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GEOMETRY IN WARLI: MERGING FOLK ART WITH MATHEMATICS TEACHING

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ABSTRACT

The study was themed on art integration (folk art "Warli" and geometry images) in mathematics teaching and its effect on learners' achievement. The objectives were (i) to develop art-integrated mathematical instructional modules to teach mathematical concepts and (ii)To measure the effect of an art-integrated mathematical instructional intervention on learner achievement. The quasi-experimental post-test research design with a single group post-test design was used. 45 participants of 7th-grade students from Govt Upper Primary School have been selected. The intervention was designed on the Triangle and its Properties through Warli folk art and geometry images. After obtaining post-test scores, data analysis was done. Therefore, learners' overall achievement was based on learning outcomes. The results revealed that the range of achievement was between 60-95%, and achievement of remembering, understanding, and applying learning objectives was 89%, 83%, and 84%, and analyzing learning outcomes achieved 64% while evaluating and creating learning outcomes were committed to 63 % and 69 %. The results showed that the art-integrated instructional intervention was found to be positive in higher-order cognitive abilities.

Keywords: Art-Integration, Folk Art and Geometry Images, Mathematics Teaching, Learners' Achievement

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1. INTRODUCTION

Instruction and direct action are urgently needed in mathematics education to improve students' accuracy and comprehension. An observed fact is that mathematics teachers value creating an engaging and stimulating environment that considers learners' experiences and future attitudes to engage them in mathematics. The focus should be on creating formative experiences and assisting students in acquiring creative inclinations, including flexibility, perseverance, curiosity, intuition, and creativity, which are crucial for learning mathematics (Hutchinson, 2005). Art can uniquely identify, develop, and promote critical thinking, communication, collaboration, and creativity. The arts can be integrated into all forms of learning across all disciplines and levels. In the words of Brunkalla (2009)

outstanding abilities such as curiosity, communication, and expression may be developed through artistic integration which can create a positive link between academic success and arts inclusion. Surprisingly, an art-integrated approach to teaching mathematics provides a stimulating environment to the mathematics class as it talks about multiple ways of understanding. Teaching mathematics with art integration is not a new phenomenon in education. It existed in mathematics in ancient times as “Bhaskar Acharya” wrote “Lilavati text” in poetic form, including mathematical operations to be solved by some techniques and formulas considered Vedic mathematics (Bresler, 1995). Thus, researchers affirm the link between mathematics and the arts traces back to the prehistoric epoch.

Generally, mathematics and Art seem like two poles of a magnet as “mathematics is considered the mother of all sciences, and art has the same for humanities”. Confer to this, “Mathematics always deals with numbers, logic, abstractness, structures, theorems, facts, and evidence, while art deals with feelings, emotions, derives, motives, and passion (DeMoss and Morris, 2002). Mathematical and artistic connections have been proven by many academicians to extol the uniqueness and usefulness of blending these two fields. Particularly, some contend that incorporating arts in mathematics instruction assists in establishing a close connection between mathematical concepts that are both concrete and abstract (Winner et al., 2007). In addition, some scholars assert that when learners cognitively link learning content to real-world contexts, for instance, they encounter the arts and learn more effectively. Furthermore, they argue that forging linkages between mathematics and other disciplines does not hinder students' ability to use mathematics effectively. The integration of Art into mathematics is recommended to achieve a holistic approach to learning.

Educators of all disciplines acknowledge the significance of arts integration in their fields, especially math teachers. Gustline (2012) cited that McCollum illustrates how geometry activities can engage students with limited spatial cognition. Using artistic materials, they learn and scoop up math. McColm underlines that if students have prior knowledge of art experiences, they won't struggle over the learning opportunity to study. Thus, art is acknowledged as the foundation of an effective curriculum.

Gustin (2012) reports that cross-curricular integration and experiential learning (hands-on activities through Art) engage the learner's imagination as an effective tool to hold students' attention and prevent them from becoming overwhelmed by the blackboard. Consequently, she started incorporating Art into the school curriculum to integrate Art into teaching for learners to be active, focused, and motivated and came to the conclusion that multifaceted and creative skills are demanded in fields like physics, language, and mathematics. Thus, art integration is a way of educating students and providing the scope of how children can learn best. Therefore, Art can be a way of teaching content that is more inspiring than the usual way.

Concerning “Art integration” in education, the Indian NEP 2020 recommendation states that "Art integration is a cross-curricular pedagogical instructional strategy that employs multiple elements and forms. It is a root for education concepts. A portion of the more practical education, integrated art instruction can focus on schoolroom activities and not just by creating enjoyable classrooms but also by instilling Indian values over the integration of Indian Art and nation in the instruction and learning progression at all levels. This united approach Art may support the link between education and principles" (National Education Policy 2020, P. 4.7).

In the present scenario, it is demanded to do art integration in various disciplines as a cross-curricular pedagogical approach to teaching concepts in different fields. The present study has themed on the art integration in mathematics as a cross-curricular approach.

2. LITERATURE REVIEW

2.1. ART INTEGRATION

Arts integration is a "cross-curricular pedagogical approach" that aims to expand students' understanding of both the arts and non-arts curriculum through the integration of the arts (Beena & Atladara, 2021). The culture of the entire classroom can be influenced by arts inclusion with focused energy when they actively participate (Conway, 2019; Goldberg, 2016). Art is an individual's creative expression that has the power to convey thoughts of the human mind. Art genres classified as visual arts include architecture, video, painting, crafts, design, photography, sculpture, and printing (Torres, 2020). Aspects of the visual arts and other forms of arts are present in many artistic fields (such as textile Art, Conceptual Art, and performing arts). However, in addition to being primarily for aesthetic objectives, applied visual arts also include ornamental arts, decorative Art, computer art, calligraphy, fashion design, interior design, jewellery design, woodcraft, and so on (Conway, 2019).

