Journal of Education and Learning (EduLearn)
Vol.12, No.2, May 2018, pp. 159~165
ISSN: 2089-9823, DOI: 10.11591/edulearn.v12i2.8289

Levels of Geometrical Thinking of Students Receiving Blended Learning in Jordan

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Article Info

Article history:

Received Dec 12, 2017
Revised Feb 12, 2018
Accepted Apr 20, 2018

Keywords:

Geometrical Thinking
Open Education
Pre-serve Teachers

ABSTRACT

The study aimed at investigating the levels of geometrical thinking among students receiving blended learning in Jordan. The study sample consisted of (104) students/teachers of open education systems in Jordan for the 2015-2016 academic year. In order to answer the questions of study, the researcher developed a scale of geometric thinking, it is validity and reliability has been verified. The results of the study showed a low level of geometrical thinking among students receiving blended learning. The percentage of students in the first level (visual) (51%), the percentage of students in the second level (descriptive) (15%), and the percentage of students in the third level (logical) (3%). Also it showed differences in the levels of geometric thinking between males and females in favor of males, as well as differences in the level of geometrical thinking between students from the scientific stream and students from the literary stream in favor of scientific stream. In the light of the results of the study, the researcher recommends that pre-service teachers should be trained on programs contains geometrical thinking at open learning universities.

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1. INTRODUCTION

Mathematics is considered an important tool in our life, through which a learner can provide various solutions to problems in engineering, economy, technology, arts and medicine. It is seen as being the queen as well as servant to other sciences. Math is one of the topics of the public education in the Ministry of Education in Jordan. It is therefore very important for curricula developers to pay a high concern to curriculum development and teaching methods as well as teachers training before and during service. They should be well-trained in using modern teaching methods to overcome the problems faced by their school students.

In order to obtain an efficient educational output in mathematics, it is necessary to rethink the curricula, especially the geometric topics in the courses taught., where students suffer from a marked weakness in mathematics in general and geometric in particular, The International Association for the Evaluation of Educational Achievement conducted every five years for students in Jordan, it found the level of students in Jordan in the last study in 2015 is less than the world level by about 91 points [1].

According to Descartes, there is no thinking without mathematics, and no mathematics without thinking. Thinking is a tool used by mathematics to activate the mental activities and complex sensory experiences that aim at raising the learner's awareness of his learning, monitoring and planning in order to keep abreast of the developments in the information age and digital technology [2].

Mathematics plays a major role in the development of thinking, The teaching thinking skills and justification is one of the pillars of the basic process on which the teaching of mathematics. The international standards of the mathematics curriculum emphasize the importance of developing students' abilities in the

use of mathematics in solving problems, thinking and communication, the value of mathematics and their confidence in their ability to solve mathematical problems. The application of standards encourages the students to consider the mathematics as a daily activity that they can employ to make sense of the world around them. Thinking takes place within a context, and through the context the thinking appears. Therefore we expected the differences in the strategy which used by the teachers of mathematics in teaching, and how developing the thinking.

Based on the above, it is necessary to prepare teachers before and during service in different ways of thinking, taking into consideration the individual differences among learners, and integrating the global programs that are interested in thinking in the curricula that develop creative, critical, geometric, and metacognition thinking. And to develop habits of mind overcomes the difficulties and educational problems in mathematics in general, and the topics of geometry in particular.

Integrated program which used at Arab Open University [3] as one of the programs of preparing teachers is preservice, it supports the students/teachers before service with academic knowledge and teaching skills, methods of thinking, and merging the technology at education, as well as the system of university provide the qualifications in the education field. The Arab Open University is one of the educational institutions that relies on the teaching of blending, which combines the direct classroom meetings, the use of different sources in education, the use of modern technology in communication between learners, and the opportunity for graduates of the general secondary in Arab country to join in the various university programs, including the College of Education.

