Doi: 10.34120/0085-035-140-020

Teaching Geometry using an Educational Program Based on Enrichment Activities to Improve the Visual Thinking of Basic Stage Students

Dr. Emad A. Barouq
MOE
H.K.J

Prof. Ali M. Alzoubi
College of Education
Yarmouk University
H.K.J

ABSTRACT

The study aims to investigate the effectiveness of using an educational strategy based on enrichment activities in teaching geometry on improving the visual thinking of 8th grade students. To achieve the objectives of the study, a visual thinking test was built. Validity and reliability were secured. The sample of the study consisted of 47 students. The experimental group (n = 24) were taught according to enrichment activities, while the control group (n = 23) were taught using the traditional method. Results showed statistically significant differences between the Means of the performance of the students of the experimental and control groups on the visual thinking test that can be attributed to the teaching method and in favor of the experimental group. In light of the results, the researchers recommended using enrichment activities in teaching geometry.

Keywords: Enrichment Activities, Teaching Geometry, Visual Thinking.

Introduction

The twenty-first century is characterized by rapid development, scientific and technical progress in all fields of knowledge, as there is an increase in interest in developing thinking skills, by making the school curriculum more thinking-provoking. Geometry is one of the important branches of Mathematics and one of its components (Abu Lom, 2005). It is a fertile field for training students to use different thinking

patterns, especially visual thinking skills. Visual thinking in mathematics is highly related to the student ability to read and interpret the symbols and stimuli he receives visually. Students can use such ability in understanding and acquiring information and interpreting it through sensory interaction, to bring about desired changes in their learning. Dealing with sensory materials and distinguishing them visually can enhance the ability to perceive relationships, interpret information and analyze it. Visual thinking is one of the mental activities and skills that help students get, represent, interpret, perceive and memorize information, then express their own ideas visually and verbally. Thus, visual thinking occurs in a developing way, when vision, imagination and representation merge in an active interaction to clarify the relationship between them; (Alsarif, 2020). Badawi (2008) claims that visual thinking is often associated with the right hemisphere, and the visual-spatial learner model is based on new discoveries in brain research about the different functions of the two hemispheres of the brain. The left hemisphere functions as an analytical sequential information processor that takes time into account. The right hemisphere perceives and understands motion in space. Thus, visual thinking can be defined as one of the thinking patterns of mental ability that is directly related to the visual perceptual aspects. This type of thinking occurs when there is coordination between what the student sees in terms of shapes, drawings and relationships, and what is updated of linking mental outcomes based on the vision and the presented drawing (Brand, 2020).

Aldeb (2015) defined visual thinking as consideration accompanied by management and reflection through which knowledge, information, discoveries and the knowledge of laws are generated. Almasry & Alamer (2016: 23) defined it as "a pattern of thinking that stimulates the student's mind by using visual stimulae to understand the relationship between knowledge and mathematical information, to comprehend, represent, organize, integrate it into his cognitive structure or match it with his previous experience and turn it into meaningful acquired experience ". Abu Dan (2013) defined it as a mental capacity in which images, shapes and drawings are used, analyzed, interpreted and converted from a visual language into a written or spoken language, leading to the required understanding among students. Abdalmola (2010) defined it as a system of processes that translates the learner's

ability in separation of the study on reading the visual figure, converting the visual language that shape carries into a written language, and extracting information from it. This system includes skills, namely: recognition of the shape, its description, analysis, connection, perception of ambiguity and its interpretation, and the skill of extracting meaning, as shown in figure (1):

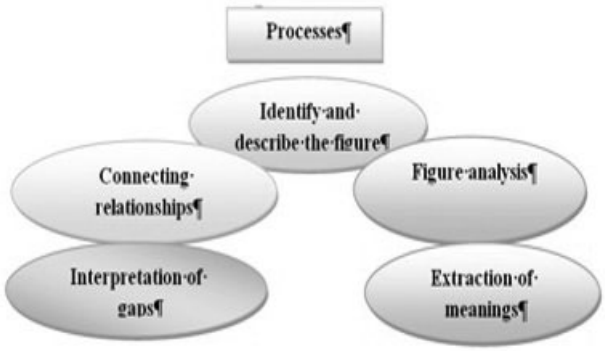

Figure 1

Skills Visual Thinking

The importance of developing visual thinking skills in geometry has emerged through what has been called for by the reports of many local, regional and international bodies. In the report of the (National Council of Teachers of Mathematics in the United States [NCTM], 2009), emphasis was placed on the need to develop visual thinking skills to help solve geometric problems. Moreover, the National Council of Supervisors of Mathematics [NCSM] has identified what it called the basic components of mathematics in the twenty-first century and mentioned in the forefront the solution of geometric problems (NCSM, 2000). Afani (2002) believes that those who think visually employ vision, imagination and drawing in an active and graceful way, and they move during their thinking from an imagery to another.

