laboratory has evolved clearly and significantly over time, as it has accompanied the progress and great development achieved in various fields of education and technology, and its concept became broader than being a special room for the teaching of mathematics.

Mathematics lab forms:

There are three forms of mathematics lab referred to by Al-Sayed Qassim, (2006) and Al-Khdidi (2014:74), including:

The mathematics lab in the classroom: It is done in the regular classroom, where furniture is arranged in the class so that the student can work in groups using the educational techniques necessary for laboratory activities and tools, and they are kept in a corner of the same class.

The mathematics lab in a private room: It is done in a specialized room for mathematics and especially mathematics teachers where it includes various departments such as; department for conducting laboratory activities, a department for educational techniques, a department for the lab library and a section for computers and the Internet.
Portable Mathematics Laboratory: In this type the educational tools and techniques needed to conduct laboratory activities are equipped in a bag, so that the teacher can move them in the classes.

The mathematics lab components:

Bell, (1986) referred to some components of the mathematics lab and mentioned audio-visual aids, geometrical models, graphics, geometrical tools and various measuring tools, as well as mathematical games, laptops, various computers, curving devices and conical pieces.

Afana et al., (2012) added that the components of the appropriate mathematics lab are; publications, devices, educational tools, geometrical tools, mathematical games, and laboratory activities and include data collection, experimentation and the work of different forms and different models.

Objectives of Mathematics lab employment:

The employment of the mathematics laboratory contributes to the teaching of many subjects of mathematics and to the achievement of many important educational objectives, including:
Bell, (1986), Sidra, (1999), Al-Sadiq, (2001:222), and Al-Kasbani, (2008).

- Learn and remember facts, apply skills, understand concepts, analyze and install principles.
- Achieving educational emotional goals such as developing tendencies and willingness to respond to mathematical activities, and preferring values in the study of mathematics.
- Enable students to discover mathematical principles and develop skills to find mathematical patterns that can lead them to generalizations of mathematical issues and problems.
- Provide the student with exciting problems where the student pushes to solve them, and create a comfortable and stimulating learning environment so that the student can learn according to the speed of their learning and help them take responsibility for their learning.
- Help the student gain direct sensory experiences
- Training and development of some mathematical thinking skills.

The role of the teacher in the laboratory:

The role of the teacher in employing the mathematics lab is to: (Al-Jubouri, 2010)

- Do good planning for the lab lesson.
- Prepare the lab by arranging the seats and ensuring ventilation and lighting.
- Encourage and motivate students to research, learn, participate in model building, and ask questions to raise their thinking skills.
- Identify strengths in order to enhance them, and weaknesses to address them and try to overcome them in various ways.

The role of the learner in the laboratory style:

The role of the learner is to employ the laboratory by actively participating in the implementation of various types of laboratory activities, and interacting with laboratory educational tools and means. (Al-Jubouri, 2010)

1.2.2 Geometrical Proof Skills:

Mathematic Proof:

Mathematical proof and its geometrical applications are an essential goal of teaching mathematics at all educational stages, which is a symbolic and verbal treatment consisting of a sequence of phrases that derive from those that precede them based on the assumptions, theories, data and definitions recognized for their validity and the development of styles according to logic (Obeid, Al-Mufti, and Eliah 2000)

Afana (2001:7-8) and Hassan (2003: 22), defined it as " structured construction based on logical foundations to reach a specific conclusion or several specific conclusions, where this structured construction begins with logical introductions linked to specific relationships to reach a certain result or required results, and these constructions consist of an geometrical sentence with acceptable rationales (definition, data, assumption... etc).

Ghariba (2010), pointed out that it is possible to separate the geometrical proof and the mathematical proof, as the geometrical proof is a kind of mathematical proof, and also mentioned that the proof if in the subject of geometrical is called geometrical proof. Geometrical proof skills may distinguish from the algebraic mathematical proof. The proof in its general capacity is the discussion, analysis and presentation of evidence that convinces a person of a particular issue (Bell, 1987), and mathematical proof and its applications in geometrical as a skill of several sub-skills where skills in its mathematical framework include mathematical methods and algorithms including mental processes of all levels (Al-Dufiri, 2010: 26)

Ibrahim (1997:77), defines the skill in mathematics and geometry as "a set of procedures that the student undertakes, whether by manual, procedural or mental, such as understanding concepts, and solving problems that is done with a great degree of mastery and at the fastest time and less effort.

