

Effectiveness of Diverse Fun Learning Activities in Enhancing Foundational Numeracy Skills Among Preschool Children with Hearing Impairment

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Abstract

Education is vital for the all-round development of children. It will help them succeed in their life by providing knowledge and skills. Conventional learning methods provide a foundational understanding of mathematical concepts for children with hearing impairments. Still, they often lack multisensory engagement and may not fully address the unique learning needs of these children (Bradley et al. (2008). However, incorporating diverse, engaging, and fun learning activities into mathematical concepts can actively engage children, making learning enjoyable and accessible, which is especially beneficial for children with hearing impairments. So, it is essential to investigate the effectiveness of diverse, fun learning activities in improving the understanding of mathematical concepts among preschool children with hearing impairments. In this study, the term "hearing-impaired" refers to children with hearing loss, specifically with mild to moderate hearing loss, based on the ASHA classification (Clark, 1981). With this background, we have done an experimental research study on 12 control and 12 experimental groups of preschool children, employing both pre-test and post-test assessments to evaluate comprehension levels of mathematics at the preschool level. In the present study, two hypotheses were tested using paired t-tests. The pre-test comparison (Ho1) found no significant

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difference between the two learning methods, retaining the null hypothesis. The post-test comparison (Ho2) revealed a significant difference, with diverse, fun learning activities proving more effective than conventional methods, thus rejecting the null hypothesis. Our research study highlights the benefits of incorporating diverse, fun learning activities in educational programmes for preschool children with hearing impairment. These activities can improve the comprehension of mathematical concepts, suggesting that educators and curriculum developers integrate engaging and interactive methods into their teaching strategies to improve the learning outcomes of children with hearing impairment. This study also examines instructional strategies tailored to the sensory and communication needs of children with hearing impairment, addressing common learning constraints such as limited auditory access and language delays.

Keywords: Conventional learning, Effectiveness, Diverse, Fun learning comprehension, Children with hearing impairment

INTRODUCTION

In early childhood education, creating a strong foundation in mathematical concepts is vital for all children, along with children with hearing impairment. Children with hearing impairment face unique learning constraints, including limited auditory input, delayed language development, and difficulties accessing oral instruction, which affect their comprehension of mathematical concepts. The National Council of Teachers of Mathematics-MCTM (2000) said that children with hearing impairment face unique challenges in their academic journey, especially in subjects requiring aural comprehension, such as mathematics. A paradigm change in mathematics education has occurred recently as teachers have come to understand the transformative power of incorporating enjoyable and exciting activities into teaching strategies. Traditional teaching methods often involve rote learning and formal procedures,

sometimes neglecting the need for a dynamic and enjoyable learning environment. It may only sometimes resonate with these children, necessitating a shift towards more inclusive and enjoyable approaches. Patricia S. Moyer-Packenham and Jennifer Suh conducted a meta-analysis in 2017, and their study investigated the impact of hands-on activities on mathematical comprehension and achievement across diverse children's populations. Their findings revealed that there is a significant improvement in learning outcomes, suggesting that hands-on activities could serve as effective instructional strategies, particularly beneficial for children with hearing impairment. "Bragg (2003) emphasises the significance of investigating the effectiveness of fun-based approaches in teaching mathematics to preschoolers with hearing impairment. They argue that such research is academically pertinent and contributes significantly

to the broader discourse on inclusive education, highlighting the importance of adopting innovative and engaging instructional methods to meet the need of diverse learners. Cockett and Kilgour (2015) have done a longitudinal study exploring how experiencing joy and excitement in the learning process positively impacts student engagement, motivation, and cognitive outcomes over time. Their findings underscore the importance of fostering joyful learning environments for optimal academic development.