Alsahib & Almafton (2012) indicated that the visual shape can be represented by three tools. Under each tool, there are several subsidiary tools to serve such tool. Those tools are: images, symbols, and diagrams, as shown in figure (2).

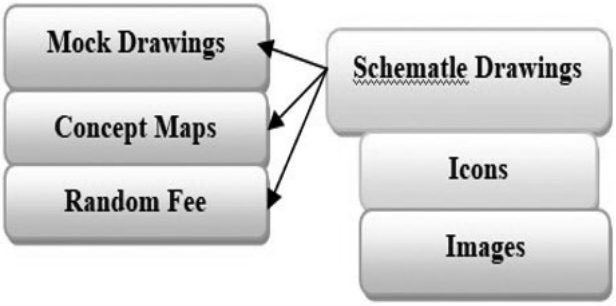

Figure 2

Instruments of Visual Thinking

Several studies in different subjects emphasized the importance of developing visual thinking among students (Alhazem, 2018; Algholam, 2018; Kapanadze, 2018; Almuflih, 2019; Bomgaars & Bachelor, 2019; Frazier & Bryant, 2019; Baz, 2020). Despite the attention educators give to developing students' geometric problem-solving skills, students' performance level in solving geometric problems rarely matches aspirations. Studies, also, indicate that the low performance of students in solving geometric problems is not due to their lack of knowledge, but rather to their inability to understand relationships in geometric drawings, and lack of insight and imagination of the nature of these relationships, and the link between them (Alkasendar, 2008). Zachariah (2020) conducted a study to observe the effects of manual activities in mathematics on the teacher's confidence in geometry and statistics. Alain (2018) aimed to identify the effectiveness of visual thinking procedures in enhancing visual thinking skills and encouraging students' participation and exchange of ideas among themselves. Sholihah & Maryono (2020) also conducted a study to explore the role of visual thinking in solving problems by presenting enrichment activities for students. Momcilovic (2020), as well, conducted a study aiming at identifying the effectiveness of Scratch application in mathematics, in studying basic geometric shapes.

Therefore, the interest of scholars has focused on modern teaching strategies and methods, which call for the use of mind and the development of higher thinking skills, including visual thinking skills, and avoiding methods that focus on filling students' minds with

information that quickly becomes forgotten and of low value in the student's cognitive system, and caring for the learner as the main focus of the educational learning process (Alsadi, 2003). Among these strategies is the enrichment activities strategy; as a strategy based on providing students with activities that provide them with rich experiences through engaging in realistic, non-routine problems that make them able not only to obtain knowledge, but to generate and invest it in a way that develops their mental skills and abilities to make their learning meaningful (Kojak, 2001).

The enrichment activities strategy is considered one of the educational strategies based on the social constructivism theory of Vygotsky, which considers the student as an active member of the learning process and constructs his/her knowledge in a cooperative social environment. The enrichment activities strategy works to improve students' thinking skills by applying its principles, which are based on encouraging students to work in a rich environment with educational interactions and situations, to engage in mathematical discussions, correcting their mathematical concepts, linking previous knowledge and experience with modernity and providing immediate feedback. Such process makes the learning of Mathematics meaningful, (King, 2019; Voskoglou, 2019). Zytoun (2000: 34) defined a number of basic principles necessary to achieve the effectiveness of educational enrichment activities; considering learning an intellectual activity, indicating that the superficial processing of information leads to the lack of effective learning, and the learner must realize his need to increase his knowledge, and that learning has a social aspect, and the application leads to confirmation of what has been learned.

Schnell (2017) considered enrichment as a type of activity that works to improve and increase the skills and talents of students, and helps students define concepts based on inquiry and justification, solve mathematical problems with multiple solutions, construct representations and mathematical models, and form logical relations. Piggott mentioned (in: Alsharif, 2020) that enrichment activities consist of two factors; content and education. With regard to content; problem solving and mathematical thinking require mathematical skills, and in education; problem solving covers the general range of skills that are applied through solving mathematical problems. Mathematical thinking is also

linked to specific mathematical skills that students need in order to solve problems. Alseed (2001) mentioned that there are many goals for enrichment activities, including: facilitating the understanding of some abstract Mathematics topics, reducing the fear that accompanies the study of Mathematics, and assisting teachers enrich the teaching practice with different activities. Alsalem (2008) believed that educational activities, problem-solving, and activities with mock puzzles constitute a way to better satisfy students' needs and their scientific tendencies, as they all generate new scientific problems and questions and confirm the continuity of self-learning, the learners' self-confidence, sense of self-actualization and the development of scientific tendencies and trends. Albohi & Farouki (2001) referred to a set of school enrichment educational functions; of which: the development of the learner's cognitive skills, the development of tendencies, trends and values, the link between theory and practice, the development of communication skills, and learning to plan and work in a team,

In reference to previous studies on the strategy of enrichment activities, Alsharif (2020) conducted a study in Jordan to identify the effect of enriching activities in geometry on improving spatial reasoning, critical thinking and motivation in mathematics among 6thgrade students. Albisr (2021) also conducted a study in Saudi Arabia that aimed to investigate the effectiveness of an enrichment program in improving the mathematical skills of the Kangaroo Competition to raise the level of results for talented students in the 5th and 6th grades in the schools of Royal Commission in Jubail.