What are the skills of geometrical proof?

It has several definitions such as; Al-Riachi & Baz, (2000:83), as "the ability of the student to understand the elements of the problem or the situation and the relationships between those elements to understand the relationship between the data and what is required, and to translate the words into symbols so that it eventually reaches a plan to solve the geometrical problem that he faces, and then he implements it to reach a solution to it, and confirms the accuracy of the solution and its suitability". Ahmed (2005:25) defined it as "mental procedures - mental activities – mathematics carried out by the student when faced with a mathematical situation requires to prove the validity of a mathematical issue, from thinking about the proof to verifying the validity of its steps after registering it in writing or seeking another or more proof of the same issue in question". Hilal (2007:155) sees it as "the ability to perform the stages and processes involved in the mathematical proof with accuracy, speed and mastery, and grow these skills with the training and practice to which the student is exposed."

Components of geometrical proof skills:

There were several previous literatures and studies that classified geometrical proof skills, including:

Al-Karsh (1999), Hafiz (2006), and Refaat (2008) classified geometrical proof skills to four skills, namely the planning skill of geometrical proof, the skill of formulatinggeometrical proof, the skill of formulating geometrical proof and the skill of evaluating geometrical proof.

Metwally (1995), identified them in five key skills:

- Analysis skill: Includes drawing and translating the issue, identifying the data and what is required and distinguishing between them.

- Relationship inference skill: Includes deriving results from the given and deriving new results with justification.
- Skills to reach the general idea of a solution: include neutralizing the relationships between the given and the required and linking them to reach the result.
- The skill of the solution in more ways and methods: it means the use of more than one verse of different methods of proof to reach the solution.
- Solution review skill: It includes evaluating the steps followed and detecting error if any.

Shoihe (2009), identified it as the skill of determining the given and what is required, the skill of drawing the matter, the skill of determining the generalizations necessary for the solution and the skill of proof. They are summarized as follows: Data +required + drawing + generalizations needed for solution + proof →complete resolution of the issue.

The importance of geometrical proof:

Ahmed (2005), Metwally (2006), Saleh (2008), Shoihi (2009), Ibrahim (2010) and Habib (2012) indicate that the importance of geometrical proof is:

- Help the student to know and understand several ways when installing and forming geometrical activities solutions.
- Help the student to form a new knowledge structure by reworking some of the previous experiences during the proof by rearranging ideas that may represent new learning experiences.
- It increases the understanding of formulas and remembers relationships by rearranging them in a way that facilitates and benefits the solution.
- The different methods and styles of proof help the student solve some of life problems by accustoming it to careful thinking, experience, careful observation and trying.

1.2.3 Previous Studies:

1.2.3A- Studies and research on the laboratory method of teaching mathematics:

Al-Saadi (1995), Samaan (1995), Todri (1998), Maddah (2001), Al-Khdidi (2003), Al-Hayali (2004) and Abu Soria (2016) indicated the importance of the mathematics laboratory in the development of mathematical concepts, achievement and the attitudes towards some mathematics and the survival of the effect of its learning in the student. In addition, studies referred the importance of the mathematics in helping the student to overcome the difficulties of learning, recommended the establishment of laboratories equipped to teach mathematics and train teachers to use the laboratory method in the teaching of mathematics. Khalafallah (2013), Al-Ethawi (2014), Suleiman (2015), and The Maghamsi (2016) aimed to reveal the effectiveness of employing the mathematics lab in the development of geometrical thinking skills, and achievement and mathematical thinking in both the primary and secondary school student. The results of the study showed that there are statistically significant differences at the level of ($\alpha \leq 0.05$) between the means of scores of female students of the experimental group and the control group in the pre-test of geometrical thinking and the pre-test of achievement in favor of the experimental group. The study recommended to add the math lab to the courses of teaching methods, where it provides enjoyment, participation and teamwork to the math lab within the lesson. While the study of Abdul Razek (2013) aimed to identify the impact of the use of the mathematics laboratory in recognizing the geometrical concepts of slow learners. The results showed the superiority of the experimental group over the control group, and the impact of the use of the laboratory on the perception of the geometrical concepts of the slow learners.