Cody and Jon (2013) have experimented on the impact of fun activities on student engagement and appreciation for learning. Their findings suggest that integrating fun elements into educational practices fosters a positive and inclusive atmosphere, where as at the same time, it will encourage children to explore, question, and develop a genuine appreciation for the subject. Boggan *et al.* (2010) emphasise the critical importance of multisensory learning approaches in mathematics education. These methods engage multiple senses like auditory, kinesthetic, visual, etc., simultaneously, which is especially advantageous for children with hearing impairment. Multisensory learning activities leverage visual, tactile, and kinesthetic modalities, reducing dependence on auditory cues and thereby supporting better engagement and understanding among hearing-impaired learners. By incorporating

visual, tactile, and kinesthetic elements in academics, children can get a quality education. This is particularly beneficial for children with mild to moderate hearing loss, as they can more effectively engage with multisensory activities that rely on visual and tactile stimuli. Multisensory activities enhance the accessibility and enjoyment of mathematical concepts. This integrative approach not only improves comprehension levels but also enriches the overall learning experience, making it more effective for children with hearing impairment. These approaches extend beyond entertainment, simplifying abstract concepts, promoting critical thinking, and facilitating deeper engagement. These activities will act as a catalyst in active learning through games, puzzles, or hands-on experiments, allowing students to apply theoretical knowledge to real-world situations. Our research study aspires to shed light on innovative methodologies that can empower educators and caregivers to create an environment where every child, regardless of hearing ability, can thrive in their mathematical journey.

Furthermore, the effectiveness of diverse fun learning activities lies not only in engaging children but also in transforming the learning process itself. These activities always help the children to actively participate in the learning process, stimulate curiosity, encourage exploration, and foster social interaction, which will help in cognitive development. For preschool children with hearing impairment,

such approaches provide multiple pathways to grasp mathematical concepts through visual, tactile, and kinesthetic experiences rather than relying solely on auditory instruction. This process-oriented learning enhances motivation and retention by connecting abstract concepts to concrete experiences, thus making math more meaningful and accessible. By involving children in hands-on activities and collaborative play, these activities also build foundational problem-solving skills and confidence, which are essential for retention and long-term academic success. Therefore, diverse, fun learning activities do not simply teach content but reshape how children engage with and internalise mathematical ideas, offering a powerful tool for inclusive education.

NEED AND RATIONALE

The necessity for this research comes from a significant void in knowledge regarding the use of a playful method to efficiently enhance the learning of math ideas for children with hearing impairment. This current study is crucial because it explores a topic that has not been extensively researched. The effect of a playful method on the understanding of mathematical ideas in children with hearing impairment will be high. Although there have been previous studies on inclusive education and the success of engaging learning methods, this research concentrates mainly on the relationship between hearing difficulties, early education,

and diverse, fun, and enjoyable activities. Our research method stands out because it concentrates on evaluating the unique needs of preschool children with hearing disabilities, providing a detailed analysis that follows their progress as well as exploring various activities that engage them. By concentrating on these details, the research aims to move away from broad conclusions and provide guidance for teachers and decision-makers on creating effective and inclusive mathematics learning programmes for this particular group of learners, that is, children with hearing impairment. The findings of this research will have broader implications, not only benefiting children with hearing impairments but also children without disabilities. The study aims to demonstrate that the effectiveness of diverse, fun learning activities extends beyond children with hearing impairments to all young learners. Fun learning strategies, when thoughtfully designed and implemented, help children engage deeply with educational content, enhance their problem-solving skills, and promote socio-emotional development. While this study focuses on children with hearing impairments, it is essential to recognise that fun, interactive learning strategies benefit all children, regardless of ability. For typically developing children, playful learning fosters creativity, collaboration, and deeper engagement with content, making learning not only more effective but also more

enjoyable. These activities stimulate curiosity and encourage children to approach problems with a sense of exploration and fun, which are key to maintaining long-term motivation and interest in learning.

