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The educational and geometric psychological impact of origami on sixth graders

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1. Introduction

Teaching mathematics in general depends on traditional learning in most schools, as it hinders the acquisition of the skills and mathematical concepts behind the processes they use when solving a mathematical problem or question, and thus students have difficulty understanding the properties of the concepts they have learned and linking them with other concepts.

Therefore, the present study comes to show the importance of teaching mathematics to overcome such problems and difficulties, which shows the importance of multiple representations in mathematical and geometrical learning, and the importance of multiple examples in the educational process, which depends on learning through origami. Contributes to student activity in the learning process as it contributes to the identification of learning processes. Learn, discover and build information by ensuring their active participation with appropriate tools and activities.

Thus, the aim of the present study is: The present study is designed to know the effect of origami's educational and geometrical interaction on sixth graders.

The results indicate that learning through paper folding, i.e. origami, contributes to the development and improvement of students' educational skills more than traditional learning.

2. Literature review

2.1 Representations in Mathematical teaching

Mathematics, which is taught as a core and weighted course the rough out the years of education from elementary to high school, is considered by students as an abstract and difficult course to understand, it allows them to memorize it directly and thus efforts are made only to improve it. As most teachers say, the definition of succeeding in mathematics is the ability to use formulas and their rules and methods instantly correctly, and to do the calculation in the right way today. Therefore, when mathematics is taught in traditional teaching processes, the information is prepared, presented and followed by solutions with individual and correct answers that are required to the use of what is learned.

In such an educational environment, it is difficult for students to acquire the skills and attainment that the mathematics curriculum expects of them. So, many students are unaware of the mathematical concepts behind the processes they use when solving a mathematical problem or question and what mathematics actually means; Hence students think of learning mathematics as performing actions using meaningless formulas and symbols and try to learn mathematics by routine learning. As a result, students have difficulty grasping the characteristics of the concepts they have learned and relating them to other concepts (Omer, 2020).

Therefore, mathematics must be taught in order to overcome such problems. If students are meant to learn a mathematical concept intentionally and hesitantly, they should be allowed to ask questions about the idea, exchange opinions with others, and perform activities. As is well known, students learn best through practice and experience; by choosing the right toolkit and materials, classroom environments should be designed to ensure that students are active in the learning process (Turkosy & Taslidere, 2016).

In other words, the teacher needs to prepare appropriate learning environments that will be effective in the students' learning process and help them become familiar with the learning processes and the discovery and construction of information by ensuring their active participation (Akpinar, 2010).

When teachers select and use appropriate materials, that will help students embody concepts while learning mathematical concepts that are abstract in nature, (Teyfur, 2011) by creating effective learning environments through the use of appropriate tools and activities so that curriculum objectives can be more easily achieved.

Manual activities that students do by themselves by actively participating in them during the course allow them to learn better concepts, as well as use models, tools and mathematical materials to enable students to take a more active role in the math teaching process.

Thus, the use of learning environments allows different teaching materials for students to clearly examine previously explored concepts for their ideas, explore some new features of the idea, discuss and present their own meaningful information enabling students to achieve more and more memorable learning by providing tangible learning results (Bozkurt & Polat, 2011).

It is important and necessary to make concrete use of the material as much as possible in teaching new concepts, and assessments to be made when teaching mathematics in primary and secondary schools (MEB, 2018), which helps students realize the basic properties of a concept and improve their imagination and scientific ideas.

2.2 Origami

(, for paper folding) it is the ancient art of paper folding; Traditional origami usually involves only straight folds on a flat (square) piece of paper so that tearing, cutting or gluing will not be allowed. After folding the origami a scalable surface is created that can develop into a flat plane (isometric with a flat surface), and like that; some of the activity of paper binders around the world is related to engineering. Starting with a flat initial piece of paper, its folding allows the design of patterns (flat or non-flat) related to geometry and / or art. The folding action itself involves the flat sheet as a particular mechanism, the small portion of the thickness above the volume of the paper allows it to bend along the fold lines and not stretch the fabric inside the plane. Depending on the application, the mechanical one can attach the flat sheet model to the film without bending stiffness and high tensile stiffness.

However, significant distortions occur along the fold lines that can be considered as axes between groups of individual pieces of paper that have no folds; Much progress in origami leads to flat folded models, although there are three-dimensional models available (Dureisseix, 2012).