It has been one of the most important contemporary global trends considering the improvement of thinking, especially visual thinking, as a basic goal that educational institutions must be keen on (Saleh, 2012). Moreover, because the enrichment activities strategy has a priority, not only to work on improving cognitive abilities, but also skills and mentalities, it enhances educators to think seriously about feeding curricula, including Mathematics curricula, with a strategy of enrichment activities, as they may work to enrich the teaching-learning process, and reconsider the curricula and teaching methods that depend on students' memorization of knowledge rather than thinking about and understanding it; resulting in making their learning meaningless (Ababneh& Abu Zina, 2010). Despite the importance of the strategy of

enrichment activities and the importance of improving visual thinking, there is scarcity (according to researchers' knowledge) in studies that combine the strategy of enriching activities with visual thinking in teaching and learning geometry, which is one of the important topics in Mathematics.

Problem and hypotheses

Identifying the research problem stemmed from the following:

- Lack of interest of Mathematics teachers in providing learning activities to train students in visual thinking skills, and they resort to using indoctrination as a teaching method that depends on memorization, to explain the theories and generalizations of geometric shapes with a focus on teaching students their laws, concepts and theories, and training them on how to find relations between the properties of geometric shapes; based on conventional training to solve problems. The main goal is success in the final exam, resulting in Mathematics teachers' lack of interest in presenting the applied or aesthetic aspect of the geometric shapes that students study.

- The students' results in the tests of Mathematics especially geometry (Trends in International Mathematics and Science Studies [TIMSS], 2007, 2011, 2015) (Ababneh, 2017), revealed a deteriorating status in students' abilities to solve geometric problems that require relations, representations, modeling, drawing geometric shapes, identifying properties of geometric shapes, reasoning and linking between the conceptual and procedural knowledge in solving geometric problems. This indicates a general weakness of students' abilities in visual thinking skills. The reason for this weakness may be due to the teaching methods used. Such methods that depend on memorization and indoctrination and not on thinking and understanding.

Based on the above, as well as literature review of the enrichment activities strategy and studies, that have proven effective in teaching different subjects; such as (Wiggins et al., 2017; Yazicioglu & Akdal, 2020; Albsir, 2021), this study comes to investigate the effectiveness of using educational strategy based on enrichment activities in teaching geometry on improving the visual thinking, by answering the following main question:

What is the effectiveness of using an educational strategy based-on enrichment activities in teaching geometry on improving visual thinking?

From this question, the following two null hypotheses stem:

- No statistically significant differences at the level of (á = 0.05) exist between the means of the experimental and control groups on the visual thinking test.

- No statistically significant differences at the level of (á = 0.05) exist as of the means of (high, medium, low) students' achievement level in the experimental and control groups on the visual thinking test.

Study significance:

The study derives its theoretical significance from its approach to the use of an educational strategy based on the social constructivism theory, in which the student becomes an active participant by constructing his knowledge in a cooperative social environment; based on classroom mathematical discussion so that the link between his previous and present knowledge is established, as well as for dealing with Visual thinking, which referred to the improvement of his abilities in understanding geometric shapes, describe, identify, compare between them and determine their properties in solving geometric problems.

As for practical significance, it provides teachers with a strategy in geometry teaching that may be used to help students improve visual thinking skills in a social context, communication, and cooperative work. It, also, helps them develop visual thinking skills, in line with global trends in the development of learning and teaching processes. It falls under the umbrella of the structural curve that takes into account the individual differences and developmental requirements of students, through the application of the educational program prepared by the researchers, which contains activities, worksheets, exercises and mathematical problems; linking knowledge in geometry science to life, as presented in every classroom session. It may also benefit curriculum developers in terms of designing educational activities in textbooks and manuals. This importance is represented by the quality of the study tool, in addition to that it may open the way for researchers to pay

attention to this strategy to be used in teaching other subjects in geometry and for different classes taking other types of higher thinking skills.

Limitations:

The current study sought to investigate the effect of using an educational strategy based on enrichment activities in teaching geometry on improving visual thinking skills of 8thgrade Students. Accordingly, the limitations of this study must be taken into consideration when generalizing its results.

