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Origami: An Effective Tool for Enhancing Mathematics Learning at Primary Level Students

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Abstract

The research paper investigates the educational potential of 'Origami'as a teaching-learning tool to enhance mathematics learning at primary level. Mathematics is a fundamental part of human thought and logical thinking.It provides the effective way to built mental discipline and logical thinking Learning Mathematics is a foundational skill to be learned at primary level.National Educational Policy gives emphasis on pedagogy and acquisition of 21st century skills like, critical thinking,problem solving, logical analysis, creativity and conceptual clarity.Origami an ancient art of paper folding offers a joyful and engaging approach to teach mathematical concepts fostering logical thinking problem solving skills,spatial reasoning and deeper understanding of mathematical concepts.

Through a combination of students' assessment,classroom observation and teachers' perception , this study examines the effectiveness of incorporating Origami based activities curriculum. It also investigates how origami can be integrated to teach fundamental concept of geometry,symmetry,fraction measurement .

The research findings indicates origami also integrate art with mathematics to reinforce creativity within the child and also this simple hands on activities of origami not only captures the interest and enthusiasm of the primary children but also promotes deeper understanding of mathematical concepts.It has the potential to enhance students' engagement, concentration attention and logical thinking like higher order skills to create holistic learning experiences.

In conclusion this research highlights origami as an effective tool for learning mathematics at primary level students.The integration of origami activities not only make mathematics learning more enjoyable but also foster to acquire the 21st century skill. The findings of the research paper provide insights for the teachers, educators, curriculum developer seeking innovative approach to enrich mathematical teaching in primary level students.

Key words: Origami, Mathematics learning, Holistic development,Primary students, National Educational policy 2020

Introduction

"Mathematics is not about numbers, equations, computations or algorithms, it is about understanding"

Srinivasa Ramanusan

Mathematics is a fundamental part of human thought and logical thinking.It provides the effective way to built mental discipline and logical thinking Learning Mathematics is a foundational skill to be learned at primary level. National Educational Policy gives emphasis on pedagogy and acquisition of 21st century skills like, critical thinking, problem solving, logical analysis, creativity and conceptual clarity. In teaching mathematics at primary level is always a perennial challenge for teachers ,educators and researchers. Teachers are always seeking new innovative methods that not only foster understanding but also cultivate interest in the subject Origami is an ancient art of paper folding offers a joyful and engaging approach to teach mathematical concepts fostering logical thinking, problem solving skills,spatial reasoning and deeper understanding of mathematical concepts. Origami has emerged as an unconventional pedagogical tool for better understanding of the mathematical concepts.The art of paper folding is an incredible tool for demonstrating mathematical concepts, complex structural design, and many engineering marvels. It is because of this that origami should be considered an asset to STEM learning.

By combining the art of folding paper with concept of mathematics, this study aims to investigate the effectiveness of origami as a learning tool for mathematics at primary level.This study seek to uncover how origami can not only simplify mathematical understanding but also ignite a passion for learning within the children.

Review of Related Literature

For centuries, mathematics has consistently remained a fundamental subject in the school curriculum. It is an essential part of a child's education. In addition to its evident everyday applications, mathematics is recognized as an essential component in preparing students for the workforce requirements of the 21st century (Ferrini-Mundy, 2000).

Origami, derived from the Japanese term meaning 'folding paper,' is an ancient art form with its most iconic representation being the Japanese paper crane. Its origins can be traced back to as early as 905 CE during the Song Dynasty (Laing & Liu, 2004). And in the late 20th century, people started to understand origami in both aspects of artistic and scientific. Artists and scientists like Robert J. Lang and Erik Demaine have integrated origami with principles from mathematics and physics.

The exploration of the mathematical aspects of origami commenced in 1893 when an Indian civil servant named T. Sundara Rao published Geometric Exercises in Paper Folding which used paper folding to demonstrate proofs of geometrical constructions (Rao &Row, 1917). In 1980 was reported a construction that enabled an angle to be tri-sected, and trisection are impossible under Euclidean rules before it was proved by origami (Thomas, 2015).