2.2.1 Origami development and paper folding

Before World War II there were many folding traditions that may have common roots but in which they develop completely independently. The oldest documented tradition of paper folding is the Japanese tradition in Germany, Friedrich Probel - the founder of the kindergarten, promoted folding exercises in his activities for children. Thus, the first man to create the paper folding design is known as the Adolf Branch painter who created a two-layer model of a horse and rode it in the early 19th century.

The horse and raven model begins at the same folding stages called the windmill base, so that the windmill base itself begins by folding all the corners to the center and back one; this law form is called "Fold Blinz".

In the 1950s, Akira Yoshizawa developed a number of basic new forms and a new technique for creating pieces of origami by wetting paper, called wet folding.

This was accompanied by the invention of a marking system for origami folding sequences plus Yoshizawa arrows, as a result; the system became known as Yoshizawa-RandlettSystem and is the most common form today for transmitting two-dimensional origami instructions. This new marking allows sharing of more complex folding sequences.

By 1964, it already contained instructions marked by Yoshizawa while origami practice and the term spread around the world through printed publications and special interest groups.

Only in the 1980s did public awareness of origami rise (Weidner, 2018).

2.2.2 Origami are two main turning points during its development.

The first is the introduction of the common suspension system, and the second is the application of mathematics to what was the traditional art of paper folding so that origami artist Akira Yoshizawin proposed the oldest marking system in 1954. It was further modified by Randelt and Harbin in 1961, and is known as the Yoshizawa system -Randlet is still the official blogging system of the origami community.

Fold lines or geometric patterns within paper such as Florida in a sheet of paper can further define the wrinkle pattern by wrinkles, vertices and face. The fold is the line along which the fold occurs, the vertex is the meeting point of the number of wrinkles and the face is the areas restricted in wrinkles. Head rank is the number of folds closest to the head; the fold is a fold with the angle of fold assigned as a deviation from the drop in the case of a cut between the sheet and a plane perpendicular to the fold (Meloni, Cai, Zhang, & Lee, 2021).

(Lang, 2017) In short, by looking at the paper from the same face of the reference plane always where it stands, two types of folds can be identified: a mountain fold if convex and a valley fold if a cave (angle between 0 degrees and 180 degrees). The Yoshizawa-Randlettnotation system represented mountain folds as ridgelines and valley folds as dashed lines; but for complex patterns.

It has been shown that origami can be applied to solve mathematical problems such as quadratic, cube, quadratic, pentagonal equations with rational coefficients, triangulation and cube multiplication.

Thus, mathematics has been widely applied in the process of designing and optimizing origami structures, it is worth noting that the mathematical models adopted during the previous design process often negate the effect of realistic properties such as capacity or thickness of a given material.

The main two reasons why such characteristics are omitted are firstly; the characteristics are simply unknown at an early stage of the planning process. Secondly: omissions can help expand design options.

Given the construction process, local design changes become necessary to adopt appropriate coupling solutions that match the initial wrinkle pattern. Once applied in a homogeneous material such as paper, origami can be described as compatible mechanisms for achieving movement through elastic deformations of wrinkles or sides. In particular; because they are fabricated into two-dimensional shapes, they can be considered as evolving lamination mechanisms and equal layout mechanisms can also be achieved using rigid panels and rotary hinges (Meloni, Cai, Zhang, & Lee, 2021).

2.3 The effect of origamis on geometry and mathematical concepts

Therefore, it is more used to build three-dimensional geometric shapes, origami can contribute to understanding the concepts of geometry (Wares, 2016).

It enables students to realize concrete mathematical concepts and improve their mathematical ideas. This way, that the use of origami in education will influence the significant contributions to the development of children's motor, mental and creative abilities in origami activities in which students participate personally. So that origami can ensure its realization in the senses field (attention and stimulation) and the psychomotor field too (requiring eye and muscle coordination) for the student, as well as in the cognitive realm of learning (MEB, 2018).
It is stated that the use of origami in mathematics teaching would increase student involvement from cognitive, emotional, and psychomotor aspects and so they could learn mathematics more easily. You can clearly see that different geometric shapes are formed even if you fold a piece and open the paper we are dealing with. The folds and knots formed when making the origami represent the different elements (side, corner, edge, surface ...) of the same shape. It allows using origami in teaching geometrical topics; a visual presentation of some concepts, features, and relationships without measurement tools such as a meter, ruler, and spur; because origami also provides visual evidence for purposeful support and conservative learning in teaching mathematical achievement (Omer, 2020).