1.2.3B- Studies and research on geometrical proof and skills:

The studies were divided into two directions: the first emphasizes the importance of geometrical proof in the development of thinking skills in general and mathematical thinking in particular, such as Al-Saadi (2000), and Al-Dufiri (2010). The second phase of the studies emphasized the use of modern teaching methods in the development

of geometrical proof skills such as active learning, and problem solving input and software. Studies have emphasized the need to overcome the difficulties faced by students in practicing geometrical proof skills using such modern methods, such as Afana (2001), Saleh (2008), Shoihe (2009), Gharibi (2010), Al-Ali (2010), Al-Taweel (2011), Habib (2012), Hamada (2013), and Ibrahim (2018).

3.1 Questions of the Study:

The study answers the following main question:

What is the reality of employing the mathematics lab and its relation to the development of geometrical proof skills among high school students?

The following questions are derived from the main question:

- What is the reality of employing the math lab from the point of view of high school teachers?
- What are the necessary geometrical proof skills for a high school student?
- Are there statistically significant differences at the level of significance (0.01) (between the means of scores of the first group) whose teachers employ the mathematics laboratory in teaching (and the means of scores of the second group (whose teachers do not employ the mathematics laboratory in teaching) in the test of mathematical proof skills ?

2. Methodology:

2.1 Design:

The study aimed to reveal the reality of employing the mathematics laboratory and its relations with the development of geometrical proof skills among high school students and to achieve the goal of research, the descriptive method was followed in the theoretical framework and interpretation of the results and answer the first and second questions, and the semi-experimental method in measuring the difference in the scores obtained by the students of the two research groups in the geometrical thinking skills test.

2.2 Society:

The research community included female mathematics teachers and students in high school in Jubail, Saudi Arabia for the academic year 1439-1440 H

2.3 Sample:

The study sample consisted of 12 teachers and 57 students and was randomly selected from female math teachers and high school students in Jubail City. Table (1) shows the research sample and its classifications after excluding a number of incomplete responses.

Table1 (Distribution of study sample)

Sample	N
Teachers 4 Schools	12
First group of students	28
Second group of students	29

2.4 Variables:

The current study includes one independent variable (employing a math lab) and one dependent variable (geometrical proof skills) and the following is the definition of the two variables:

2.4.1 Mathematics Lab:

It is defined procedurally as an educational environment equipped with modern tools, materials and techniques in which the student learns mathematics and realizes mathematical concepts through interaction with the environment.

2.4.2 Geometrical Proof Skills:

The current research adopts a valid definition (2008:148) for geometrical proof that is "a set of overlapping processes may include identifying the idea of a solution, reformulating the data and modifying the data or sometimes modifying what is required, and these processes start from just thinking about the solution and end when this solution is confirmed, and are linked to procedures based on planning, formulateting, drafting and evaluating the geometrical proof."

2.5 Instruments:

The following are the two study tools:

2.5.1 Geometrical proof skills scale: (Appendix[-1])

This scale was prepared with the aim of measuring the level of geometrical thinking skills of high school students in Jubail schools, where literature and previous studies were found and the basic skills and sub-skills of geometrical proof required for the high school student were reached to master the solution of the geometrical proof issues; which is the skill of planning for the proof, the skill of the inferring of relationships, the skill of the formulation of the proof and the skill of evaluating the proof, as described in table number (8), which is mentioned later. The basic skills of a set of sub-skills and behavioral patterns were tested by specialists to ensure their validity and appropriateness to achieve the purpose of the scale. Table (2) shows the specifications of the geometrical proof skills scale.

Table2(Specifications of The Geometrical Proof Skills Scale)

N	Items	Positive phrases	Negative phrases	Total
1	skill of planning proof	3،4 ،1،2،6	5	6
2	The skill of inferring relationships	7،8،13	14	4
3	The skill of formulation proof	9،11،16	18	4
4	skill of evaluating proof	10،12،15	17	4
	Total			18

Face validity of the questionnaire was examined by a number of specialists in the field of curriculum and teaching methods who assured that it was suitable for Saudi Math students. The reliability of the scale was verified after being applied to a pilot sample and measured by the Alpha Cronbach reliability factor, where the value of Alpha Cronbach was (0.701), indicating that the research tool has suitable degree of reliability and can be relied upon in the field of application.

2.5.2 Preparing a questionnaire for female mathematics teachers at the secondary level: (Appendix [2])

In order to reveal the reality of the employment of the mathematics laboratory, the resolution consists of several dimensions, and each includes a set of phrases, as the resolution consists of an open question aimed at knowing the opinions of the teachers about the mathematics laboratory, and was referred

to the study of the Al-Wnous (2017) and then took advantage of its tools. Then, it was presented to a group of arbitrators to ensure that it is suitable for the purpose of research and the credibility of the external survey. Table 3 shows the internal consistency of Pearson correlation transactions between each dimension of the survey and the survey as a whole.

