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learning and teaching mathematics through origami method to primary school students in Iran

Abstract

This study aims at determining the correct and applied methods of origami techniques to facilitate learning mathematics concepts, and presenting them to primary school teachers. This was quasi-experimental research done with pre-test and post-test with a control group within six months in Iran. The statistical sample consisted of 92 girl students in the primary grade of Hazrat Zainab school as the examination group and 87 girl students from Farhang and Adab schools were also selected randomly as a control group. Nonparametric and Chi-square tests were used for data analysis. The findings of this study confirmed the hypothesis of determining the correct and applied method of origami art as a teaching method to facilitate learning mathematics concept and presenting it to primary school teachers (P-value of ≤0.05). The next hypothesis of the effectiveness of origami as a teaching method to enhance manual dexterity was confirmed (P-value of ≤0.05). Also, another hypothesis determining the correct and applied methods of origami techniques to create better order and arrangements in the works was confirmed (P-value of ≤0.05). And the last hypothesis about determining the correct and applied methods of origami techniques to turn the mathematics class into a fun and happy atmosphere was confirmed too (P-value of ≤0.05). In conclusion, origami as a new method of teaching in primary school can be entered into the educational system.

Keywords: *Origami method, Mathematics, Primary school students*

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1. Introduction:

Art is the most effective instrument and approach for educating people today. It provides a variety of benefits, particularly for creativity and mental wellness. It is more important than ever to employ art in classrooms to foster creativity and improve kids' mental health since it can help humans reach the pinnacle of evolution in terms of their great requirements[1-3]. The formative years of school are a good time to build the student's logical thinking and to organize their minds around the concepts of time, location, and cause. As a result, the child's autonomy would decrease, and their sensorimotor coordination would be clinically developed. Teaching origami is crucial for the growth of required abilities, the fostering of mental and nurturing qualities, the reinforcement of creativity, the coordination of motions and actions with emotional relationships, and the improvement of focus and attention. [4].

In fact, mathematics is a course that is difficult for most students from primary education up to the level of secondary education; and statistics show that the majority of students fail the final exams of mathematics more than other courses. Today duties and responsibilities of teachers have become heavier and more complex than in the past. It is no longer possible to lead Society and its people to a sophisticated and advanced development by traditional methods [5].

Therefore, when learning mathematics, the use of charts or forms increases the speed and depth of learning in students. The peak of efficient use of charts is the use of hand-made shapes. Making forms with paper and folding in addition to being simple, accurate, and cheap can result in scientific learning and rediscovery of mathematical rules by students themselves. In particular, the use of these hand-made shapes in teaching geometry rules can simplify remembering them. The use of folding paper and making forms in art is different from that in teaching mathematics. In art, paper and folding are used for making crafts or displaying animals, while, paper and folding in teaching mathematics is used to show that the mathematical theorems and geometric problems are true; and mathematical rules and problems are also used to determine proper folds which can enable the paper to show a theorem [6].

Therefore, origami is full of dreams which are mixes of art and science. When a paper is folded, peace and wish are displayed especially in this era in which everything is motorized and humans have cold and spiritless feelings. Origami makes the relationship between humans closer. It is an art therein creativity and accuracy lie, therefore from the economic point of view, it really helps. After the invention of paper, it seems that folding paper is inherent in human beings and there is no need for specific learning and teaching it. Earlier, origami was used to make tools and equipment of life but gradually became a visual art. Intellectual designing, a combination of shapes, and coordination of colors are needed for constructing an origami form. Special visual powers which form all these visual arts are needed for making three-dimensional objects. Origami art efficiently increases handcrafts and learning them, and handcrafts lead to scientific progress which requires using hands accurately. Extensive use of lines and pages when working with origami leads to an increase in concentration and attention, and in terms of mental health leads to peace of mind and strengthened self-confidence [4].

Andreass recounted his experiences of teaching origami as an extracurricular activity to middle and high school students. His experiences include teaching and learning processes of origami based on organized workshops in some schools. His research aims at revealing the effect of this art on the education process at two levels: 1. behavioral (effective improvement in the relationship between students and teachers), 2. Learning (origami helps students develop their understanding) [7]. Pearl in an article titled "Folding paper for learning and teaching mathematics by manual dexterities" concluded that students can learn mathematics well if they acquire and build their own mathematical understanding [8].

Conadas used origami to teach three-dimensional geometry concepts. Investigations showed that when people construct origami models, they use their hands and focus on the work; and this leads to meaningful learning. Previously, researchers had worked on training to focus and learn flat geometry concepts, such as parallelism, polygons, angle, and so on by making an object out of the paper [9]. Also, Chen reviewed the use of origami in teaching mathematics to students who are deaf and hard of hearing and found that origami can be extremely beneficial for training people and general education. Students who are deaf and hard of hearing learn better by seeing, feeling, and touching. Some suggestions on how to teach mathematics to students with hearing impairment using origami are included in this article [10].