2.3.1 Symmetry

Symmetry is an important aspect of origami in geometry. For different types of paper, constructions are grouped or classified according to types of symmetry. So that translations, rotations and satisfactions are all connected to each other in symmetry because they are both isometric; so, they become the creation of a number of other identical shapes that preserve space, angle and distance. Thus classifying origami constructions by symmetry is also a way of presenting art from a mathematical point of view and can be easily used in class when symmetrical shapes are sometimes referred to as reflexive symmetry; In addition a line of symmetry on one side that will fit the other side in a similar way.

The origami can be divided by reference to rotational symmetry and thus produce symmetry by rotating clockwise or counterclockwise; in mathematical terms, transition symmetry is the “smoothing” of a shape in any direction, as long as the shape remains the same (Hook & Paul, 2013).

2.3.2 Use of technology

Computers can be used to explore origami at a deeper level, allowing for the creation of complex volumes and numbers that would otherwise not be possible to build. There are many computer programs, such as TreeMaker, that help create complex origami designs using geometric algorithms (Hook & Paul, 2013).

2.3.3 Euclidean geometry

(Ben-Lulu & Ben-Ari, 2020) added that the basic structure of Euclidean geometry is: Angle, copy part line, copy angle, construct perpendicular to line from point A not to line, and construct perpendicular to line from point to line. So that all these can be applied in origami structures; in way that the origami power comes from placing two points on two lines, and it turns out that it allows constructions that cannot be performed using a ruler or a compass, especially constructions that require calculation of the cube roots.

2.4 Origami in Israel

Since 1993, Israeli artist Miri Golan has used origami as a tool for Israeli and Palestinian children to recognize each other as equals. Golan, founder and director of the Israeli Origami Center, founded Folding Together and oversees its Israeli component, the non-profit organization that brings children from East and West Jerusalem; who would not otherwise meet, together creating origami works (Weiss, 2018).

2.5. Purpose, research question and hypothesis

2.5.1 Research Objective:

The present study was designed to perceive the impact of origami-educational-geometrical interaction on sixth-graders.

2.5.2 Research question:

How does origami develop the geometric cognitive perception for sixth graders?

2.5.3 Research hypothesis:

Origami learning contributes to the development of effective learning and the construction of more conceptual mathematical knowledge than traditional learning.

3. Methodology

3.1 Study Design

The research set-up is a quantitative demonstration.

3.2 Study population

The study population is sixth-grade students from an elementary school in state-Arab education.

3.3 Study participants

The participants in the study are 30 sixth-grade students from an elementary school in the northern district of the country from the Arab sector. The research-related questions presented to the students were supervised by the teachers supervising my training in the field of education, and were approved accordingly.

3.4 Research tools

- Questionnaire of 10 questions in geometry.
- An educational lesson using origami
- Statistical plot SPSS according to model T.

3.5 The research procedure

- Initially, 10 geometrical questions will be handed out to show students' abilities that are dependent on traditional learning.
- Then students will be taught the origami method.
- Eventually, the questionnaire will be distributed by itself, and the students will solve it, which depends on the origami learning method.
- Accordingly, the scores are entered into the SPSS statistical program according to model T, so that it shows the difference in scores and hence; the difference between traditional learning and origami learning is collected.

3.6 Research variables

3.6.1 Independent variable

• Geometrical studies

3.6.2 Dependent variable

• Origami - Learning by folding paper

3.7 Data Processing and Analysis

The data dependent on the questionnaire were processed and reviewed by the teachers supervising my training as a teacher, which clarifies the questions in the questionnaire, and is therefore approved.

So the results of the questionnaire were analyzed using the parameter "" using the SPSS statistical program, which showed that learning through origami improves higher educational skills more than traditional learning and this, is what the research is based on.

4. Results

In this chapter, the researcher will present the results of the study, as the study included 30 sixth-grade students in an elementary school in the north of the country.

Table 1: Students who participated in the study are presented by gender.

Gender	Students number	Percentages %
Male	14	**46.6%**
Female	16	**53.3%**
Total	30	**100%**

The questionnaire questions are intended to show the possibility of identifying the objects learned in sixth grade on the subject of Objects in terms of knowing the shape, their name, and knowledge of how to create the shape, the difference between the sizes of the geometric shapes ... and so on. Therefore, the results of the questions were classified in terms of the answer into two possibilities (which are: agree or disagree), expressing the importance of knowledge or lack of knowledge. This is according to the questions presented to the students; the contents of the questions are in the sense that I can, I know, or I agree, and therefore represent the positive aspects of learning.

At the beginning, the first questionnaire was presented: the questionnaire was distributed based on the students' educational knowledge through classroom learning (traditional learning); so the student got to know the models through the supply bag that came with the geometrical book, which contains brushes for the models.