In a broad sense, the premise and integration of visual arts in the classroom are not as challenging as one might think. Visual arts are a better fit for naturalistic, comprehensive, and actual learning. Conway (2019) distilled Art into three categories as a part of school education; "Art as Curriculum," "Art- Enhanced Curriculum," and "Arts-Integrated Curriculum." Thus, integrated art curricula are core to engaging in the creative process. Numerous connections exist between mathematics and the arts, and both fields require the ability to think rationally despite the extensive efforts of teachers to foster mathematical thinking and explain the relationship between Art and mathematics to meet standards in both math and geometry. The integration of the visual arts has confirmed that sustained engagement in art activities may aid students' mathematical reasoning drawing from visual imagination, and reflection on how to develop original ideas. In addition, teachers who actively engage in all these activities are armed with information that can assist students in rediscovering what initially interested them in teaching.

2.2. INTEGRATION OF FOLK ART BASICS IN MATHEMATICS EDUCATION

For thousands of years, folk art has been passed from generation to generation. Ancient people produced several works of art and art forms via diligence and insight (Jiang, 2020). Importantly, folk art is a priceless component of any nation reflected in a rich heritage of Art and culture, which must be preserved and continue to be practiced in all of its forms to beautify the environment. There is a close association between folk art and folklore rituals, such as festivals and ceremonies, holiday celebrations, sacrifices, and so forth (Jiang, 2020). These activities often incorporate art forms like paper-cutting, candles, mud toys, pottery sculptures, and artwork. Additionally, ethnic minorities' festival attire and decorations are considered forms of folk art. Using these artistic elements in math instruction can enable the students to comprehend certain cultural and religious beliefs, broadening their horizons while also helping to bring math education closer to daily life (Akhmetova, Mayorov & Makhmutova, 2016).

The importance of art integration in education helps the students to learn various art forms and develop a deeper understanding of Art. Teachers can use folk art aspects in the classroom to develop students' observational, creative, and imaginative skills. Despite its importance, there is no need to be Picasso or Michelangelo as a novice in essential curricular Art; the teacher simply needs to be driven, eager to learn, excited to teach, and enthusiastic about pupils. Furthermore, mathematics has generally been viewed as an utterly emotionless discipline, free of individual emotions. A partnership between arithmetic and the aesthetic delights of the arts weaved together and laced with the abstract beauty of mathematical ways of knowing (Sunzuma & Maharaj, 2020).

In contrast, Art integration in mathematics is not well documented in the existing literature and has been difficult for educators to implement in their classrooms. Recent mathematical studies reveal the academic value of art integration in classroom teaching (Bondar et al., 2021; Das et al., 2023).

2.3. RESEARCH IN THE LIGHT OF ART INTEGRATION AND MATHEMATICS

For instance, in teaching mathematics, the investigator reviewed a few previous research studies to understand what is already known in the study area and to get insight on how to proceed further. A detail of a few studies is given below; research led by Niranjana & Arjun (2021) to test the successful implementation of an integrated strategy for the Art of achieving mathematics among high school students in Kerala. The investigator noted that the implementation of pre-quasi-experimental design on 67 Eighth-grade students determined that the integrated arts strategy could be used in mathematics transactions. Still, it could not be declared an effective strategy as the constructivist strategy regarding middle school students' mathematics achievement. Sunzuma & Maharaj (2020) explored ethnomathematics approaches to teaching and learning geometry through forty in-service mathematics teachers and suggested integrating them with teaching.

As Ariba and Luneta (2018) note, primary school students at elementary schools are oriented toward creative thinking throughout mathematics and add that a Creative Assessment Tool (CAT) has been second-hand to analyze and calculate mathematical situations throughout mathematics. The findings showed sufficient evidence to support the theory that combining Art and mathematics can boost and encourage new students' imaginative propensity to obtain mathematical knowledge and understand the material and conceptual understanding. Integrating Art in Montessori mathematics influences learners' feelings about mathematics. A case study by Maneen (2016) for developing 21st-century skills of creativity, communication, collaboration, and critical thinking through art integration practices revealed that art-integrated school practice promotes the acquisition of 21st-century skills. The study recommends redesigning the curriculum emphasizing the connection between art integration practices and 21st-century skills, and adapting school infrastructure.

All the studies mentioned above exhibit the better impact of art integration in mathematics teaching and learners' achievements in terms of understanding and retention, and development of creativity, communication, critical thinking, and collaboration The studies showed a good relationship between Art and mathematics. Excepting one study in Kerla, most studies have been carried out abroad. Therefore, there is a need to explore about art-integration in mathematics teaching. The study themed to explore Art integration in mathematics as a cross-

curricular pedagogical approach to teach some mathematical concepts like a triangle and its properties and see their effect on learners' achievement.

1) Research questions

This study was twofold aimed; (i) To develop art-integrated mathematical instructional modules to teach mathematical concepts and (ii) To measure the effect of the art-integrated mathematical instructional intervention the learner achievement. Mainly, this study focuses on the art integration (folk art and Geometry images) in mathematics teaching to influence the learner's achievements. According to the anticipated art integration, there are two research questions.