The open learning system at Jordan branch in the faculty of education, learners are adequately trained in teaching methods through direct experience in schools, thinking strategies in math and science courses, as well as planning, implementation and evaluation skills in mathematics (Arab Open University).

Geometry is one of the important topics of mathematics [4] because it is more related to the ability of thinking, and at the same time it considered a vital and enjoyable subject. Its properties and components are related to our reality. Learning geometry, such as the knowledge of geometric shapes and the ability to distinguish them in terms of the least possible characteristics, the distinction between perimeter and surface, surface and volume, the ability to prove geometric theories, and their use in different situations. For example: the use of Pythagorean Theorem in the calculation of lengths, the use of congruence and similarity in the calculation of lengths and angles.

The geometry is a fertile environment for the study of mathematical constructions. For example, Euclidean geometry provided a logical basis for the geometry, such as Theories, and mathematical evidence, which is a remarkable achievement for mathematicians

The standards and principles of mathematics education confirm that geometric plays a major role in the primary stage and this is evident in the development of mathematics curricula. Many students look at the issues, concepts and geometric aspects as interesting and enjoyable, but the study of traditional geometry is ambiguous and frustrating. Research by starting or highlighting the achievement of an agreement between the mathematical and psychological perspectives in teaching of geometric.

Teaching geometry at schools according to national council of teachers of mathematics requires learners to [4]:

a. Analyze the recipe and characteristics of geometric shapes of two and three dimensions, and develop mathematical arguments about geometric relations.
b. Set coordinates, describe spatial relations using coordinate geometry and other assimilation systems.
c. Apply transformations and symmetries to analyze mathematical positions.
d. The use of visual representation, topological justification and geometric modeling to solve problems.

Van Hiele and his wife Dina focused on teaching of geometry, thinking, levels of geometric thinking, and the role of teaching methods to improve those levels. In the late 1950s, this pair developed a theory of geometric thinking, the learning process is not connected; there are leaps in the learning curve, and research has been done in the United States on verifying this theory and studying the levels of geometric thinking, do they exist? And its compatibility with students at all stages of education.

The five levels of geometric thinking identified by Van Hiele in his model of teaching geometry are following [5]:

a. Visual level: Reflects nonverbal thinking, at this level, the student recognizes shapes through playing, classifies and describes them in his own way, and learns the examples and non-examples. The student draws the geometric shape and examines the right angles, straight lines, and a cute angles in an informal way (i.e., does not include the scientific definition of these concepts but in a practical intuitive way).
b. Descriptive level: where the object is judged by characteristics that describe it. For example, to hear a child say square because it's four sides are equal and its angles are rights. At this level, the student classifies the forms and writes or interprets the classification criteria used by the student. And geometric patterns using the protractor and the ruler. The student uses the triangle or any other form, noting and

recording his observations about the equal angles, triangles or identical shapes, similar triangles. Using standard forms, students measure the components and properties of these shapes, justify their conclusions to these properties, and write the properties that have been derived for all polygons, and then begin the process of sorting these properties for each shape separately.

c. Logical level: At this level, the student arranges the properties logically, draws one by one, and uses the properties that he knows to form the definitions through which to justify relations. For example, they use the definition of the box to explain why each square is rectangular. At this stage, the student does not understand the meaning of the conclusion, which is the role of concepts, definitions and theories. Van Hail, through his experience as a teacher, believes that many students do not reach this informal stage.
d. Deductive level: Through which the student uses the mathematical deductive evidence, which depends on the definitions, axioms and theories, and vice versa in verifying the validity of a guess. At this level, the student thinks mathematically through the mathematical construction which depends on the imposed beliefs and any change in these transformations.
e. Abstract level: The student valued and assessed for exploring different mathematical systems and the mathematical logic system. This level is usually related to university studies.

