

Abstract of the study

Study title	Using Self-Regulated Learning Strategies in Teaching Mathematics for Developing Secondary Stage Students' Geometrical Proof and Mathematical Connections.
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Study problem:

This study aimed at investigating the effect of the use of self-regulated learning strategies for developing secondary stage students' geometrical proof and mathematical connections skills. This study relied on the descriptive approach, was used to survey the previous studies which are related to the study variables and its hypotheses, and help with designing its tools, and then building theoretical framework, and the experimental approach which the sample of the study included two groups, one experimental involved "32" students who studied "Geometric and Measurement" unit, which is introduced to second year secondary school students "scientific section", using the self-regulated learning strategies, and the other is the control group involved "34" students studied the same unit using traditional methods, and the study revealed the development of the geometrical proof, and mathematical connections skills for the study sample, also the students who studied using self-regulated learning strategies, outperformed who studied using traditional methods regarding the aforementioned variables.

Key words:

Self-Regulated Learning Strategies - Teaching Mathematics -geometrical Proof Skills - Mathematical Connections Skills - Secondary Stage.

The summary in English

Introduction:

The purpose of the teaching and learning process is not only to prepare generations provided with knowledge, but also to prepare a generation capable of anticipating the future and adapting to its challenges, train mature human minds and unleash potential mental capacities. This is because the current age witnesses a lot of cognitive innovations in various fields, which requires the development of students' thinking skills in a way that helps them in solving their problems, accepting others' viewpoints, and formulating acceptable habits and trends.

Students in the advanced educational stages (secondary stage and university students) have the aptitude to self-regulate their learning, and they also need training in using self-regulated learning skills and strategies.

Mathematics, in general, is a complex abstract science that has integrated and inter-related branches which help students understand the structure and nature of mathematics, and thus facilitate their understanding of mathematics applications in different fields and in real life. Geometry in particular is the branch of mathematics that helps students to arrange ideas, rather than to memorize and apply them. Geometry may be viewed only as a set of facts and information, but beyond that it is a way of thinking about confronting different problems. Hence, the interest in teaching geometry should not be limited to communicating the facts to the students. Rather, the teaching of geometry

should focus on helping students identify the starting point for solving a problem and arrange facts to reach the required result.

Furthermore, geometry has many applications in practical life such as calculating areas, lengths, and sizes, and reading geographical maps. Geometry also has many applications in other disciplines such as the teaching of fractions and functions of all kinds; this makes it a fertile field area for developing students' ability to understand mathematical relationships.

The problems faced in geometric proof in general weaken students' ability to make a relationship between geometry and the various branches of mathematics, as well as their ability to connect it to other subject matters or even to practical life, making this type of connections is known as mathematical connections (i.e, connecting mathematics to students' real life and environment, other subject matters, as well as connecting different branches of mathematics).

In order to achieve the goal of teaching geometry to contribute to the development of students' ability to solve geometric problems, the practical aspects of geometry teaching should be focused. Hence, there has been a need to link school mathematics to its applications in students' lives in order to make the teaching material more meaningful and valuable.

There is a reliable relationship between mathematics and self-regulated learning as self-regulated learning is based on the learner's use of many cognitive and meta-cognitive strategies that rely on meditation, thinking, and self-observation. This is in line with the requirements for studying mathematics which stems from the learner's ability to develop thinking skills, geometric proof, and problem solving required for learning concepts, generalizations, and mathematical skills.

Learning is more effective when it starts as self-directed. Moreover, it is considered that one of the main objectives of school is to develop individuals able to be autonomous learners, especially in the secondary and tertiary levels. So, self-regulated learning is expected to have significant contributions in overcoming students' problems while studying mathematics in general, and geometry in particular, which will help develop the skills of geometric proof, and mathematical connections.