- **RQ1:** How can art integration teach mathematics concepts to learners using Folk and Geometry images?
- **RQ2:** How do art-integration pedagogical approaches affect learners' achievements?

2) Method

The research study was carried out through a Quasi-Experimental design. The sample was not randomized, as the whole class with diverse learners has taken for implementing Art -integrated instructional modules. A single-group post-test design is used for conducting a research study where an experiment group is taken without a control group, the intervention to implemented in a real classroom situation, and finally assessed by a post-test Mathematics achievement test (MAT).

3) Participants

The participants included forty-five 7th-grade mathematics students from Govt. Upper Primary Schools were selected through the convenience sampling method. The investigator had taken the principal's permission from the school administration before attending the teacher experiment and involving the participants in the study.

4) Art-integrated instructional modules

To achieve the first objective and answer the first research question, the art-integrated Instructional intervention was designed on Triangle and its Properties, following the sub-topics taken to discuss content in detail (see Table. 1). During the preparation of the instructional module's investigator prepared a "discoursed based mathematics modules" and sent to expert opinion. They chose a topic that fits into folk art (Warli folk art) and geometry images. Instead of preparing an explanation of the theory, they used folk art and sketched image-based math problems or tasks for the students to make a solution.

Table 1

Duration (40 min.)	Topics &	Images	Remarks
Day 1	Angle sum of a triangle	A group of dancing girls	The total measure of the three angles of a triangle is 180 degrees.
Day 2	Exterior angle theorem	3D image prepared with triangle	A triangle's exterior angle is equal to the sum of its opposite angles.
Day 3	Vertically opposite angle	Girls are dancing on a circular path	Vertically opposite angles are equal.
Day 4	The geometric meaning of Pythagoras' theorem	Image prepared with right-angle triangle	This theorem applies only to right-angle triangles.
Day 5	Statement of Pythagoras' theorem	Peacock art poster	The hypotenuse length in a right-angle triangle equals the square of the other two sides.
Day 6	Scalene triangle	A group of dancing girls	A scalene has no line of symmetry, and all sides of a triangle are unequal.
Day 7	Isosceles triangle	Rectangular box prepared with triangles	Two sides are of equal length.
Day 8	Equilateral triangle	Triangle	All sides are of equal length.
Day 9	Right-angle triangle	Heart art poster	One of its interior angles is equal to 90 degrees.
Day 10	Acute angle triangle	Rectangular poster prepared with triangles	Each angle is less than 90 degrees.

Table 1 Timeline of the Art-Integrated Instructional Modules on the Topic

5) Art-integrated Instructional Intervention Modules

Module No. 1 ("Angle Sum of a Triangle")

To Teach the “Angle sum of a triangle," authors have sketched the image of "A group of dancing girls." The Warli folk artwork is the kind of tribal artwork created by tribal people in the northern Sahyadri range. The artistic work of warli tribal artwork originally belonged to Maharashtra.

Table 2

Step 1- On colored paper, draw a triangle and label the interior angle of the triangle.	
Step 2–Now, cut it out and arrange the three angles so that their vertices meet at one point with no overlap. Then we get a straight-line angle which is 180 degrees.	 Hence "the total measure of the three angles of a triangle is 180 degrees."
The teacher selects the image of a group of dancing girls for art-integration	
	
Step 3-In image 1, learners chose triangle ABC, then marked all angles, cut it out, put it on a straight line, and observed that three angles of triangle ABC covered the upper part of the line. Similarly, they choose triangle ADE, and we get that angle A+D+E =180 degrees.	
Step 4-Learners choose the triangle HGF of image 2 and calculate that angle H+G+F =180 degrees. Then choose angle HIJ and get that angle H+I+J = 180 degrees.	
Step 5-Similarly, learners verify that for image 3 Angle K+L+M =180 and Angle M+N+O =180	
Similarly, learners choose the triangle from the other figures and calculate the sum of the angles. They infer that every figure has two opposite triangles with a sum of 180°. The number of girls can be added to the image to do more practice.	

Table 2 Warli Folk Art-Based Angle Sum Organization for Student
Source https://images.app.goo.gl/dR7mmv695L8mh5pD8

Module No.2 ("Exterior angle theorem of a Triangle")

To teach "the Exterior angle theorem of a triangle," the authors have sketched the 3-D image. The image was developed for calculating the area of the 3D image with the help of a given triangle.

Table 3

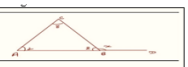
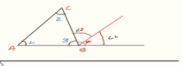
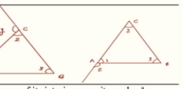
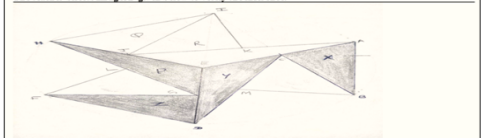
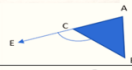
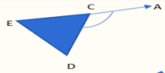
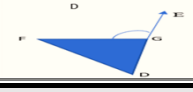
Step 1- On colored paper, draw a triangle ABC and label the interior of each angle. Now increase the AB line to D and make an exterior angle X.	
Now cut out the opposite interior angle of X and arrange two angles so that their vertices meet at one point B with no overlap on the exterior angle side. Here we can see that angle 1& angle 2 cover angle X properly.	
Similarly, learners can draw two other triangles with measure and conclude that Angle Y =angle 1 +angle 3 and Angle Z=angle 2+angle 3	
Hence, it is inferred that "An exterior angle of a triangle is equal to the sum of its interior opposite angles." **The teacher selects Image3D given below to verify the inference.**	
	