In this context other researcher [6] conducted a study to investigate the levels of geometric thinking of the students at the Faculty of Education at Mustansiriya University in Iraq. The results of the study showed the low level of geometrical thinking of students in the Faculty of Education, where the proportion of students in the three stages below the visual level, The researcher recommended the need to define teachers at Van Hiele levels of geometric thinking according to the educational and mental stages of the transition from one level of thinking to another to help them to arrange their ideas, evaluate the level of Van Hiele in their students, and build on it before starting to introduce a new geometric topic and interest in improving the level of understanding in students at educational faculty.

Other researcher conducted a study to investigate the levels of geometric thinking among the teacher students. The results of the study showed that 27.5% did not reach the visual level, 60.1% at the cognitive level, and 87.6% did not reach the logical level, the results of the study also showed that the student cannot perform the assigned duties within a certain level unless he has sufficient experience at the level that precedes him [7].

In pre-service teacher training programs, other researcher conducted a study aimed at investigating the impact of geometric design on the development of geometric thinking among pre-service teachers in Turkey. The results of the study showed the effect of geometric lessons on raising the level of geometric thinking among teachers [8].

In a study conducted by other researcher to investigate the levels of geometric thinking of pre-service teachers in Turkey, the results of the study show that teachers are mostly in the third level, and there are no differences in the level of geometric thinking due to gender, age and the cumulative rate overall average [9].

Similarly other researcher [10], investigated the levels of geometric thinking among secondary and primary teachers before service, and their relation to some variables, the results of the study showed that the teachers did not reach the required level, there are no differences between teachers in the secondary and primary levels, as well as no differences between the related to gender, and the type of secondary school certificate in the level of geometric thinking.

Additionally the study of Yenlimez and Korkmaz aimed to study the relationship between self-efficacy in geometric and the level of geometric thinking. In addition to studying the differences in self-efficacy in geometry according to the variables: gender, grade, achievement, Self-efficacy, the results of the study showed a weak correlation between self-efficacy and level of geometric thinking. The results of the study showed differences in self-efficacy according to the variables: achievement, gender and grade [11].

To investigate the level of geometric thinking among primary school students, other researchers performed on fifth grade students. The results of the study showed that nearly half of the students did not reach the first level and 28% reached the first level, indicating a low level of geometric thinking in primary school students, and the results of the study showed differences related to gender as well as the level of parental education [12].

In a study to identify the levels of geometric thinking among students aged 9-11 years in Slovenia, the results of the study showed that 4% of students in the zero level, 61% between zero and first, and 32% In the first level, and the second level reached only 1% of students, and the results of the study showed the weakness of students in the choice of geometric language [13].

The current study differs from previous studies in the field of university education students in Jordan using blended learning. It seeks to investigate the levels of geometric thinking among open education students in the faculties of education in order to provide educational opportunities that help them to develop

themselves in the field of geometric, through the provision of educational opportunities that develop geometric thinking.

This study was conducted to identify the levels of geometric thinking among student's receiving blended learning in Jordan, and their relation to certain variables such as gender and the type of secondary certificate stream.

1.1. Questions of Study

a. What is the level of geometric thinking among students of open education systems in Jordan?
b. Does the geometric thinking of open education systems students in Jordan differ according to gender (male, female)?
c. Does the geometric thinking of students of open education systems in Jordan differ according to the stream of certificate (scientific, literary)?

1.2. Terminologies of Study

a. Thinking: Complex mental activity intended to seek a solution to problems that require treatment, decision, or answer using his experience and previous knowledge.
b. Geometric thinking: is defined as a form of thinking or mental activity of geometry which is based on a set of mental processes of students' ability to perform a set of activities at each of the following levels of geometric thinking: visual, descriptive, logical, deductive, and abstract.
c. Levels of geometric thinking: the stages of the development of geometric thinking, which are five levels: visual, descriptive, logical, deductive, and abstract. It is defined procedural by the grades which students achieved by the scale of levels of geometric thinking.
d. Open Education systems: is the kind of university education that offers students the opportunity to combine classroom meetings with the use of the Moodle website in the presentation of abstracts and videos, dialogue through forums, online communication with students, and providing students with educational resources using modern technology.