Then, a geometrical lesson is taught based on the art of origami; the questionnaire was then presented to students again to show the difference between traditional learning and origami art.

Thereby, the results showed the following:

Table 2: Explains the importance of educational perception

The statement	average	Standard deviation	minimum	מקסימום
Traditional learning	1.23	0.93168	Agree (1)	Disagree (2)
Learning through the art of origami	לא מסכים (2)	0.20423	Disagree (2)	Agree (1)

Table 3: Shows the differences between the levels of imitation learning and the level of origami learning using the results of the questionnaire.

	Learning through the art of origami $N = 30$	**Traditional learning** $N = 30$	$t(29)$
Average	1.86	1.23	-6.652^{**}
SD	0.93168	0.20423	

$** \, p < 0.001$

As a result, the results table shows that the more origami in the teaching process in geometry, the greater the mathematical perception of students, and therefore the origami learning is better than traditional learning.

Therefore, the results indicate support for the hypothesis, since the results showed that:

$$\{t\ (-6.652) = , p < 0.001\}$$

This shows the differences between the means so that the average level of origami learning (M = 1.86, SD = 0.93168) is higher than the average level of traditional learning (M = 1.23, SD = 0.20423).

Hence the hypothesis was achieved: origami learning contributes to the development of effective learning and the construction of more conceptual mathematical knowledge than traditional learning.

5. Discussion

The discussion in this chapter depends on the results that the researcher has reached in addition to the theoretical material written in the theoretical background and thus his relevance or opposition to the results.

By referring to the results and that a very large percentage of students do not learn mathematical geometry using multiple methods or tangible tools that allow students to relate to analytical perception; in addition to the higher skills presented by the Bloom scale, the results showed that the traditional learning in we use in schools, that is dependent on teaching books. Thus, showing the abstract idea of the student. It was found that the students suffer from a lack of understanding of the content and education. The results showed that 76.66% of the students lack full understanding; (Omer, 2020) stressed that students in the educational environment find it difficult to acquire the skills and achievements that the mathematics curriculum expects of them. This is why many students do not understand the mathematical concepts behind the actions they use when solving a mathematical problem and what mathematics actually mean, and for this reason, students think that learning mathematics is to deal with meaningless formulas and symbols, and trying to learn mathematics through routine learning. As a result, students have difficulty internalizing features of the concepts they have learned and relating them to other concepts.

Thus, the researcher reached at presenting the educational lesson to figures, which depend on

the organic figure, by changing the results to 83.33% in favor of organic learning, which represents the importance of learning using several tools and representations in conceptual development of the educational process; which is consistent with the theoretical material. Thus (Teyfur, 2011) confirmed that the appropriate educational materials will help students embody concepts while learning abstract mathematical concepts by nature, by creating effective learning environments through appropriate tools and activities.
This way it is easier to achieve the objectives of the curriculum. Subsequently, manual activities in learning environments for different materials allow students to explicitly examine previously discovered concepts for their ideas, explore some new features of ideas, discuss and present their own meaningful information, enabling students to achieve more and more memorable learning by providing concrete learning outcomes (Bozkurt & Polat, 2011). It helps students realize the basic characteristics of the idea and improve their imagination and scientific ideas (MEB, 2018).

So that it will be used more for building your own three-dimensional geometric shapes, which origami contributes to the understanding of geometrical concepts (Wares, 2016) so as to teach a class in sixth grade using figures that express three-dimensional objects; This origami provided visual evidence for purposeful support and conservative learning in teaching mathematics, in agreement with (Omer, 2020).

Validity and reliability

The means of validity and reliability required for the quantitative research method were taken in this study, since it covered an area of sixth grade students from an extensive area from the elementary school State-Arab for education (15 different areas). It also contained male and female students and students from different sectors.

Thirty students from 15 schools that are located in different areas were selected by simple random sampling for research.

It was also ensured that the students participating answered any question regardless of their current achievement level in order to achieve internal validity during the data collection application.

It should be noted that the questionnaire was reviewed based on comments from professionals.

In addition, for the purpose of external validity, the findings were presented in accordance with the research question.