Internationally, paper folding in the classroom dates back to the 1800s when the founder of kindergarten, Froebel, included the art in his curriculum as a way of promoting children's mental growth and grasp of basic geometry. Writers have cited a range of advantages, such as becoming acquainted with geometric figures and principles (Pearl, 2008), cultivating spatial awareness (Robichauz & Rodrigue, 2003), and involving children in mathematical discussions (Cipoletti & Wilson, 2004).

The new National Education Policy (NEP), 2020, provides a good platform to enhance logical reasoning and mathematical thinking. This is the necessity in the 21st century to develop logical and mathematical thinking to get employment. The NEP admits the use of mathematical skills to make the country as 'Vishwaguru'.NPE 2020 give emphasis on play way methods teaching learning process in mathematics at pre-primary and primary level:

A student is likely to remember the concepts they learn while engaged in play. Students learning and playing go side by side. It is widely recognized that learning becomes more accessible and effective when we engage in stress-free activities without the burden of academic pressure. Origami is a low cost effective and easily available learning tool which can fulfill this purpose.

Objectives Of The Study

This Paper aims to

- Study the effectiveness of origami as a learning tool in mathematics on conceptual understanding of primary students.
- To examine the motivation and engagement level of the primary students in a mathematics class through origami activities
- To investigate the teachers' perception towards integration of origami activities in math curriculum at primary level.

Hypothesis

- Origami is an effective learning tool to foster conceptual learning in mathematics for primary students.
- Hands on activities of origami can motivate the primary students to learn mathematical concepts and engage them in the class.
- The teachers have an positive perception towards the integration of origami in mathematics curriculum at primary level.

Theoretical Framework

Constructivism

The theoretical framework for using origami in mathematics education is rooted in constructivist learning theory, which emphasizes active engagement, hands on experiences and meaningful activities for construction of knowledge. Origami aligns well these principles.

Spatial Visualization

Spatial visualization is an critical skill can be learned through mathematics. It is an ability to mentally manipulate2 –dimensional and 3- dimensional figures.Origami enhances this ability among the students. This skill is essential for understanding geometry, symmetry and transformation.

Student Engagement

Students are more engaged when learning mathematics through origami activities. The hands-on nature of origami captures students' interest and motivates them to explore mathematical concepts with enthusiasm.

Conceptual Understanding

Research has demonstrated that origami can improve students' understanding of mathematical concepts such as geometry, fractions, and symmetry. Origami provides a concrete, visual representation of abstract ideas, making them more accessible and memorable.

Experiential Learning

Experiential learning is the concept of acquiring knowledge through practical engagement. It encourages students to gain firsthand experience with the subject matter. Origami, which children often enjoy, is a prime example of this approach, as it captivates students' attention through hands-on exploration and play, making learning more engaging and memorable. By constructing and deconstructing paper manipulative, activating prior knowledge, and experiencing it first hand, children find learning becomes more meaningful.

Classroom Activity

An origami-integrated mathematics lesson around the model to be folded, in this case a model of simple sail boat.

Mathematical concepts	Origami activities	Key questions
Straight Line,Square and fraction(1/2, 1/4)	Start with white side up. Fold one side of square to meet its opposite side.	- When you make both folds what shapes do you make? - How do the areas of the new squares compare to the old ones?
Diagonal of a Square, Triangle, concept of symmetry	Fold one corner of the square to meet an opposite corner of a square. Crease along fold line then open back up to the original square.	- When you fold in the diagonal of the square, what kind of shapes do you have now? - Where do all the fold lines meet?
Parallel lines, Perpendicular lines, right angle, bilateral triangle.	Take one set of opposite corners and fold them into the center of the square,	- Which two lines meet each other in right angle? Identify the parallel lines by the paper folding.

	where the two existing fold lines meet.	- How many types of triangles are formed?
Area Angles- acute, obtuse, right Quadrilateral	Hold paper in a cupped hand so it sits naturally in it.Gently push finger in center of square where folds all meet at a point. Carefully squash along folds to make shape	- What kind of angles can you find if you darken in the line segments? - How does the area of the big triangle compare to the two smaller ones?
Trapezoid and spatial relation	Fold top corner of the square up to meet the point where the two triangles meet.	- With the last fold done, what shape is the base of the boat?