Problem of the study

The problem of the study is that there is a weakness in secondary school students' ability to do geometric exercises because of their inability use the skills of geometric proof. This problem is emphasized by other studies such as Samia Hussein Gouda (2010: 15) who confirmed the existence of common mistakes and difficulties facing secondary stage students in answering geometric exercises which was also confirmed by: Hadia Abdel Latif Abdel Latif (2013), Wafaa Suleiman Ibrahim (2011) Maher Mohammed Saleh (2008), and Khaled Mustafa Hafez (2006). Previous studies also showed that Poor level of geometric proof skills leads to high level of students' mathematical anxiety in general, and geometric anxiety in particular. So, it becomes clear that this is a serious problem facing students at different educational levels.

As for mathematical connections, there is a weakness in understanding the mathematical relationships between the branches of mathematics, between mathematics and other sciences, or between mathematics and the daily life of students. This is emphasized in the studies done by Ghada Salem Al-Naimi (2016) and Ahmed Ali Khattab (2013). The low level of mathematical connection skills negatively affects students' level in geometric proof skills, as proved by Businskas (2008, 8). The problem of the current study is also confirmed in the

findings given by Makkah Abdel-Moneim El-Banna (2013,117) who noted that the absence of appropriate strategies for the development of self-regulation skills can lead to a decline in students' achievement in geometry.

So, the researcher tried to address this weakness in students' skills of geometric proof, and mathematical connections by using self-regulated learning strategies. Students in the advanced levels such as the secondary stage, are willing to self-regulate their own learning process, but they need to be trained in using such strategies, which will help them overcome the problems they may face in studying mathematics in general and in doing geometry exercises recognizing mathematical connections in particular.

Problem of the Study:

The following main question can be answered through this study:

"What is the effect of using self-regulated learning strategies in mathematics on developing geometric proof and mathematical connection skills of secondary school students?"

This question can be branched into the following sub-questions:

1. What are the geometrical proof skills required for second year secondary school students?
2. What are the mathematical connection skills required for second year secondary school students?
3. What is the form of the "Geometry and Measurement" unit that is planned for secondary school students in the light of self-regulated learning strategies?
4. What is the effect of using self-regulated learning strategies on developing geometrical proof skills of second year secondary school students?

5. What is the effect of using self-regulated learning strategies on developing mathematical connection skills of second year secondary school students?

Study Hypotheses:

The following hypotheses were tested:

1. There are statistically significant differences between the mean scores of the experimental group and the control group in the post implementation of the geometrical proof skills test in favor of the experimental group.
2. There are statistically significant differences between the mean scores of the experimental group students in the pre and post implementations of the geometrical proof skills test in favor of the post one.
3. There are statistically significant differences between the mean scores of the experimental group and the control group in the post implementation of the mathematical connection skills in favor of the experimental group.
4. There are statistically significant differences between the mean scores of the experimental group students in the pre and post implementations of the mathematical connection skills in favor of the post one.

Aims of the Study:

This study aimed at investigating:

1. The effect of using self-regulated learning strategies on developing geometrical proof skills among second year- secondary school students.
2. The effect of using self-regulated learning strategies on developing mathematical connection skills of second year- secondary school students.

Importance of the Study:

This study may help with:

1. Developing geometrical proof skills for second year- secondary school students
2. Developing mathematical connection skills among second year- secondary school students
3. Providing a procedural model of the implementation of self-regulated learning strategies for those who prepare and develop mathematics curricula.
4. Providing teachers with a guide that includes a range of activities and tasks that may help them to use self-regulated learning strategies in teaching mathematics.

Delimitation of the Study:

The study was delimited to:

1. A group of second year- secondary school students from Fayoum Secondary School for Girls -Fayoum Educational Administration, and Umm Al Moameneen Secondary School for Girls-East Fayoum Educational Administration.
2. The unit of “Geometry and Measurement” of second year- secondary school students (The scientific section) included the mathematics application book.
3. Some geometrical proof skills: drawing the geometric figure - determining the given data and the requirements - determining the appropriate plan for solving - assuming hypotheses - conducting additional work - concluding geometrical relations - formulating proof - making sure the solution is correct.
4. Mathematical connection skills: connecting mathematics to science – connecting mathematics to life situations – connecting mathematics topics to each other.