6. Summary

The traditional learning that results from studying the book and its results are nothing but abstract concepts that the student does not understand. They contribute to his despair and isolation from an attractive learning and represent the educational process of the passive teacher who wants to complete the educational curriculum. Thus, this method affects the student negatively, contributes to delay in the process of thinking and intellectual development and does not contribute to the achieving goals of the Bloom scale goals in educational skills, and therefore it represents the lower skills of Bloom scale, which depends on purely pictorial understanding.
On that account, teachers must treat education with everything new. Origami is not considered a new subject, as it has been discovered since ancient times. However, the teaching process in schools in Israel through origami is a modern educational method that rests on its goals on the higher concepts and skills on the Bloom scale. This enables students to realize concrete mathematical concepts and improve their mathematical thinking and ideas. so that the use of origami in mathematics and geometrical education in general has an impact on significant contributions to children's motor, mental and creative abilities in origami activities in which students personally participate, and psychomotor (which requires eye-muscle coordination) as well as in the field of cognitive learning.

Thus, the use of origami in mathematics teaching increases student participation from the cognitive, emotional and psychomotor aspects, and thereby they can learn mathematics more easily, products when making origami representing the various elements (side, corner, corner, edge, surface ...) in the same way.

These imagine some concepts, features and relationships without measuring tools such as abacus, ruler and catalyst, so this origami also provides visual evidence for purposeful support and conservative learning in teaching mathematics, especially geometry.

7. List of sources

[1] Akpinar, B. (2010). The role of teacher, student and parent in constructivist approach . *Overview of Education, 6(16)*, 16-20.

[2] Ben-Lulu, O., & Ben-Ari, M. (2019). The Mathematics of Origami for Secondary-School Students. 1-32.

[3] Bozkurt, A., & Polat, M. (2011). Teachers' views on the effect of modeling with counters on learning integers. *Gaziantep University Journal of Social Sciences, 10(2)*, 787-801.

[4] Dureisseix, D. (2012). An Overview of Mechanisms and Patterns with Origami. 1-14.

[5] Hook, N., & Paul, K. (2013). Beyond the Fold: The Math, History, and Technology behind Origami. *Ohio Journal of School Mathematics 67*, 21-26.

[6] Lang, R. J. (2017). Mathematical Methods forGeometric Origami,.

[7] MEB. (2018). Mathematics curriculum (Primary and Secondary School 1, 2, 3, 4, 5, 6, 7 and 8th Grades). Ankara: Talim Terbiye Board President. .

[8] Meloni, M., Cai, J., Zhang, J., & Lee, D. S.-H. (2021). Engineering Origami: A Comprehensive Review of Recent Applications, Design Methods, and Tools. *The Authors. Advanced Science published by Wiley-VCH GmbH*.

[9] Omer, N. (2020). Use of Origami in Mathematics Teaching: An Exemplary Activity . *Asian Journal of Education and Training* , 285-296.

[10] Teyfur, M. (2011). The evaluation of the effect of classroom management ımplementation in constructive learning approach applied by the form tutors. *The Inonu University Journal of the Faculty of Education, 12(2)*, 139-164.

[11] Turkosy, E., & Taslidere, E. (2016). Effect of ınstruction enriched with active learning tecniques on 5th grade students’ academic achievement and attitudes towards science technology course. *Journal of Kirsehir Education Faculty, 17(1)*, 57-77.

[12] Wares, A. (2016). Mathematical thinking and origami. *International Journal of Mathematical Education in Science and Technology, 47(1)*, 155-163.

[13] Weidner, W. (2018). Origami - from ancient tradition to global art, Diffusion of Origami to the USA and Germany in the 1980s. 1-11.

[14] Weiss, M. (2018, MARCH 1). *ORIGAMI ARTIST BRINGS TOGETHER ISRAELI AND PALESTINIAN CHILDREN*. Retrieved from THE DAYTON JEWISH OBSERVER: https://daytonjewishobserver.org/2018/03/origami-artist-brings-together-israeli-and-palestinian-children/

8. Appendices

8.1 Appendix 1: The Student Questionnaire

Dear Student: Answer the questions according to your knowledge of geometrics in the subjects you have studied.

By placing a circle on the answer that seems right to you.

Questions	I agree	I disagree
1. I love the geometry subject.	(1)	(2)
2. I participate in educational events in geometry.	(1)	(2)

3. I can identify objects by their different names.	(1)	(2)
4. I can classify geometric shapes by: surface, angles, polygon...	(1)	(2)
5. I can distinguish between polyhedrons.	(1)	(2)
6. I draw three-dimensional models.	(1)	(2)
7. I call the stereotype according to the rule.	(1)	(2)
8. I can distinguish between the triple pyramid, the square pyramid, the pentagonal pyramid ...	(1)	(2)
9. I can distinguish between a cube and a box.	(1)	(2)
10. I built a three-dimensional model.	(1)	(2)