Sze examined ways to solve the mysteries of mathematics with origami. In his opinion, good teaching to students gives them the opportunity to learn mathematics in the context of constructing origami models; so, since origami is cheap and does not have budget and equipment constraints, it can be a good alternative for many learning assist tools and computer equipment and facilities for making diagrams and etc [11]. In another research, Sze showed that origami is an indicator of six productive learning styles: 1. Hands-on learning, 2. explicit instruction, 3. Higher order thinking, 4. multimodal instruction, 5. Social learning, and 6. Self-management strategies. In his opinion, origami is a process that adjusts mental and physical models by providing the limited environment, purposeful learning, multiple intelligence, multimodal instruction, mental concepts, various pedagogy models, self-management, problem-solving, positive reinforcement, and recognizing proper training methods; because at the time of creating origami models, both right and left brain hemispheres are simultaneously involved [12]. And Philips in his research concluded that origami can be an appropriate learning method for those students who do not listen to the teacher in the classroom [13].

In his article, Babaee came to the following conclusion on the impact of the origami process on tree domains: First, in the area of cognition, training in origami has been shown to be beneficial for reinforcing knowledge of geometric ideas, directions, spatial intelligence, and problem-solving, as well as for boosting creativity. The development of emotional connections has benefited from learning origami in the second affective domain. The pupils also felt a sense of satisfaction and pride when creating the forms. The psychological-emotional domain is the third, because mastering origami helps pupils feel confident, improves their scientific knowledge, and uplifts their spirits [4]. In his article, Amiri came to the conclusion that the originality of the girls who had mastered origami was greater than the inventiveness of the boys. Additionally, origami-trained boys and girls showed greater inventiveness than their non-origami counterparts [14].

If we know that the main goal of education is applied learning methods and training powerful and formidable persons, the question arises as to how schools can make this goal possible. According to the research on teaching mathematical concepts and easy learning for primary school children, origami and paper games can facilitate learning for children.

Aims of the Study

Determining the correct and applied methods of origami techniques to facilitate learning math concepts and provide them to primary school teachers.

Determining the correct and applied methods of origami techniques to enhance manual dexterity.

Determining the correct and applied methods of origami techniques to create better order and arrangements in the works.

Determining the correct and applied methods of origami techniques to turn the mathematics class into a fun and happy atmosphere.

Material and Methods

Study design

A quasi-experimental design with a pretest and posttest with a control group was used. The present research is applied and its independent variable is the factor of teaching math concepts through origami that was performed on the experimental group. The dependent variable of this research is facilitating learning math concepts through origami (manual dexterity, creating order and arrangement, sense of cooperation, turning mathematics class into a fun and happy atmosphere) whose changes were measured after and before performing the independent variables on the experimental group. Training items were selected from first to sixth-grade books.

Study sample

The statistical population of this research consisted of 92 girl students of Hazrat Zeinab private school who are enrolled in the academic year 2014-2015. The sample of the study was selected randomly from first-grade to sixth-grade students. The students are aged between 7 to 12 years. The control group in

this study consisted of 87 students from Farhang o Andishe private school who were selected randomly.

Search strategy

In this study, at first, a meeting with the school principal and all six grade teachers as well as origami teachers was held and the researcher described the method of teaching math concepts through origami to make them acquainted with the process and educational goals. Data collection was through observation: Using origami method for schoolchildren and the students' work in class and collection tools in this study are divided into two parts:

a) The first part is related to the main hypothesis of the research in which October Mathematics scores of students as pre-test was collected for measuring the ease of learning mathematical concepts. From early November to late February, origami training in mathematics classrooms was done by an origami teacher. In early March, the mathematics scores of the students were collected as post-test.

b) Second part is related to sub-hypotheses of the research in which a questionnaire made by the researcher herself was used for assessing manual dexterity, creating order and arrangement, a sense of cooperation, and turning mathematics class into a fun and happy atmosphere. The questionnaire was presented to teachers in the form of 4 questions 4 options and a nonparametric chi-square test was used for data analysis.

Results

Because the points are presented sequentially, it is not possible to evaluate this hypothesis using techniques like analysis of covariance; instead, a nonparametric chi-square test was utilized. The chi-square test was used to determine if grouping had an impact on how the scores changed or not. The following hypothesis may be expressed statistically as follows:

Table 1. Agreement relating to points changes in control and experimental groups in the Origami method is effective in facilitating learning mathematical concepts hypothesis.

Total	points changes				
	Improvement	No change			
92	27	55	Number	Experimental	groups
%100	%33	%67	percent		
87	11	64	Number	control	
%100	%15	%85	percent		
157	38	119	Number	Total	
%100	%24	%76	percent		

P-Value ≤ 0.008 Degree of freedom=1 chi-square= 7/12

According to **(table 1)**, after the course, we observed a point change (improvement) of 24% in the samples analyzed. This change in the control group was 15% while changes in the experimental group were 33%. So, the improvement in points in the experimental group is far more likely than in the control group and according to the test statistic and probability (P-value of ≤0.05).