Step 2- Learners have chosen triangle X and increased line AC for point E, then by exterior angle theorem, they get Angle C=angle A+ angle B	
Step 3-Another that learners get extra triangle Y and for that draw exterior angle C then angle C= angle E + angle D	
Step 4-Learners have chosen triangle Z and increase line DG for point E, then but exterior angle theorem, and get Angle G=angle D+ angle F	

Table 3 3D Image-Based Exterior Angle Theorem Organization for Students

Module No. 3 ("Vertically opposite Angle")

To teach "Vertically opposite angles," authors have sketched the image of dancing girls on a circular path. By using the concept that vertically opposite angles are equal, we can divide a circular path into equal parts. The following pedagogical activities have been taken:

Table 4

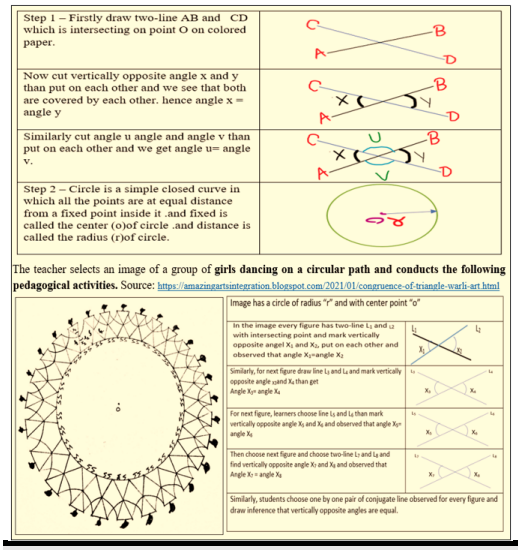


Table 4 Dancing Girl Image Based Vertically Opposite Angle Organization for Students
Source https://mobile.twitter.com/julierwright/status/767962342357204992

Module No. 4 ("PythagorasPythagoras Theorem")

To teach the "Pythagoras theorem," authors have sketched the image of a triangle prepared with a right-angle triangle. This image was created by Julie Wright mathematics teacher. This image was created to calculate the area of some big Right-angled triangles by dividing them into small triangles.

Table 5

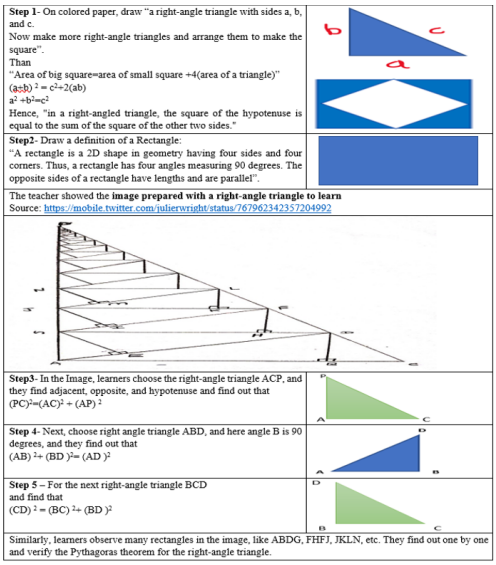


Table 5 Mathematics Teacher Created an Image-Based Pythagoras Theorem Organization for Students

Module No.5 ("The Statement of Pythagoras Theorem")

To teach "the Statement of Pythagoras theorem," authors have sketched the Image of a Peacock art poster. Pythagorean spiral was initially made by "Theodorus of Cyrene, Ga reek Mathematician of the 5th century BC". A Pythagorean spiral is a circular pattern arrangement of right triangles wherein the hypotenuse with one right triangle is a leg of the next right triangle.

Table 6

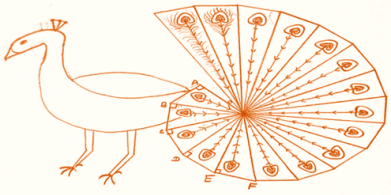
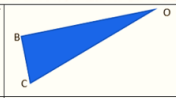
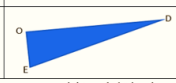
Rule: "In a right-angled triangle, the square of the hypotenuse is equal to the sum of the square of the other two sides."

Step 2 – Now, by selecting the hypotenuse of triangle OAB as adjacent to right-angle triangle OBC, then apply Pythagoras theorem for that. $[(OC)^2 = (OB)^2 + (BC)^2]$ 
Step 3- (Students activities) Learners select the next right-angle triangle OCD and find out that. $[(OD)^2 = (OC)^2 + (CD)^2]$ 
Step 4 – For the next right-angle triangle ODE, they find out that $(OE)^2 = (OD)^2 + (DE)^2$ 
Similarly, learners observed that in this image, there are many right-angled triangles and the hypotenuse of the first angle is the opposite side of the next right-angle triangle. By repeating this process, learners verified the Pythagoras theorem for all right-angle triangles in this image.

Table 6 Peacock Art Poster Image-Based Statement of Pythagoras Theorem Organization for Students

Source https://amazingartsintegration.blogspot.com/2021/06/pythagoras-theorem-from-artists.html

Modules No.6 ("Scalene Triangle")

To teach the "Scalene triangle," authors have sketched the image of a group of dancing girls. This Warli art-folk artwork is a kind of tribal artwork.

Table 7

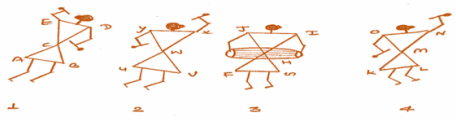
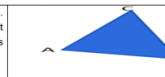
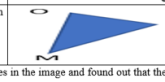
Step 1- Draw a triangle with sides A, B, and C on colored paper (All sides are different) There is no symmetric line. 