For preschool children with hearing impairments, comprehending concepts related to math is vital because it creates the foundation for cognitive growth and problem-solving abilities. However, for some children, conventional teaching strategies might not work either. Therefore, we need to look into alternate approaches. The present research study focuses on children with mild to moderate hearing loss, ensuring that the learning strategies are adapted to their specific needs. The present research study addresses a critical need to evaluate and compare the effectiveness of conventional and diverse fun learning activities in enhancing mathematical comprehension among this demographic. It underscores the importance of incorporating engaging, fun, diverse, and interactive learning strategies tailored to children with hearing impairment. By demonstrating the superior efficacy of fun learning diverse activities, this research study will provide valuable insights for educators and curriculum developers, advocating for integrating such methods to foster better educational outcomes and support the holistic or all-around development of children with hearing impairment. These findings will also be valuable

for children without disabilities in mainstream education, emphasising that playful, engaging learning methods can improve educational outcomes, promote inclusivity, and support the holistic development of all children, regardless of their ability. Thus, our research study investigates the effectiveness of diverse, fun learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment.

OBJECTIVES OF THE STUDY

- To assess the effectiveness of conventional learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment during the pre-test stage
- To assess the effectiveness of conventional fun learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment during the post-test.
- To assess the effectiveness of diverse, fun learning activities to enhance the comprehension of mathematical concepts among preschool children with hearing impairment during the pre-test stage
- To assess the effectiveness of diverse, fun learning activities to enhance the comprehension of mathematical concepts among preschool children with hearing impairment during the post-test.

RESEARCH QUESTIONS

- To what extent does the effectiveness of conventional learning activities enhance the comprehension of mathematical concepts among preschool children with hearing impairment during the pre-test stage?
- To what extent does the effectiveness of conventional fun learning activities enhance the comprehension of mathematical concepts among the preschool children with hearing impairment during the post-test?
- To what extent does the effectiveness of diverse, fun learning activities enhance the comprehension of mathematical concepts among the preschool children with hearing impairment during the pre-test stage?
- To what extent does the effectiveness of diverse, fun learning activities enhance the comprehension of mathematical concepts among the preschool children with hearing impairment during the post-test?

RESEARCH HYPOTHESES

- There exists no significant difference between conventional learning methods and diverse, fun learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment during the pre-test.

- There exists no significant difference between conventional learning methods and diverse, fun learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment during the post-test.

METHOD

Research Design

Experimental research where two groups were purposively selected for a pre-test and a post-test design

G1 O1 X1 O2

G2 O1 X2 O2

Where X1 = Treatment given with diverse, fun learning activities

Where X2 = Treatment given by conventional learning activities

O1 = pre-test

O2 = post-test

Sample Size

24 Preschool CWHI (12 CWHI per group) were nominated as the subjects of the study. Specifically, those with mild to moderate hearing loss were included in this study. According to the classification system established by Clark (1981) and referenced by the American Speech-Language-Hearing Association (ASHA), the hearing loss was categorised as follows:

- Mild hearing loss: 26 to 40 dB HL
- Moderate hearing loss: 41 to 55 dB HL

Purposive sampling technique is being used in their research.

Tool

A researcher developed a closed-ended questionnaire, including 'MCQ,' 'matching,' 'fill-in-blank,' and 'true-false,' based on the method of teaching at the pre-primary level, that is, Maria Montessori, play way and Kindergarten method, validated by an expert group of five special educators, was used as the tool. A sample of items from the questionnaire is provided in Table 1.

oriented approach that emphasises active engagement and multisensory exploration. This approach promotes conceptual understanding through hands-on experiences rather than passive reception of information. The instructional strategies were specifically tailored to accommodate the unique learning constraints of children with hearing impairment, including reduced auditory input and reliance on visual and tactile

Table 1
Sample Items in the Questionnaire

S.No	Area	Sample Questions
1.	Pre-Number Skills	1. Can you point at the small tree in the picture? 2. Which object is shorter? the pen or the feather 3. Point to the heavier object: the rock or the feather. 4. Choose the lighter object: the feather or the rock.
2.	Matching Numbers	1. Match the numbers with the stars provided. 2. Count the objects and write the corresponding numbers. 3. Draw an object representing the given number.
3.	Number Sequencing	1. Write the numbers in sequence from 1 to 10. 2. Fill the missing numbers in the sequences provided.
4.	Number Comparison	1. Circle the greater/more significant number in each pair. 2. Add the given objects and write the sums.
5.	Basic Arithmetic	1. Solve the additional problems provided. 2. Solve the subtraction problems provided.
6.	Counting and Marking	1. Count and mark the objects corresponding to the given numbers. 2. Trace the numbers and draw raindrops to match the number.