Table 3(Correlations between dimensions and total)

N	Dimensions	Pearson correlation
1	• Employment of mathematics laboratory	*0.791
2	• Using the components of the math lab.	*0.233
3	• Math lab effect	*0.379
4	• Math lab obstructions	**0.876

As for the reliability of the survey, it was verified by the Alpha Cronbach reliability factor, where the value of Alpha Cronbach was (0.641), indicating that the research tool has an acceptable degree of reliability and can be relied upon in field of application. Table 4 shows the specifications of the survey:

Table 4(Specifications of the Survey of Mathematics Teachers in the Reality of Employment of the Mathematics Lab)

N	Dimensions	Positive phrases	Negative phrases	Total
1	• Employment of mathematics laboratory	1،2،8	16	4
2	• using the components of the math lab.	6،10،11،13،19	9،14،15	8
3	• Math Lab Effect	12،5 ،3،4،7		5
4	• Math Lab Obstructions	18	17،20	3
	Total			20

2.6 Procedures:

The study tools were applied to the sample during the second semester of the 2018/19 academic year, and then the data was collected, monitored and processed using the Statistical Packages for Social Sciences program (SPSS) where frequency and percentages were used to describe study sample scores, means and standard deviations to answer the second question. The research used "t" test to find the differences between the means of scores of the first group (for which the mathematics laboratory is employed in teaching) and the second group students (which do not study mathematics using the mathematics laboratory) in the measure of geometrical proof skills, in addition to the use of mathematical means of scores of teachers in the survey on the reality of employing the mathematics laboratory in teaching. The length of the category has been determined in the light of the following equation:

Interval Width= range divided by the number of intervals.
The term = the largest value for alternative intervals - the smallest value for alternative intervals = 3-1 =2
So, Interval Width 3/2 = 0.76 .show table (5)

Table 5(The criteria of judging the level of the value of the mean calculated for the survey.)

Criteria of judging	Means	
	From	To
Low	1	1.66
moderate	1.67	2.33

high	2.34	3

3. Results &Discussion:

Following is a view of the search results in light of his questions:

3.1 Answer to the first question: which stated:

"What is the reality of employing a math lab from the point of view of high school teachers?"

To answer this question, the arithmetic averages and standard deviations of the four-dimensions paragraphs and the total degree of the dimension were calculated, as shown in Table (6).

Table 6 (Results of the mathematics teachers' survey for the secondary level on the reality of employing the mathematics lab)

N	Dimensions	Mean	SD	Degree
1	Degree of Employment of mathematics laboratory	2.10	0.38	Moderate
2	Degree of using the components of the math lab.	1.64	0.18	High
3	Degree of Math Lab Effect	1.03	0.12	High
4	Degree of Math Lab Obstructions	2.50	0.36	Low
5	Total degree of the survey	1.81	1.48	Moderate

It is clear from table (6) that the reality of employing the laboratory from the point of view of the secondary school teachers in Jubail city has generally come with a medium and an average calculation of (1.81). It is may be due to the lack of availability of mathematics laboratories in secondary schools and therefore the lack of awareness of the secondary school teachers on how to employ the math laboratory or they may have no motive to provide the tools of the laboratory despite its absence, and therefore did not use them which led to the difficulty of using the devices and tools that are supposed to be available inside the lab.

It is also clear from table (6) that the average responses of female teachers expressing the degree of their utilization of the components of the mathematics laboratory was (1.64). This result indicates that their overall degree of benefit is significantly high. The degree of approval of the impact of the mathematics laboratory was also high and with an average calculation (1.03). It is also clear that the average response of the research sample expressing their employment to the math laboratory was (2.10) and this indicates that the female teachers employ the laboratory to an average degree and this is due to the lack of employing a math laboratory in some schools. It has been noted through the responses of the research sample that the sample supports the presence of mathematics and believes that the laboratory of mathematics has a positive effect in increasing the effectiveness of learning, and helps students to acquire different skills and contribute to improving the educational process. The table shows that the math laboratory's score was very low and with a mathematical average of (2.50), which means that the math laboratory's constraints are very low.