Step 2- First, learners take triangle ABC from Figure No. 1 in the given image. On measuring sides, they get that all sides have different measurements. Therefore, this is a scalene triangle. 
Step 3- Similarly, they chose triangle CDE and observed that side CD, side DE, and side EC are different. This is verified that this is also a scalene triangle. 
Step 3 –Learners choose triangle UVW for Figure 2 in the image and find out that. $UV \neq VW \neq WU$. Therefore, again verify that this is a scalene triangle. 
Step 4- Learners choose triangle MNO for Figure 4 in the image and find out that $MN \neq NO \neq OM$ Therefore, this is a scalene triangle. 
Similarly, learners chose other triangles from the figures in the image and found out that their sides were not equal and verified that the triangles in the image figures were scalene.

Table 7 Warli Art-Folk (Dancing girls) Image-Based Scalene Triangle Organization for Students

Source https://images.app.goo.gl/dR7mmv695L8mh5pD8

Module No.7 ("Isosceles Triangle")

To teach the "Isosceles triangle," the authors have sketched the image of a rectangular box prepared with triangles. This was created for calculating the area of a rectangle if the area of triangles is given.

Table 8

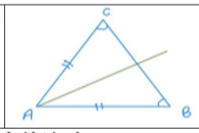
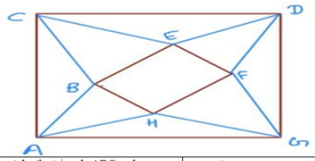
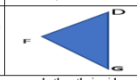
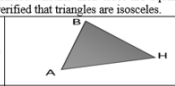
Step 1- Firstly, draw a triangle ABC with two sides of the same length (AB=AC). Then draw a line AD on BC, which is the symmetry line of the triangle. On folding the triangle with symmetry, it is observed that angle B is equal to angle C. Thus, in an isosceles triangle – (i) two sides have the same length (ii) the base angle opposite to the equal sides is equal.	
The teacher took an image of a rectangular box prepared with triangles.	
	
Step 2- In the image, learners take the triangle ABC and measure that side AB = BC. Now fold this triangle with symmetry, then find that angle A = angle C. Therefore, this is an isosceles triangle.	
Step 3- Select triangle DFG and measure that side DF=FG. Now fold this triangle with symmetry, then find that angle D= angle G Similarly, learners verified that triangles are isosceles.	
Step 4- Similarly, learners select triangles AHG and DEC, measure whether their sides are equal or not, check their symmetry, and determine whether their angles are equal. They verified that triangles are isosceles.	
Step 5- Select triangle ABH and measure that side AB = AH. Now fold this triangle with symmetry, and find that angle B = angle H. Hence, this is an isosceles triangle.	
Step 6- Select triangle DEF and measure that side DF=DE Now fold this triangle with symmetry, then find that angle E= angle F	
Similarly, learners verified that all triangles are isosceles in the image.	

Table 8 Rectangular Box Image-Based Isoscalene Triangle Organization for Students

Module No. 8 ("Equilateral triangle")

To teach the "Equilateral triangle," authors have sketched the image of a triangle. This image was created for calculating the area of an equilateral triangle if one small equilateral triangle area was given.

Table 9

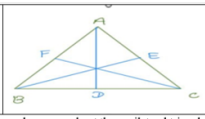
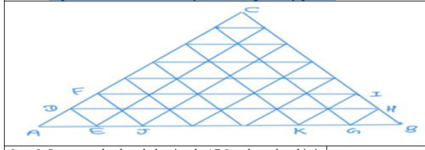
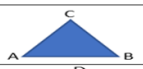
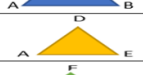
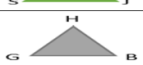
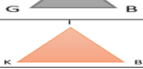
Step 1- Firstly, learners draw a triangle ABC, which is symmetric about line AD on BC, line BE on AC, and line CF on AB. Therefore, by using the isosceles triangle property, they get that "AB=BC=AC And angle A=angle B =angle C" Hence "A triangle in which all three sides are of equal length is called an equilateral triangle."	
The teacher takes the Heart Geometry Puzzle image given below to explore more about the equilateral triangles. Source: https://www.whatdowedoallday.com/heart-geometry-puzzle/	
	
Step 2- Learners take the whole triangle ABC and see that this is symmetric with three lines and AB=BC=CA. Hence this is an equilateral triangle.	
Step 3-Select triangle ADE and see that this is symmetric with three lines and AD=DE=EA. Hence this is an equilateral triangle.	
Step 4-Choose triangle AJF, and we see that this is symmetric with three lines and AJ=JF=FA. Hence, this is an equilateral triangle.	
Step 5- Select triangle BGH, and we see that this is symmetric with three lines and BH=HG=GB. Hence this is an equilateral triangle.	
Step 6- select triangle BIK, and we see that this is symmetric with three lines and BI=IK=KB. Hence this is an equilateral triangle.	
Similarly, learners verified that all triangles are equilateral in the image.	

Table 9 Teacher Sketched Image-Based Equilateral Triangle Organization for Students
Source https://www.whatdowedoallday.com/heart-geometry-puzzle/

Module No. 9 ("Right-angled triangle")

To teach the "Right-angled triangle," authors have sketched the Image of Heart Poster. This image was created to calculate the area of the heart with the help of a small right-angled triangle.