1.3. Significance of Study

Mathematics preserve teachers in the basic stage need to learn the methods and strategy of teaching geometrical thinking, developing students' thinking, and increasing the ability of students to understand geometric, and connecting the topics of geometry with algebra and other contents of mathematics.

Awareness of the preserve teachers about methods of developing geometrical thinking and it is levels, and training the preserve teachers to assessed the levels of geometrical thinking learners. The importance of merging geometric problems and in the curriculum, and importance of modern strategy in teaching geometry [14].

Based on the importance of the outputs of faculty of education as one of the most important sources of preparation, training and graduation of teachers, and the importance of geometric in the development of geometric thinking.

1.4. Limitations of Study

a. Students of the faculty of education at the Arab Open University/Jordan Branch in mathematics courses (ED360), (ED 359), and teaching methods of mathematics (ED364).
b. Levels of geometric thinking were limited to the following levels: descriptive, descriptive, logical, and the skills of each sublevel: knowledge. analysis, conclusion.

2. RESEARCH METHOD

The study sample consisted of (104) students from the Faculty of Education at the Arab Open University/Jordan branch for the academic year 2015-2016, who's registered in mathematics courses.

The study tool was constructed from a scale in the levels of geometric thinking and the skills of each sublevel. The scale was prepared after studying the theoretical framework on geometric thinking and its levels, and looking at similar measures in this field, for example [5]:

2.1. The Scale Consisted of Three Levels:

a. Visual level: 9 paragraphs divided into 3 paragraphs each of the following subskills: knowledge, analysis and conclusion.
b. Descriptive level: 9 paragraphs divided into 3 paragraph each of the following subskills: knowledge, analysis and conclusion.

c. Logical level: 9 paragraphs divided into 3 paragraphs each of the following subskills: knowledge, analysis and conclusion.

In total, the scale consists of 27 paragraphs, of which 21 are multi-choice, 3 are complement and 3 are true and false questions. The validity of scale was verified by presenting it to a group of specialists in the field of teaching mathematics. The observations were taken and the paragraphs were modified based on their comments. The determine the reliability of the test, the researcher used internal consistency of Cronbach Alpha, and the coefficient of reliability was 0.89, so the scale appropriate for the purpose of study.

2.2. Procedures of the Study

a. Inquiring the theoretical framework of geometric thinking and its levels, as well as previous studies related to geometric thinking.
b. Prepare the study scale and verify its validity and reliability.
a. Application of the study tool to a sample at open education system students in Jordan (Arab Open University).
b. Dissemination of students' responses to Excel software, the use of statistical packages of SPSS, arithmetical averages and standard deviations was computed, and the classification of students to levels of geometric thinking. And the use of two way variance analysis (ANOVA).
c. Reaching the study results, discuss and write recommendations.

3. RESULTS AND ANALYSIS

3.1. The Level of Geometric Thinking among Students of Open Education Systems

Arithmetic averages, standard deviations, and percentages were used as shown in the following table. Noticed from the previous table that the percentage of students who reached the logical level 3%, descriptive level 15%, and visual level 51%, and the proportion of levels for males greater than females at the three levels.

Table 1. Arithmetical Averages, Standard Deviations and Percentages of Levels of Geometric Thinking among Open Education System Students

	Level	No	Arithmetic mean	SD	The percentage of students in the level
Male	Visual	48	5.0	1.4	55%
	Descriptive	48	3.0	1.3	16%
	Logical	48	3.7	1.1	4%
Female	Visual	56	4.3	1.1	47%
	Descriptive	56	2.5	1.0	13%
	Logical	56	2.6	1.1	2%
Total	Visual	104	4.6	1.3	51%
	Descriptive	104	2.7	1.1	15%
	Logical	104	3.1	1.2	3%

This indicates that the levels of students in geometric thinking are low, with only 3 students in the third level, the second level 16 students and the first level 53 students. The results of the descriptive analysis indicate that 51 students did not reach the first level.