The first dimension points to the degree of employment of the mathematics laboratory, where the degree of teachers' responses was moderate due to some reasons including the lack of availability of mathematics laboratories in Jubail schools and the lack of awareness of the secondary school teachers on how to employ the math lab and achieve the desired results. Teachers agreed on the importance of the math laboratory and its necessity in the school as the teachers of the school where the laboratory was not available recommended the need to establish the laboratory so that it can be employed and to benefit from its components. These results are consistent with the study of Al-Wnous (2017), Al-Maghamsi (2016), and Al-Khdidi (2014). The study of Al-Wnous indicates that the obstacles from the point of view of the teachers are mostly physical, which means the lack of equipment and geometrical tools that enable teachers to employ them in laboratory activities.

The results of the second dimension indicate that the teachers benefit from the components of the mathematics lab to a very high extent if existed. Teachers prefer to explain the models and tools found in the laboratory as the mathematics lab provides the tools and means that the teacher can use in the educational process. The availability of these tools and educational means in one place which is dedicated to the subject of mathematics may help the teacher in employing and using them. In addition, the mathematics lab provides teachers with flexibility of movement, and provides them with the opportunity to innovate in administering practical activities to different female students.

The results of the third dimension also confirmed that the teachers on the positive impact of the math laboratory on both female teachers and female students, and this can be attributed to many reasons including; the mathematics laboratory helps to provide a stimulating and work-friendly learning environment, and is based on improving the teaching practices of the teacher, which means improving the educational process of all female students in particular, and helps female students acquire different skills, such as mathematical thinking skills, mathematical linking and geometrical skills.

This may also be due to the fact that the mathematics lab offers mathematical content with a practical perspective that helps students to visualize abstract ideas and develops imagination and creativity.

These results are consistent with Nabulsia (2018), Abu Soria (2016), Al-Ethawi (2014), and Khalafallah (2013), which indicated that motivation and orientation increases among female students when employing a math laboratory and that the laboratory method provides female students with mathematical knowledge in a more effective way.

From previous, the results indicate the need for a fully equipped mathematics laboratory and the need of the teachers to stimulate and receive moral and material support from the administration so that this contributes to creating a suitable educational environment for female students and promoting positive orientations towards the subject. It is clear that the obstacles of the mathematics lab from the point of view of the teachers were mostly the lack of laboratories, equipment, geometrical tools and models for mathematics. This finding is consistent with the Al-wnous (2017) and Al-Khdidi (2014).

3.2 Answer to the second question: which stated:

"What geometrical proof skills are needed for a high school student?"

This question was answered through the theoretical framework, where the geometrical proof skills required for secondary school students were identified in the light of reference to literature and previous studies, including Habib (2012), Al-Dufiri (2010), and Shoihi (2009).

These skills consisted of basic and sub-skills. The basic skills were divided into four dimensions; (proof planning skills, the skill of inferring relationships, the skill of formulating proof, and the skill of evaluating proof). These skills can be summarized in table (8), which are the most important skills needed by high school students as confirmed by the evaluation of the specialists in the field of education and mathematics.

Table7(Geometrical Proof Skills)

Basic skill		**sub-skills**
1- Planning	·	• Clarify the mathematical issue.
	·	• Accurately identify data.
	·	• Determine the required precisely.
	·	• Translate the verbal image into geometric alchemy
	·	• Develop a plan to resolve the issue.
2-Inferring of relationships.	·	• Come up with the general idea of a solution by linking the given and what is required.

	·	• Choose the right method for the solution.
	·	• Deriving useful conclusions from the data.
	·	• To reach what is required through generalizations, theories, results and formulas.
	·	• Deriving the new result from its previous step.
	·	• Link two previous results to a new result.
3- Formulating	·	• Written expression of his findings.
	·	• Identify the generalizations necessary for the solution.
	·	• Take clear steps to reach what is needed
4- Evaluation	·	• Review each step of proof to verify its authenticity.
	·	• Discover the error in the proof.
	·	• Prove the validity or error of the matter.

3.3 The answer to the third question: which stated:

"Are there statistically significant differences at the level of significance (0.01) between the means of scores of female students in the first group (for which the mathematics laboratory is employed for them during teaching) and the means of scores of the second group (which do not have a mathematics laboratory) in the geometrical proof skills scale?

To answer this question, different dimensional means were calculated. Then, the (t) test was used to measure the differences between the means of the first group and the second group regarding the change in the employment of the mathematics laboratory. The first group of female students were taught geometrical proof through the employment of the mathematics laboratory, and the second group of female students were taught geometrical proof without employing the mathematics laboratory. Table 8 shows means of scores of the two groups, the value of the (t) test, and the value of the level of indication.