- The study was applied to a sample of 8thgrade students, in Amman.
- This study was applied during the second semester of the academic year (2020-2021) during the Corona Crisis where the teaching was on line.
- This study dealt with the Triangle Unit, taught using the traditional method for students of the control group, while taught using enrichment activities strategy for students of the experimental group.
- The generalization of the results of the current study may be limited to the nature of the study tools and their psychometric characteristics in terms of validity, reliability, application procedures, and on societies that resemble the current study sample.

Terminology:

The study includes the following terms and procedural definitions:

- Enrichment activities: a set of procedural steps in which the student is placed in an educational position that facilitates the employment of his mathematical abilities in solving geometric exercises as an enrichment activity that facilitates the solution of geometric problems (in the Triangles unit).
- Visual thinking: the performance level of the study sample on the visual thinking test on the (Triangles Unit) and measured by the score the student gets on the test; developed by the researchers.
- Achievement level: the amount of experience, knowledge and skills that the student has acquired, and it is measured by the score obtained on the achievement test. The level of the pre-achievement

test has been classified into three levels, the lower level includes students who obtained the a score which ranges from 0 - < 10 in the achievement test in the experimental and control groups, and the intermediate level includes students who obtained a score that ranges from 10 -15 in the achievement test in the experimental and control groups, and as for the high level, it includes students who obtained the score ranging > 15-20) in the achievement test in the experimental and control groups, noting that the total score is 20.

Methodology

The study adopted the quasi-experimental approach with a pre-post design for two equivalent groups: experimental and control. The achievement test for the second semester of the previous year was considered as a pre- application. It consisted of 5 essay questions, while the visual thinking test was considered as a post application and it consisted of 20 MCQ.

Sample: An intentional sample was chosen from the 8^{th} grade students in the (Um Alsemak Alshamali) school in Amman, which contains two or more groups of the 8^{th} grade classes during the second semester of the academic year (2020-2021). The sample of the study (n = 47) students was randomly divided into two groups: experimental (n = 24), control (n = 23). The experimental group was assigned to a teacher; trained in the strategy of enrichment activities, and the control was taught using the traditional method.

Tools and Instructional Material:

Visual Thinking Test: The test was constructed to measure visual thinking. The test items (n = 20) were of short essay type. The test items dealt with visual thinking skills: recognizing and describing the shape, analyzing the shape, linking relations in the form, perceiving and interpreting ambiguities and extracting the meaning, 1 mark for each item. Thus, the total score for the test is 20.

The validity of the test was secured in two ways:

A. The face validity: The test was presented to a jury of expertise in Mathematics (Dept. Curricula and Teaching Methods, in Jorda-

nian Universities), for phrasing and suitability for eighth-grade students, and some items were amended, the visual thinking test remained in its final form consisting of 20 items.

B. Internal consistency: This is done by applying the test to a pilot sample (n = 15), and the test took 45 minutes, the Pearson correlation coefficient was calculated between the score of each item and the total score of the whole test, as it ranged between 0.29- 0.78 which indicates the validity of the test, and the difficulty and discrimination factors were calculated for the test items, and the difficulty coefficients ranged between 0.33- 0.76, and the discrimination coefficients between 0.28- 0.74, which means the items are suitable for use in the study (Alnajar, 2010).

The reliability of the test was verified using the method (Cronbach's Alpha), and the reliability factor of the test reached 0.85, and this value is suitable for the study purpose (Alnajar, 2010).

Achievement Test: The researchers constructed an achievement test on the Triangles unit, consisting of 4 essay questions, in order to measure the amount of experience, knowledge and skills the student acquired in the Triangles unit. The test aims to classify the students into three levels depending on their achievement High, Medium, Low, with the grades of students with low achievement 0- < 10, medium achievement 10 -15, and high achievement > 15- 20, and the test was built after analyzing the mathematical content of the Triangles unit and its concepts, generalizations and geometric issues, and determining the educational outcomes; to be achieved after studying this unit. The unit included the following topics: Types of triangles with respect to the sides, Types of triangles with respect to angles, the Pythagorean Theorem, the opposite of the Pythagorean Theorem. In order to verify the validity of the test, it was presented to a committee of expertise (n = 6) from the faculty members Dept. of Mathematics Curricula and Teaching Methods, Measurement and Evaluation in some Jordanian universities, to verify its suitability to achieve the goals of the study. and the extent of representation the questions were of the educational material and their conformity with the objectives of the study. Amendments proposed by the jury were made. The final test consisted of 4 questions. The test questions dealt with: finding the measurements of

angles, determining their types by linking the relationships between their measurements, making use of the parallelism of the sides and determining the lengths of the sides by applying the Pythagorean theorem and making use of the perimeter and area of the triangle.

The reliability of the test was also verified by applying it to a pilot sample (n = 15).The test period took 45 minutes, and the internal consistency coefficients were calculated using the Cronbach Alpha coefficient, where the reliability coefficient reached 0.83 and this value is considered acceptable For the purposes of this study and upon correction of the test 4 marks were calculated for each correct answer, so that the total score of the test is 20 marks.