This result is consistent with some of the studies that indicated the low level of university students in geometric thinking for educational curricula at the level of schools and universities that take into account the international standards for the development of geometric thinking, as well as the need to include textbooks in the teaching of mathematics lessons in geometric and geometric thinking such as [6], [7], [9], [10].

3.2. The Geometric Thinking of Open Education Systems Students in Jordan Differ according to Gender

Two way ANOVA analyses were used to study the differences between male and female students. The following table illustrates this.

It is noticed from the previous Table 2 that there were statistically significant differences ($\alpha \leq 0.05$) between the average scores of males and females in geometric thinking with f-value (46.3), it indicates the superiority of males in levels geometric thinking. This study is consistent with the Yenlimez and Korkmaz [11] study and the Fidan and Turnuklu [12] study. This study differs with the study of Cacmac and Kubra [9].

Table 2. Results of ANOVA Analysis to Study the Significance of Differences between the Average Scores of Males and Females in the Levels of Geometric Thinking in Open Education Systems

Source	Sum of squares	df	Average of squares	F value	Level of sig.
Sex	179.8	1	179.8	46.3	0.00
Stream	342.4	1	342.4	88.1	0.00
Sex*stream	2.3	1	2.3	0.6	0.44
Error	388.5	100	3.89		
Total	12220.0	104			

3.3. The Geometric Thinking of Students of Open Education Systems in Jordan Differ according to the Stream of Certificate (Scientific, Literary)

The arithmetic averages and standard deviations of the sample responses of study were extracted on the geometric thinking scale. The following table illustrates this:

Table 3. Arithmetic Means and Standard Deviations of Study Sample Domains (Scientific, Literary) in Geometric Thinking Levels in Open Education Systems

	Domain	Arithmetic mean		Literature	
Sex	Levels of geometric thinking	Arithmetic mean	SD	Arithmetic mean	SD
Male	Visual	6.1	1.4	4.6	1.3
	Descriptive	4.4	1.3	2.5	0.7
	Logical	4.2	1.0	3.4	1.1
Female	Visual	5.3	0.6	3.7	0.7
	Descriptive	3.3	0.7	2.0	0.7
	Logical	2.9	1.2	2.3	1.0

It is noted from the previous table that the mathematical averages in the geometric thinking of students in the scientific stream are higher than in the literary stream at all levels and all students. Inquiry the significance of differences in the levels of geometric thinking in the students of open education systems between the streams (scientific, literary) as shown in Table 3, the computed f-value was (88.1), and the significance level ($\alpha \leq 0.05$) between the level of geometric thinking among the students of the scientific stream and the students of the literary stream. This is due to reasons related to the curriculum of secondary school students in terms of the availability of activities and topics related to geometric such as the applications of the maximum values determined by students of secondary school scientific stream, The desire of students of the scientific stream to study geometric, where most students of the literary stream usually think of studying specializations that have no geometric subjects.

This indicates that students in the scientific stream have a greater ability to think geometrically than students in the literary stream; this may be due to the scientific stream curriculum in the secondary stage which focuses more on geometric and mathematical thinking skills than the literary stream. This result is different from the study of Oral and Ilhan [10]. This may be due to the different courses taught in the secondary stages in Jordan in terms of interest to the students of the scientific stream, including geometric subjects.

4. CONCLUSION

We conclude that that the percentage of students who reached the logical level 3%, descriptive level 15%, and visual level 51%, and the proportion of levels for males greater than females at the three levels. It is noted from the previous results that the mathematical averages in the geometric thinking of students in the scientific stream are higher than in the literary stream at all levels and all students. In light of results of current study, the researcher recommends to train the preserve teachers at open education systems on the geometric thinking through the mathematics curricula determined by the students of the faculty of education, and including modern strategy for teaching geometry in courses of teaching mathematics, for example adding the Van Hiele levels in curricula of mathematics strategies teaching.

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