Table 8(Means, standard deviations and (t) test differences according to the employment of the mathematics laboratory)

Dimension	**Means**		**(t) value**		
	First group 28=N	o Second group N=29	(t) value	Degree of freedom	Sig.
Proof planning skills	2.319	2.178	1.501	56	0.139
The skill of inferring relationships	2.229	1.919	2.754	56	0.008
The skill of formulating proof	2.152	2.081	0.636	56	0.499
Proof evaluation skill	2.303	2.003	2.683	56	0.010

It is clear from table (9) that the means of scores of the first group's female students was (2.319), while the means of scores of female students in the second group was (2.178) regarding the skill of planning proof. The calculated (t) value between the means was (1.501) and is not significant at the level of (0.01), which means that there are no statistically significant differences between the means of scores of female students in the first group and the second group regarding the skill level of geometrical proof planning.

The means of scores of the first group in the skill of the inferring of relationships was (2.229), while the means of scores of the second group (1.919). The calculated (t) value for the difference between these two means was (2.754) and it is significant at the level of (0.01), which means that there are statistically significant differences

between the means of scores of the first group and the second group regarding the degree of relationship in favor of the first group, which studied geometrical proof by employing the mathematics laboratory.

The means of scores of first group female students was (2.152). The means of scores of female students in the second group was (2.081) in the skill of formulating proof. The calculated (t) value of the difference between these two means was (0.636), which is not significant at the level of (0.01), which means that there are no statistically significant differences between the means of scores of the first group and the second group regarding the skill of formulating the proof.

The means of scores of the first group of female students was (2.303) while the means of scores of female students in the second group was (2.003) regarding the skill of the evaluation of the proof. The calculated (t) value for the difference between these two means was (2.683) and it is significant at the level of (0.01), which means that there are statistically significant differences between the means of scores of the first group studied by employing the mathematics laboratory and the second group in favor of the first group.

Thus, the results indicate that there are statistically significant differences at the level of (0.01) between the means of scores of the first group students and the second group students regarding the skills of inference of relationships and evaluation of proof. These two skills are considered one of the most important skills of geometrical proof, which indicates the student's understanding of the geometrical proof, their ability to discover relationships, draw from the data, and link them to the required. This result may be due to the fact that the employment of the mathematics laboratory allowed the students to understand the concepts of geometry, which helped them to distinguish the given and what is required and to link them to the idea of the desired solution. The employment of the mathematics laboratory helped to simplify and facilitate geometrical concepts, which led to the understanding of the students of these concepts, as may be the reason that the mathematics laboratory contributed to the development of thinking among the students, which in return led to their ability to reach logical analysis in the geometrical proof. The statistical differences in the skill of evaluating the proof may be due to the contribution added by the mathematics laboratory in the development of the mathematical skills of the students, which is the estimating and measurement and ability to identify the error and correct it.

The reason for not having statistically significant differences between the means of scores of female students in the first group and the second group in the planning and proof skills may be due to the fact that these two skills do not depend on the employment of the mathematics laboratory because it is an essential step in solving any issue that the students used to master, regardless of their use of the laboratory, although there are differences between the means of scores of the first group in these skills than their counterparts in the second group. It shows that the employment of the mathematics laboratory contributed to the acquisition of all geometrical proof skills by the students.

These results are consistent with the results of Nabulsia (2018) which showed the high scores of students who are using the mathematics laboratory in geometrical skills testing due to the fact that the employment of the mathematics laboratory helped to learn geometrical skills, and has a positive role in the student's responsibility. Results are also consistent with Suleiman (2015), which indicated that the mathematics laboratory enables the student to build geometrical concepts in a sensual way. Al-Ethawi (2014) pointed out in his results that the mathematics laboratory contributed to the development of higher thinking skills and thinking skills in mathematics.

4. Conclusion:

It turns out that the reality of employing the mathematics laboratory from the point of view of the teachers of the secondary school in Jubail has generally appeared to a moderate degree, due to the lack of a mathematics laboratory in some schools, which weakened the awareness of the teachers on how to employ the math lab and benefit from its tools. Teachers recognized the importance of the components of the math lab and that there is a need to provide it in schools. The teachers' responses agreed on the positive impact of the math laboratory because it contributes to improving teaching practices. The results indicated that the obstacles of the mathematics lab mostly regarding materials as there is a lack of labs, equipment and tools.