Teacher Manual: It is a scheme designed for the purpose of education or training, in order to develop the performance of the teacher to suit his field and role in teaching, and the strategy components consist of: educational products, educational activities, tools and materials, methods used, and evaluation on an ongoing basis (Bokas, 2002). The (Triangles unit) was selected for the 8^{th} grade, and reformulated for enrichment activities, and an educational strategy was prepared on the Triangles unit based on:

A. Mathematics textbook for 8^{th} graders, and some references related to the content.

B. Educational literature related to enrichment activities, in order to identify the steps and principles required to be provided in the presentation of lessons.

C. Some previous studies which are similar to the current study, where the method of organizing the lessons was examined and presented; in light of the enrichment activities strategy as a study; (Sholihah & Maryono, 2020).

To achieve the objectives of the study, the strategy was prepared for the lessons of the Triangles Unit, taking into account the educational outcomes of the unit according to the enrichment activities, and the strategy included the steps for implementing the enrichment activities indicated by the study (Zachariah, 2020), the educational outcomes expected to be achieved, previous and recent knowledge, the activities and educational means, and the time distribution of the lessons. In order to ensure the authenticity of the content, the

educational strategy was presented to a group of supervisors and Jordanian university professors with educational experience and specialization in Mathematics curricula, with the aim of ensuring its linguistic and scientific integrity and its compatibility with the enrichment activities in terms of the safety of the procedures and steps followed, and their observations were taken into account.

Procedure: To achieve the desired objectives of the study, the following procedures were followed:

1 - Review the literature and educational research related to enrichment activities to improve the skills of visual thinking.

2 - Analysis of the scientific content of (Triangles Unit) from Mathematics - second part, for 8^{th} grade of students.

3 - Choose the experimental and control groups in the available way, given the work location of the principal investigator close to the school from which the two groups were randomly selected.

4 - Construct study tools and verify their validity and reliability.

5 - Train the observed teacher on the strategy and principles of enrichment activities strategy.

6 - Apply the study for both the experimental and control groups, where the students of the experimental group were taught (in 12 classes of 45 minutes each) according to the strategy of enrichment activities, while the students of the control group were taught in the ordinary method and using the unit of associations as mentioned in the textbook.

7 - The study was implemented within three weeks from 10/2/2021 - 5/3/2021 in Om Alsamak Alshamali elementary school during Corona Pandemic (Covid 19) and the teaching mode was virtual.

8 - The achievement test for students of the experimental and control groups was considered as a pre-test, and the visual thinking test was applied at the end of the study online as a post test.

9 - Entering the post-visual thinking test data, processing it, analyzing and interpreting the results, and arriving at the study recommendations and proposals.

Statistical Treatment

The study hypotheses were tested by extracting the arithmetic means and standard deviations of the scores of the experimental and control groups, and the comparison between the different performances, and the T-test was also used to ensure the equivalence of achievement groups, and for the purpose of ascertaining the significance of the differences statistically, the Analysis of Covariance (ANCOVA).

Results and Discussions

The equivalence of the two study groups was verified by extracting the arithmetic means and standard deviations and the "T" test of the research groups high, medium and low achievement on the visual pre-thinking test as in table 1.

Table 1

Means, Standard Deviations, and a test of research groups (high, Mediun. Low) achieving on the visual thinking test

Level of Achievement	Group	Frequency	Mean	St.D.	T	Sig
High	Experimental	3	17.333	.577	.000	1.000
	Control	3	17.333	.577		
Medium	Experimental	12	11.419	1.379	.681	.503
	Control	10	11.800	1.230		
Low	Experimental	9	7.778	1.481	.040	.989
	Control	10	7.800	.919		

Table 1 shows that there are no statistically significant differences between the research groups (high, medium, low) achievement in the experimental and control samples on the visual pre-thinking test, which means that these groups are equivalent to the pre-application test.

Presentation and discussion of the results related to the first question:

What is the effect of the teaching based on enrichment activities on the development of visual thinking among students of the 8th grade of

basic education in the University District Education Directorate? To answer this question, the arithmetic means and standard deviations of the real and modified pre and post applications were calculated on the visual reasoning test, as in Table 2:

Table 2

The Means and standard deviations for the visual thinking test

Application	Enrichment Activities		Ordinary Method	
	Mean	St.D	Mean	St.D
Pre-application	10.792	3.323	10.783	3.370
Post application	16.042	2.095	12.130	3.123
Modified	16.039	.427	12.133	.436

Table 2 shows the values of the means and the standard deviations of the visual thinking test, as it is evident through these values that the values of the means of the telemetry in each group have improved, noting that the mean of the post visual thinking test of the experimental group was greater. The visual thinking test of the experimental group compared to the mean of the control group, and to determine the importance and significance of the differences of the means shown, ANCOVA was used, as in Table 3:

Table 3

The analysis of covariance (ANCOVA) between the Mean of the experimental group and control group

Test	Source	Sum of Squares	df	Mean of Squares	F	Sig	2	Size effect
Visual Thinking	Pre-application	122.911	1	122.911	28.071	.000	.482	Large
	Group	179.256	1	179.258	40.940	.000		
	Error	192.656	44	4.379				
	Corrected	495.234	46					
	Total							

Table 3 shows the results of the analysis of covariance associated with the variable visual thinking between the two groups in the post application, where the value of F calculated 40.940 reached a level of significance.000, which indicates statistically significant differences between the two groups in the visual thinking test in the post application in favor of the experimental group, The eta-square coefficient shows that the size of the effect has reached.482 and that it is a large value, as (Afani, 2000) indicated that the size of the effect is considered large if the value of the eta square is greater than or equal to 0.14.

These results indicate that learning based on enrichment activities in improving visual thinking related to triangles, and the reason for the superiority of the teaching strategy based on enrichment activities over the regular teaching method may be attributed to the teaching procedures for each of them. The training program based on enrichment activities provided opportunities for the diversity of learning activities and methods used by the student to solve various mathematical problems, depending on the student's previous knowledge, and the external environment affecting learning, according to this program. Teaching is done by providing an environment rich in classroom interactions, activities and educational situations. Students solve educational activities in a cooperative atmosphere, and the teacher provides instructions, tips and hints during students' mathematical tasks, and encourages them to engage in mathematical dialogues and discussions; giving students opportunities to reflect on the work they have done and to do with more math problem solving, and homework exercises that reinforce concepts and use of math learned in class, and immediate correction of mathematical errors, and providing feedback. Constructive learning on which the learning based on enrichment activities is developed makes the student the focus of the educational learning process and helps him exchange experiences, develops his thinking, the spirit of harmony and cooperative work. All these help in creating an effective learning atmosphere. It makes learning meaningful, leads to better learning outcomes and thus better thinking. These results are in agreement with the studies (Alain, 2018; Gamze et al., 2020), regarding the effect of teaching method on improving visual thinking.

Presentation and discussion of the results related to the second question:

To answer this question, the means and standard deviations were calculated and the "t- test" for the research groups high, medium, low achievement was calculated on the Visual Thinking Test, table 4:

Table 4

Means, Standard Deviations, and the "t" test for research groups achievement (high, medium, low) on the dimensional visual thinking test

Achievement level	Group	Individuals	Mean	St.D.	T	Sig
High	Experimental	14	17.786	1.188	2.431	.048
	Controlled	3	16.667	0.577		
Medium	Experimental	7	14.000	0.817	8.064	.000
	Controlled	10	12.700	0.949		
Low	Experimental	3	8.333	0.577	.253	.001
	Controlled	9	7.667	0.779		

Table 4 shows the existence of statistically significant differences between the two groups' levels high, medium, low in the experimental and control samples on the visual thinking test and their values respectively.048,.000,.001 which means that the performance level of the group students experimental levels of different achievement may improve on the post test. This may be attributed to the effect of the teaching strategy based on enrichment activities in developing visual thinking related to geometry. It has contributed to expanding the mental structures of the experimental group students at their various levels of achievement, developing their visual thinking and creativity and making them more capable and skilled in dealing with problems of daily life as Mathematics has been linked to the reality they live, and the daily problems they face, and apply them in new life situations. It also provided them with appropriate opportunities to deal with ideas and information freely without being restricted to a certain type or level of thinking, which positively affected the level of their visual thinking. Students' involvement in an environment rich in classroom interactions

and educational activities and geometric mathematical discussions and dialogues provided by the teacher also contributed to correcting misconceptions and building correct mathematical concepts, thus forming new cognitive schemata that they expressed in their solution in the proposed mathematical tasks. The proposed strategy deepened their understanding and helped them advance to higher levels of visual thinking. This was evident in the performance of the experimental group students on the visual thinking exam and their ability to solve geometric problems that require the visual ability to recognize geometric shapes and distinguish between their properties and discover confusion and ambiguity in those geometric shapes in addition to their visual abilities. The control group students' performance on the visual thinking test showed their inability to solve geometric problems due to their failure to relate geometric relations, or to distinguish between geometric shapes and deduce ambiguity in shapes that caused wrong solutions, which indicates not possessing visual thinking skills.

Enrichment activities allowed students from all levels of achievement to correct their previous concepts through discussions between them and the teacher on the one hand and between them and students in class groups, which worked to raise their self-confidence and assess their own abilities and independence in their solution to mathematical tasks and this worked to develop their visual thinking and raise their motivation to learn mathematics and touch its usefulness to the individual and society through the nature of the provided educational activities and situations, which is reflected positively in their performance on the Visual Thinking Test. These results are in agreement with (Alain, 2018; Sholihah & Maryono, 2020) studies regarding the effect of the level of achievement on the development of visual thinking.