Tools of the Study:

The study tools (Prepared by the researcher) were:

- **treatment materials:**
 1. Student book.
 2. Teacher's Guide.
- **Measurement tools:**
 1. Geometrical proof skills test.
 2. Mathematical connection skills test.

Methods of the Study:

The study was based on the descriptive and experimental method, as follows:

- Descriptive method: was used to survey the previous studies related to study variables and its hypotheses, to prepare study tools, and to prepare the theoretical framework.
- Experimental Method: The study sample included two groups; experimental and control. The unit of "Geometry and Measurement" was administered to the experimental group using the self-regulated learning strategies and to the control group using the traditional methods.

Procedures of the Study:

To answer the study questions, the following procedures were conducted:

- 1) Reviewing the literature related to self-regulated learning; its concept, components, models and strategies, as well as the studies related to both the skills of geometrical proof and mathematical connection.
- **To answer the (first and second) questions the following was done:**
- 2) Analysing the content of the "Geometry and Measurement" Unit, which is planned for second year secondary school students to

determine the skills of geometrical proof, and the mathematical connection skills included.

– **To answer the third question:**

3) Reformulating the selected unit in the light of self-regulated learning strategies.

– **To answer the (fourth and fifth) questions:**

4) Preparing the educational materials (student book - teacher's guide), based on self-regulated learning strategies.

5) Preparing the measurement tools (geometrical proof skills test-mathematical connection skills test.

6) Selecting a group of second year of secondary school students randomly, and dividing them into two groups, one to be an experimental and the other to be a control.

7) Pre-administering the geometrical proof skills test, and the mathematical connection skills test to the two groups of study.

8) Teaching the unit to the students of the experimental group using self-regulated learning strategies, and teaching the same unit to the students of the control group in the traditional ways.

9) Post-administering the geometrical proof skills, and mathematical connection skills tests to the study groups.

10) Recoding the results, processing them statistically and interpreting them.

11) Making recommendations and suggestions in light of the study results.

Results of the study:

In the light of the procedures followed to solve the problem of the study the following results were reached:

1. There are statistically significant differences between the mean scores of the experimental group and the control group in the post-implementation of the geometrical proof skills test in favor of the experimental group.
2. There are statistically significant differences between the mean scores of the experimental group students in the pre and post implementations of the mathematical connection skills test in favor of the post one.
3. There are statistically significant differences between the mean scores of the experimental group students in the pre and post implementations of the geometrical proof skills in favor of the post one.
4. There are statistically significant differences between the mean scores of the experimental group students in the pre and post implementations of the mathematical connection skills in favor of the post one.

Recommendations of the Study:

In light of the results of the study, the following recommendations can be made:

1. Training Teachers to use self-regulated learning strategies through training courses and workshops.
2. Enriching the courses of the faculties of education with activities that aim at training students to use self-regulated learning strategies.

3. Providing the curricula at the faculties of education with various activities that develop the students'.
4. Guiding mathematics curriculum designers to enrich textbooks with activities that show the connection between the various branches of mathematics, the role of mathematics in serving other subjects, as well as the interest in the existence of various activities that develop students' geometrical proof skills.
5. Making the teacher aware of the necessity of showing mathematics in a connected and integrated form between its various branches, showing the value of mathematics and its usefulness in life, and thus the students feel the importance of what they are studying.

Suggestions of the Study:

In light of the results of the study, the following research can be suggested:

1. Effectiveness of a training program based on self-regulated learning strategies in developing the creative teaching skills of students in faculties of Education.
2. Effectiveness of a self-regulated learning strategies-based program in developing problem solving and self-efficacy skills of secondary school students.
3. Using self-regulated learning strategies to develop numerical sense skills and decision making of secondary school students.
4. A suggested training program for secondary school mathematics teachers based on self-regulated learning strategies to develop the mathematical skills of their students.
5. A study to investigate the achievement of mathematical connection criterion in the mathematics book of secondary stage based on international standards.

6. Analytical study to reveal the difficulties of solving the geometrical problems facing secondary stage students.
7. Studying the effectiveness of other teaching methods and strategies in developing mathematical connection and geometrical proof skills of secondary school students and other educational stages.