Table 10

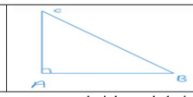
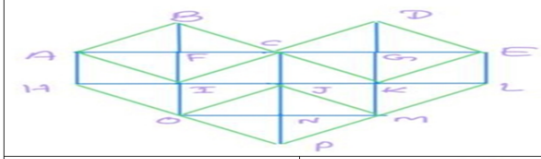
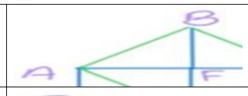
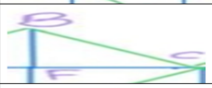
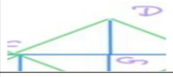
Step 1- definition – "A right-angled triangle is a triangle that has one of its interior angles equal to 90 degrees or anyone is a right angle. Here angle A is the right angle."	
The teacher takes the following image *Heart art poster* to teach right-angled triangles.	
	
Step2- Select triangle ABF, and we measure that angle F is a right angle, so this is a right-angled triangle.	
Step3 - we select triangle BFC, and we measure that angle F is a right angle, so this is the right-angled triangle.	
Step4 – Next, we select triangle CGD, and we measure that angle G is a right angle, so this is the right-angled triangle	
Step5 – Next, we select triangle DGE, and we measure that angle G is a right angle, so this is right- an angled triangle.	
Similarly, students found that all triangles are right angle and find out that right angle.	

Table 10 Heart Poster Image-Based Right Angled Triangle Organization for Students

Module No. 10 ("Acute angle Triangle")

To teach "Acute angle triangle," authors have sketched the image of a rectangular poster prepared with triangles. This image was created for calculating the area of the rectangular box by dividing the box into an acute angle triangle.

Table 11

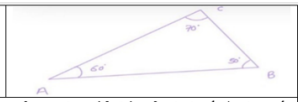
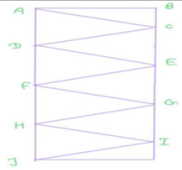
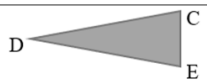
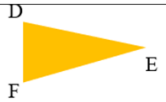
Step 1- Definition- "A triangle which has the angle between any two sides is less than 90 degrees, is called an acute angle triangle. Here all angles A, B, and C are less than 90 degrees in measure."	
The teacher takes the following image **rectangular poster with triangles** to teach Acute angle triangles.	
	
Step 2- In the image, learners choose triangle ABC and then measure each angle with the help of a protractor. They found that each angle is less than 90 degrees. So, this is an acute triangle.	
Step 3- now select triangle CDE then measure each angle with the help of a protractor. They found that each angle is less than 90 degrees. Hence, this is an acute triangle.	
Step 4- select triangle DEF, then measure each angle with the help of a protractor. They found that each angle is less than 90 degrees. Hence, this is an acute triangle.	
Similarly, they check all triangles in the image and verify that all are acute triangles. The image can be extended to give more practice.	

Table 11 Sketched Image-Based Acute Angle Triangle Organization for Students

After conducting a ten-day Art-integrated Instructional intervention, a post-test (MAT) was administered.

3. MEASURES

The self-constructed mathematics achievement test, including the 25 items to measure learners' math achievement, was used in this study. The MAT was constructed as per the Anderson Krathwohl taxonomy. The following items were constructed for each dimension of taxonomy, including Remembering (Six items), understanding (four items), Applying (Three items), Analyzing (Five items), Evaluating (three items), Creating (four items). The blueprint was developed before preparing the questionnaire following the weightage given to learning outcomes; contents (same topic as used in modules), and types of questions (True/False, Fill in the blank, Multiple-choice questions, Matching).

4. DATA ANALYSIS

The quantitative data analysis in this study involved several steps to obtain results. To achieve the second objective and answer the second research question, the scores obtained through the post-test (Mathematics Achievement Test) are shown in Table 1 given below.

Table 12

Table 12 Frequency Table of the Student's Achievement

Percentage Interval	No of the Students (%)
60-70	26
70-80	26
80-90	37
90-100	11
Total	100

The results obtained and shown in the above table describe that the mathematical academic achievement scores are found in between 60 % to 100 %. The results are also better presented through Bar Graph given below.

Figure 1

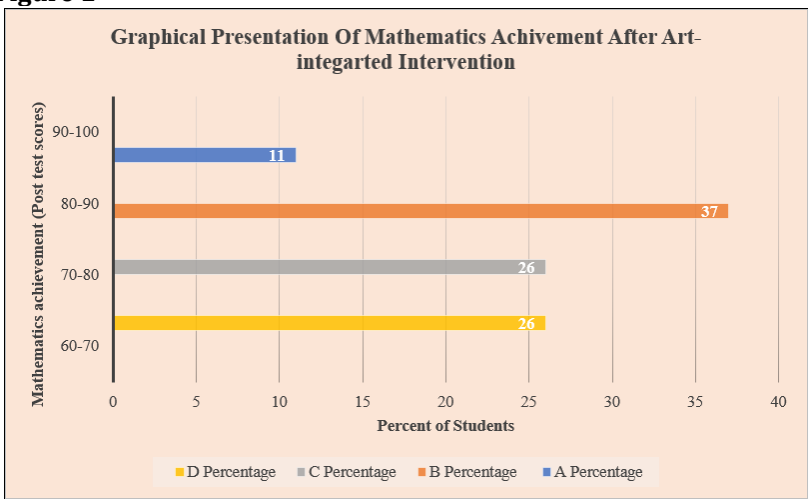


Figure 1 Percentage of Sample Student Vs. Student Mathematics Achievements

(Here, A= 60%-70%, B=70%-80%, C=80%-90%, D=90%-100%)

The results shown in the graphical presentation described that 26% of students obtained marks between 60-70 percent marks, 26% of students obtained marks between 70-80, 37% of students obtained marks between 80-90, and 11 percent of students obtained scores between 90 -100 %.