Table 2. Agreement relating to points changes in control and experimental groups in the Origami method is effective in enhancing the students' manual dexterity hypothesis.

Total	point changes				
	improvement	no change			
92	40	42	Number	Experimental	groups
%100	%49	%51	percent		
87	11	64	Number	control	
%100	%15	%85	percent		
157	51	106	Number	Total	
%100	%32	%68	percent		

P-Value ≤ 0.001 Degree of freedom=1 chi-square= 20/78

According to (**Table 2**), after the course, we observed a point change (improvement) of 32% in the samples analyzed. This change in the control group was 15% while changes in the experimental group were 49%. The improvement in points in

the experimental group is far more likely than in the control group and according to the test statistic and probability (P-value of ≤0.05).

Table 3. Agreement relating to points changes in control and experimental groups in the Origami method can be effective in creating order and arrangement in students' works hypothesis.

Total	point changes				
	improvement	no change			
92	22	60	Number	Experimental	groups
%100	%27	%73	percent		
87	10	65	Number	control	
%100	%13	%87	percent		
157	32	125	Number	Total	
%100	%20	%80	percent		

P-Value ≤ 0.05 Degree of freedom=1 chi-square= 4/39

According to **(table 3)**, after the course, we observed a point change (improvement) of 20% in the samples analyzed. This change in the control group was 13% (10 persons out of 87 persons) while changes in the experimental group were 27%. According to the mentioned material, the improvement in points in the experimental group is far more likely than in the control group and according to the test statistic and probability (P-value of ≤0.05).

Table 4. Agreement relating to points changes in control and experimental groups in the Origami method can be used for making the atmosphere of the mathematics classroom fun and happy hypothesis.

Total	point changes				
	improvement	no change			
92	46	36	Number	Experimental	groups
%100	%56	%44	percent		
87	10	65	Number	control	
%100	%13	%87	percent		
179	56	101	Number	Total	
%100	%36	%64	percent		

P-Value ≤ 0.05 Degree of freedom=1 chi-square= 31/22

According to **(table 4)**, after the course, we observed a point change (improvement) of 36% in the samples analyzed. This change in the control group was 13% while changes in the experimental group were 56%. According to the mentioned material, the improvement in points in the experimental group is far more likely than in the control group and according to the test statistic and probability (P-value of ≤0.05).

Results and Discussion

Results to show that the "Origami method is effective in facilitating learning mathematical concepts" revealing that there is a significant relationship between teaching origami and facilitating learning mathematical concepts, and in general, it can be concluded that the teaching of origami facilitates students' learning. The result of the first hypothesis of this research is consistent that origami can be an appropriate method of teaching students [13]. This research is also consistent with the results of Sze's research which explores solutions to solve mathematical mysteries by Origami [11]. Also, Chen reviewed the use of origami in teaching mathematics to students [10]. Andress also recounted his experiences of teaching origami as an extracurricular activity to middle and high school students [7]. According to the above-mentioned cases and investigations on Origami, it can be concluded that people who have regular and practical experiences with origami can learn easier than those who have not. In this research, by teaching origami or paper folding art we achieve

one of our goals which results in the students' success in learning mathematics easily.

Another finding from this study is that "the origami method is effective in enhancing the students' manual dexterity," demonstrating that there is a significant correlation between teaching origami and the students' manual dexterity. In general, it is, therefore, possible to draw the conclusion that teaching origami improves the students' manual dexterity. The outcome is also in line with the findings of previous studies [4, 7–11], which demonstrate how students may develop their physical dexterity via the practice of origami, a type of manual labor that is viewed as an intellectual game by students.

In addition, results show that there is a meaningful relationship between origami training and creating order and arrangement in works; and in general, it can be concluded that origami training creates order and arrangement in students' works [4, 7, 8, 9-11]. Therefore, artistic activities like origami in the classroom can create better order and arrangement in students' works.

And the last finding of this study is about the "Origami method can be used for turning the mathematics class into a fun and happy atmosphere". There is a meaningful relationship between origami training and turning the mathematics class into a fun and happy atmosphere and in general it can be concluded that origami training creates a fun and happy atmosphere in the classroom [4, 7-11, 15, 16]. So, Educational games like origami are meaningful and effective strategies for teaching and learning. So creativity in teaching math through origami creates a fun and happy atmosphere in the mathematics class, and the students are very interested in learning mathematics through origami.

Conclusion

This study aims at providing methods of teaching mathematical concepts through origami and providing effective and applied strategies for primary school teachers and educators in order to measure the creativity and academic achievement of students in mathematics. And origami as a new method of teaching in primary school can be entered the educational system.

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Conflict of interest

None.

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Ethics statement

None

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