Methods and Procedure

Design

A quasi-experimental design was employed in this study. Two group of primary students from class IV and V are selected as controlled group ,which received traditional mathematics instruction , and the experimental group which engaged in origami based activities during teaching learning process of mathematics to conduct the studies

Sample

- 40 students from class iv and class v were selected randomly for the purpose of the study.
- 40 primary teachers from Badachana Block having different experiences are taken randomly as sample for this study.

Tools

- Pre and post assessments were used to know the performance of the students in achieving the mathematical concepts.
- A questionnaire was developed to study the perception of the teachers of towards integration origami in class room for mathematics teaching learning process.
- Classroom observations were conducted to assess students engagement ,participation and interaction in mathematics class with origami activities
- Surveys and interviews were conducted among the teachers to gather their perception of the effectiveness of origami in mathematics at primary level.

At the outset the researcher divided the students into two groups-experimental group and control group on basis of their pretest scores.

The experimental group learn mathematics integrated with origami activities and the control group was dealt in the traditional method. At the end of the experiment the assessment of both the groups were compared and findings were arrived at.

Data Analysis

Quantitative Analysis

Quantitative data from the pre–test and post-test assessments were analyzed using statistical methods of Mean, standard deviation and t value to compare the performance of the control and experimental group.

Qualitative Analysis

Qualitative data from surveys and interviews and observations were analyzed thematically.Students/ motivation , engagement and teachers perception of origami integrated instruction were identified.

Results and Discussion

Pre test

The following were the results pre test, taken with a sample size of 20.

Group	Mean	S.D
Control group	7.5	3.2
Experimental group	8.0	3.4

Table 1: Students' Assessment

Post test

The following were the results post test, taken with a sample size of 20.

Group	Mean	S.D	't' value	Significance level
Control group	8.0	3.5		0.01
Experimental group	11.5	4.2	6.15	

Table 2: Students Assessment

The following were the results post of teachers' perception survery, taken with a sample size of 40.

Perception degree	Number	Percentage
Agree	28	70(%)
Disagree	08	20(%)
Undecided	04	10(%)

Table 3: Teachers' Perception

The above Table 1 shows that pre test stage the achievers of both the groups were nearly same. But at the post test stage Table 2 shows the experimental group shown better performance with increase in achievements mean score was increased with gain of 3.5 as against the improver in case of control group. The Table3 shows 70% teachers' perception towards the integration of origami in math curriculum is significant.

A classroom observation observation in an origami integrated mathematics class the Teacher provided clear instruction of the paper folding and ask questions basing on the mathematical concepts.

- Most of the students were highly engaged through the origami activities.They were highly enthusiastic and seeking assistance when needed.
- The Hand-on activities of origami with colored paper appeared to capture their interest,and collaborative learning working in a group.
- The origami activity effectively reinforced the mathematical concept being taught.
- Students tried to be more creative and motivated to experiment with the paper folding by their own imagination.
- They develop a spatial visualization skill by this origami activity analyzing and manipulating the 2D and 3D figures .
- A joy full and active learning environment in the class.
    - The teachers were able to facilitate individualized learning for each student.

Conclusion

The findings of of this research highlights the potential of origami as an effective tool for primary level mathematics education.It can transform mathematics education at primary level, making it more enjoyable and effective for the children .It can develop higher order skills like conceptual understanding,critical analysis, logical thinking ,problem solving ability and creative thinking among the students from the primary level and prepare them to meet the challenges of 21st century.

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Images and Diagrams