There are statistically significant differences at the level of (0.01) between the means of scores of the first group students and the second group students in the skill of inference of relationships and the skill of evaluation of proof due to the employment of the mathematics laboratory.

There are no statistically significant differences at the level of significance (0.01) between the means of scores of the first group students and the second group students in the skill of planning proof and the skill of formulating proof due to the employment of the mathematics laboratory.

4.1 Study recommendations:

In light of the findings, the study recommends:

- The need to establish mathematics laboratories in schools and equip them with educational means for mathematics
- Holding continuous courses and workshops for math teachers to train them on how to employ the math lab and achieve the best results.
- Provide the teacher with instructions on how to perform in-lab lessons.
- Attention to mathematical and geometrical skills, and how to develop them among the student by curriculum specialists, supervisors, educators and teachers.

4.2 Study suggestions:

In the light of the results of the study, a range of research can be suggested that could be an extension of them:

- Conduct further research to identify the effectiveness of the mathematics lab in developing other dependent variables such as mathematical culture and mathematical knowledge.
- Conduct further research to reveal the relationship of the mathematics lab to the development of creative thinking among the students.
- Attention to geometrical proof skills and research that reveal teaching methods that develop these skills.
- Prepare a proposed program to train teachers to employ the math lab in different ways.

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Appendix (1)

The questionnaire provided to the students in its final form to measure their ability to demonstrate geometrical skills

School:
Teacher:
Class:

Dear student, following is a questionnaire aims to measure your geometrical proof skills and your answers will be used for research purposes only, so we hope you answer credibly to achieve the purpose. Thank you for your cooperation.

Please put (√) in front of each of the questionnaire paragraphs according to the best suitable for you:

Low grade	Medium grade	High grade
1	2	3

N	Paragraphs	1	2	3
1	Mathematics develops my thinking skills.			
2	I can turn the matter from verbal to geometric alchemy.			
3	I have the ability to determine the data of the matter.			
4	I can determine exactly what's required of the matter.			
5	I'm having a hard time resolving geometrical proof issues.			
6	I like to deduce the geometric alchemy of the matter.			
7	I have the ability to come up with the idea of a solution from the given.			
8	I'm using the data to get what is required.			
9	I have the ability to formulate engineering proof.			
10	I can detect the error in the steps followed.			
11	Mathematics helps me learn the steps of problem solving.			
12	I have the ability to prove the truth of the solution.			
13	geometrical proof develops my ability to think correctly.			
14	I'm having a hard time in inferring relationships from the issue.			
15	I have the ability to detect the error in the matter.			
16	I'm taking clear steps to get to what's required of the matter			
17	I don't review the geometrical proof after I'm finished solving it.			
18	I find it hard to write mathematical proof in a sequence.			

Appendix (2)

The questionnaire provided to the teachers to identify the reality of the use of mathematics laboratories

Teacher: Class:

Dear teacher, we hope you kindly respond to all the paragraphs of the questionnaire by placing (√) in front of each paragraph, and we inform you and reassure you that the questionnaire will be used only for research purposes and the confidentiality of the information will be maintained,

Thank you for your contribution and cooperation.

N	Paragraphs	Yes	At some point	No
1	I have a fully equipped math lab.			
2	I Make sure that I employ a math lab.			
3	The math lab enhances the student's understanding.			
4	The mathematics lab helps me improve teaching practices.			

5	The math lab stimulates the student to interact.			
6	I Make sure I use geometrical tools in the math lab.			
7	I feel like the math lab is reinforcing the attitude of students towards the subject.			
8	I Make sure I give lessons in the math lab.			
9	I'm having a hard time using the techniques existed in the lab.			
10	I prepare geometrical equipment when explaining geometry.			
11	I have the ability to use the lab.			
12	The math lab helps in developing teamwork.			
13	I'd rather explain by the models in the lab.			
14	I don't benefit from the technology in the lab.			
15	I benefit from the Center for Learning Resources in Mathematics more than the lab.			
16	I think math lab doesn't matter.			
17	Time hinders me from employing a math lab.			
18	I receive support and encouragement from the school administration employing a math lab.			
19	I take advantage of the lab components in the classroom.			
20	I have a difficulty in managing female students in the lab.			

21- Your suggestions for math lab: ----------

22- Your opinion about the math lab: ----------