Recommendations

In light of the results revealed and the above conclusions, the study recommends the following:

- Using enrichment activities in teaching geometry to help improve visual thinking skills.
- Conducting training workshops for new Mathematics teachers in training programs for enrichment activities in teaching geometry.

- Enriching school mathematics curricula with the principles of enrichment activities in various mathematics subjects.
- Conducting more research by using enrichment activities to verify their effectiveness in different mathematics topics, for different educational levels, and in other areas other than mathematics.

تدريس مادة الهندسة باستخدام استراتيجية تعليمية قائمة على الأنشطة الإثرائية لتحسين التفكير البصرى لدى طلبة الصف الثامن

د. عماد عواد بروق — وزارة التربية والتعليم

أ. د. علي محمد الزعبي — كلية التربية – جامعة اليرموك

المملكة الأردنية الهاشمية

ملخص

هدفت الدراسة إلى التعرف على فاعلية استخدام استراتيجية تعليمية قائمة على الأنشطة الإثرائية في تدريس مادة الهندسة في تحسين التفكير البصرى لدى طلبة الصف الثامن في الأردن. ولتحقيق أهداف الدراسة تم بناء اختبار للتفكير البصري تم التحقق من صدقه وثباته. تكونت عينة الدراسة التجريبية والضابطة من (47) طالباً، دُرست المجموعة التجريبية (24) طالباً باستخدام الأنشطة الإثرائية، بينما دُرست المجموعة الضابطة (23 طالباً) باستخدام الطريقة الاعتيادية. أظهرت نتائج الدراسة وجود فروق ذات دلالة احصائية بين متوسطي أداء طلبة المجموعتين التجريبية والضابطة في اختبار التفكير البصري تعزي لطريقة التدريس لصالح المجموعة التجريبية. وعلى ضوء النتائج يوصي الباحثان باستخدام الأنشطة الإثرائية في تدريس مادة الهندسة.

الكلمات المفتاحية: الأنشطة الإثرائية، تدريس الهندسة، التفكير البصري.

References

Ababneh, A. (2017). *Jordan National Report on the International Study of Mathematics and Science, (2015)*, 198- 203.

Ababneh, A. & Abu Zina, F. (2010). *Mathematics curriculum for first grades* (2nd ed.). Amman: Dar Almasirah.

Abdalmola, O. (2010). *The effectiveness of a program based on social constructivism by using mixed education in teaching social studies on developing geographical concepts, visual thinking and life skills among deaf students in the preparatory cycle*. [Unpublished doctoral dissertation], College of Education, Sohag University.

Abu dan, M., (2013). *The effect of using physical models in teaching the fraction unit on the development of achievement and visual thinking skills of fourth- grade female students in Gaza*. [Unpublished MA thesis], College of Education, Islamic University, Gaza.

Abu Lom, K. (2005). *Geometry and its Teaching Methods,* (1st ed.). Amman: Dar Almasirah.

Afani, A. (2002). *The style of Games and learning Mathematics*, (2nd ed.). Amman: Hanin House for Publishing and Distribution.

Alain, G. (2018). Student Engagement through Visual Thinking Routines. *Athens Journal of Education, 5*(*2*), 161- 172.

Albohi, F. & Farouki, A. (2001). *School Activities*. Alexandria. University Knowledge House.

Albisr, M. (2021). The Effectiveness of an Enrichment Program in Improving Mathematical Skills for the Kangaroo Competition to Raise the Level of Results for Gifted Students of 5th and 6th grades in Royal Commission Schools in Jubail. *Scientific Journal, 37*(*1*), 37- 50.

Aldeb, N. (2015). *The Effectiveness of Using the Strategy (Think-Match- Share) on Developing Visual Thinking Skills and Mathematical Communication among Eighth Grade Students in Gaza*. [Unpublished MA thesis], Islamic University, Gaza.

Algholam, A. (2018). Student Engagement Through Visual Thinking Routines. *Athens Journal of Education*, 5 (2), 161- 170.

Alhazem, A. (2018). *The Effect of Visual Thinking on Developing the Adult Learner's English Language Fluency*. [Unpublished MA thesis], Ain Shams University, Cairo.

Alkasendar, N. (2008). *Evaluating the Content of Mathematics Books for the Higher Basic Stage in the Light of Visual Thinking Skills*. [Unpublished MA thesis], College of Education, Al- Aqsa University.

Almasry, I. & Alamer, T. (2016). *Visual thinking: its concept- its skills- its strategy* (1st ed.), Cairo: Arab Group for Training and Publishing.