The post-test was constructed based on a blueprint in which the weightage to learning outcomes (Anderson Krathwohl taxonomy) is also determined. Further, the post-test scores were analyzed to measure the achievement of learning outcomes those decided at the planning part of the art-integrated intervention.

Figure 1

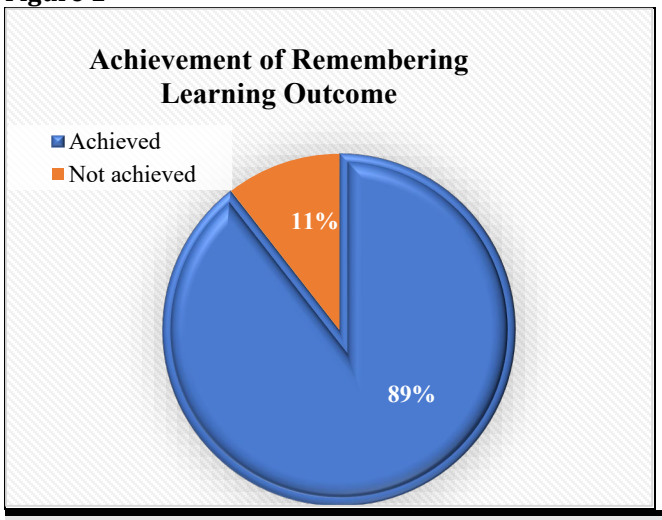


Figure 1 Distribution of Remembering Aspects

Figure 2

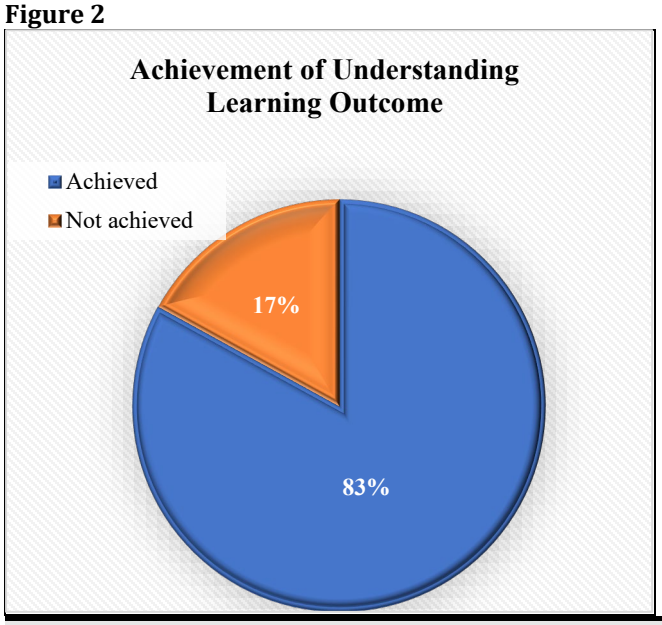


Figure 2 Distribution of Understanding Aspects

Figure 3

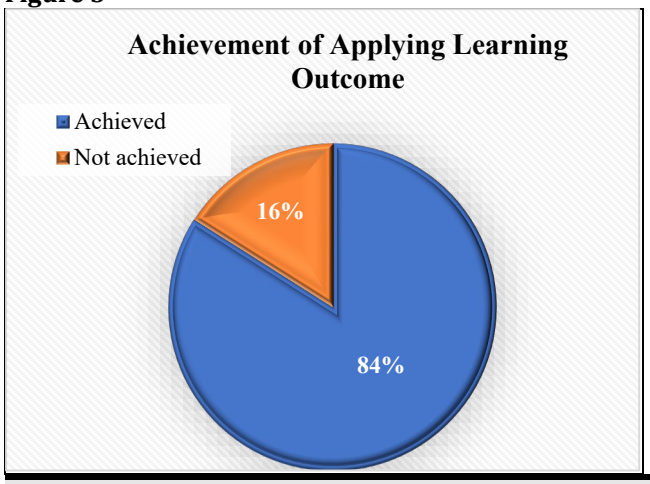


Figure 3 Distribution of Applying Aspects

Figure 4

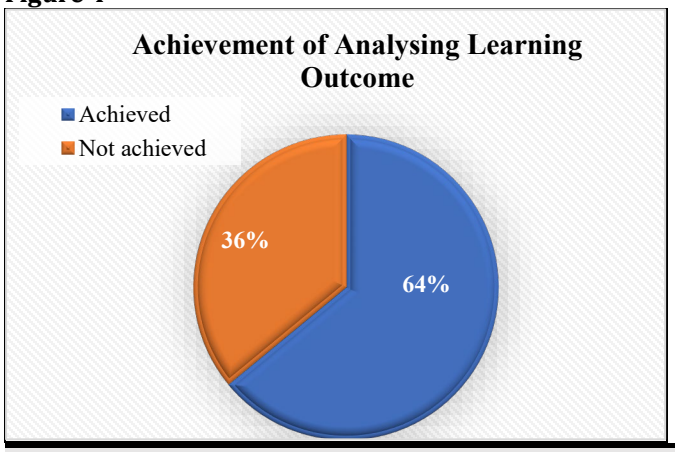


Figure 4 Distribution of Analysing Aspects

Figure 5

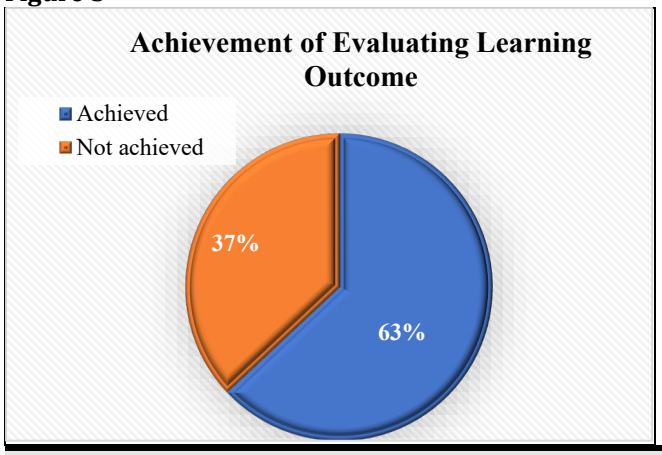


Figure 5 Distribution of Evaluating Aspects

Figure 6

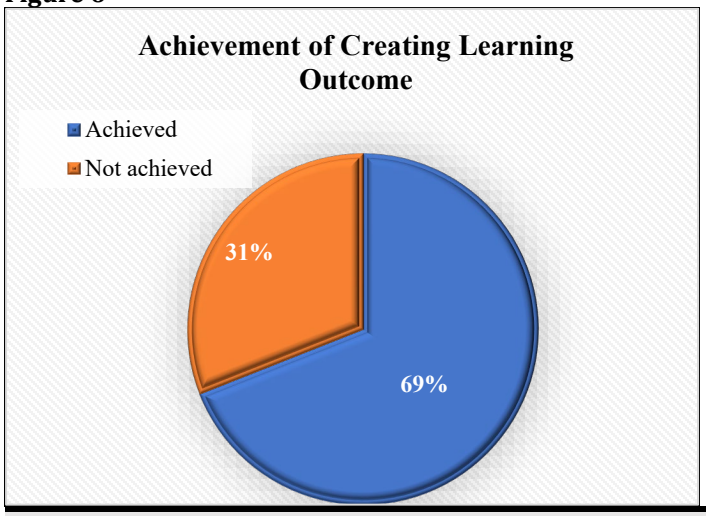


Figure 6 Distribution of Creating Aspects

From the graphical presentation given in below in pie charts, it is concluded that achievement of remembering learning outcomes is 89 % (Fig.1), Understanding learning outcomes is 83 % (Fig. 2), and Applying learning outcomes is 84 % (Fig. 3), Analysing learning outcomes is 64% (Fig. 4), Evaluating learning outcomes is 63 % (Fig. 5) and Creating learning outcomes is 69 % (Fig. 6).

5. FINDINGS

Regarding the Art integrated approach in mathematics of our conceptual model, we found that the presentation of the pictorial (folk art based) on the specific mathematical problem and their solution fostered the student's interaction and engagement to discuss the mathematical ideas referred to as "Conceptual elaboration." However, the effect of the art-integration-based learning module on mathematics academic achievements of seventh-grade learners was found to be positive, and the extent involved in building learner's mathematical thinking. Furthermore, the Art-based conceptual elaboration regarding the novice nature of teaching moved through art-integrated instructional intervention and achievement of high-order cognitive abilities-based learning outcomes. Therefore, illustration-based interaction was quickly responded to by students. We found that art-based instructions were achieved at a higher level.

6. DISCUSSION AND CONCLUSION