Almuflih, M. (2019). The Effectiveness of Using Visual Organizations in Improving Reading and Writing Skills for Students with Learning Disabilities from the Teachers' Point of View. *International Education Studies*, *12*(*3*), 135- 147.

Alnajar, N. (2010). *Measurement and evaluation: an applied perspective with SPSS software applications*. Amman: Dar Alhamd.

Alsadi, J. (2003*)*. *Teaching Thinking Skills,* (1st ed.). Amman, Dar Alshrouq.

Alsahib, M. & Almafton, N. (2012). *Thinking, Patterns, Theories, Methods of Teaching and Learning* (1st ed.). Amman: Dar Safa.

Alsalem, E. (2008). *A proposed program for science teachers on the use of computer-assisted enrichment activities and its impact on developing creativity among middle school students*. [Unpublished MA thesis], College of Education, Zagazig University, Egypt.

Alsarif, M. (2020). *The impact of Enrichment Activities in Geometry on Improving Spatial Reasoning, Critical Thinking and Motivation in Mathematics among Sixth Grade Students*. [Unpublished doctoral dissertation], College of Education, Yarmouk University, Jordan.

Alseed, R. (2001). *Enrichment Activities and their Impact on the Teaching of Mathematics at the Preparatory Stage, Publications of the Supreme Council of Universities*, the Permanent Scientific Committee for Education and Psychology, Cairo.

Badawi, R. (2008). *Including mathematical thinking in mathematics in school mathematical programs* (1st ed.). Amman: Arab Thought House.

Baz, M. (2020). Improving visual literacy skills through news photos. *Journal of Inquiry-Based Activities (JIBA)*, *10*(*1*), 61- 82.

Bokas, N. (2002). *A proposed model for a training program in developing the skills of teaching scientific curricula at the College of Education*. Saudi House for Publishing and Distribution.

Bomgaars, J. & Bachelor, J. (2019). Visual thinking strategies: exploring artwork to improve output in the L2 classroom. *Journal of Foreign Language Education and Technology*, *5*(*1*), 1- 34.

Brand, W. (2020). *Visual thinking: Empowering individuals and organizations through visual collaboration*. (Trans: Nada Alsamman; 1st ed.), Amman: Jabal Amman Publishers.

Frazier, A. & Bryant, C. (2019). Developing visual- spatial thinking in youth using sensori-motor experiences: approaches from a Piagetian cognitive framework. *Journal of Pedagogical Research*, *3*(*3*), 99- 112.

Kapanadze, D. (2018). The effect of using discourse analysis method on improving cognitive and affective skills in language and literature teaching. *European Journal of Education Studies*, 4(5), 92- 107.

King, B. (2019). Using teaching through problem solving to translate in- service teachers' thinking about instruction. *Journal of Mathematics Teacher Education of Development*, 1(3), 169- 189.

Kojak, K. (2001). *Modern trends in curricula and teaching methods*, (2nd ed.). Cairo: Alam Al-Kutub.

Momcilovic, O. (2020). Improving geometry teaching with Scratch. *International Electronic of Mathematics Education*, *15*(2), 1- 8.

National Council of Teachers of Mathematics (2009). Mathematics specialists and Mathematics coaches: what does the research says?, *NCTM Research Brief*.

National Council of Mathematics Supervisors (2000). We need elementary mathematics specialists now, More Than Ever: A Historical Perspective and Call to Action, *NCSM Journal*, 53- 60.

Piggott, J. (2004*). Mathematical enrichment: what is it and who is it for?*. Paper Presented at the British Educational Research Association Annual Conference, University of Manchester, 16- 18.

Saleh, M. (2012). *Contemporary trends in mathematics education*, (2nd ed.). Amman: DarAlfikr.

Sholihah, U. & Maryono, M. (2020). Students' visual thinking ability in solving the integral problem. *Journal of Research and Advances in Mathematics Education*, *5*(*2*), 175- 186.

Yazicioglu, T. & Akdal, D. (2020). The opinions of the classroom teachers about the enrichment educational program for gifted students who continue to the inclusive classes. *International Journal of Progressive Education*, *16*(*6*), 202- 214.

Voskoglou, M. (2019). Comparing teaching methods of mathematics at university level. *Journal of Educational Sciences*, *9*(204), 1-7.

Wiggins, H.; Harding, H.; & Engelbrecht, J. (2017). Student enrichment in Mathematics: A case study with first year university students. *International Journal of Mathematical Education in Science and Technology*, *48*(*1*), 16- 29.

Zachariah, B. (2020). Observing the effects of hands-On activities on Mathematics teacher confidence in geometry and statistics: A Case Study. *Wilf Malcolm Institute of Educational Research*, *20*(*1*), 29-42.

Zytoun, K. (2000). *Teaching Science from a Constructivism Perspective*. Alexandria: Scientific Bureau for Computer and Publishing.