As part of this study, "Art integration" was incorporated into the teaching of mathematics to provide students with a visual representation to relate mathematical concepts to various artistic images, including folk art and geometric images. Integrating the arts engages the learners and improves their comprehension skills. Art integration helps learners develop higher-order cognitive abilities. This research shows that analyzing, evaluating, and creating learning outcomes is achievable. This leads to the development of problem-solving skills, creative skills, and decision-making. Art integration teaching also connects learners to their culture, i.e., in this study, Warli folk art was used for art integration in the teaching module. In the same way, it can also include some other cultural arts. Our findings show the positive imperative impact of teaching the mathematical content

of a topic. Several studies have revealed the remarkable results of integrating teaching with the arts.

The main aim of the research is to create a link between the two disciplines of Art and mathematics so that student learning becomes effective and engaging. Middle-aged learners need to engage in experiential learning within disciplines and the exploration of interdisciplinary relationships. Children feel happy and challenged, discover mathematics in folk design and architectural geometric Art, find mathematics useful in their lives, and have a positive understanding and attitude toward learning mathematics. Learners are more inclined to dabble in related fields later in learning.

The generalizability of the results is relatively constrained because our sample consisted of a small sample of 45 seventh-grade students who were proficient in foundational mathematical skills. In addition, we did not adopt the experimental design of the control group, did not present the comparison with traditional teaching methods, and did not conduct groupings in controlled situations. Instead, a diverse group of learners is our target group to understand the impact of integrating arts into math on students' math performance and higher-order cognitive academic performance, leading to better outcomes. Although there are some limitations, our research provides preliminary evidence that learners at the foundational level retain, understand, and better analyse and evaluate content when combined with the arts. At this level, especially learning outcomes are created, which are often overlooked in the teaching process. To provide a more useful scope for art integration, there is a need for large-scale art fusion research.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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