INSTRUCTIONAL STRATEGIES AND LEARNING CONSTRAINTS

The diverse fun learning activities were designed using a process-

oriented approach that emphasises active engagement and multisensory exploration. These strategies incorporated sensory engagement, visual aids, and kinesthetic activities to ensure effective comprehension and retention

of mathematical concepts. By aligning the activities with the children's sensory strengths and minimising dependence on spoken language, the intervention aimed to overcome communication barriers and support meaningful learning outcomes.

Instructional Procedures and Process-oriented Approach

To explicitly demonstrate the process and how fun-based learning activities contributed to foundational numeracy skills, the following step-by-step instructional procedures were implemented during the intervention:

- (i) **Sensory Exploration:** Children engaged in tactile counting exercises such as sorting beads from a sensory bin, cutting play-dough into specified pieces, and inserting finger fries into straws. These activities provided hands-on experiences to connect physical sensations with numerical concepts. For example, the child counted 5 beads and physically moved them to reinforce the quantity concept.
- (ii) **Visual Math Storytelling:** The teacher used picture storybooks and flashcards illustrating mathematical operations such as addition and subtraction. For instance, a subtraction story with pictures of apples being taken away visually explained the concept without relying on verbal instructions alone. This allowed children to associate numbers with familiar contexts.
- (iii) **Interactive Games:** Children played games involving balls and different-shaped blocks to learn counting, sorting, and grouping. Visual cues like coloured shapes and hand signals supplemented the activities, enabling children with hearing impairment, to follow along without confusion.
- (iv) **Creative Arts Integration:** Mathematical concepts were integrated with creative arts by having children create robots and trees using different shapes. This activity helped children to understand geometry and spatial relations while engaging them creatively.
- (v) **Use of Visual and Tactile Supports:** Throughout all activities, visual aids (picture charts, flashcards) and tactile manipulatives (counting beads, blocks) were used. Additionally, sign language was incorporated during instruction to clarify concepts and instructions. For example, the teacher would sign numbers while showing corresponding objects.
- (vi) **Reinforcement and Review Sessions:** Each session concluded with reviewing previously introduced concepts through interactive questioning and play, ensuring retention and conceptual clarity.
- (vii) **Adapting to Learning Constraints:** Recognising limited auditory access and delayed language acquisition, the teaching

approach minimised verbal instructions and maximised visual-tactile learning. Instructions were delivered using signs, gestures, and demonstrations to ensure all children could access and comprehend the content.

This structured, multisensory, and play-based approach enabled children to actively construct understanding, accommodate their preferred learning styles, and progressively build foundational numeracy skills in an engaging and supportive environment.

DESIGN OF THE DIVERSE FUN LEARNING ACTIVITIES

- **Content Selected:** Introduction to teaching methods at pre-primary level-Maria Montessori, Playway, and Kindergarten method. (44 hours)

- **Duration of the Practice:** 2 hours per odd day in 1 week. (22 days)

- **Medium of Instruction:** Hindi

Table 2 outlines the diverse, fun learning activities for teaching mathematical concepts at the pre-primary level. Each activity is designed to engage children through creative methods that promote understanding and retention of mathematical principles. These activities have been specifically designed to address the learning needs of hearing-impaired children, with a focus on sensory engagement, visual aids, and hands-on approaches. The following activities are especially effective in supporting their mathematical understanding:

Table 2
Teaching with Diverse Fun Learning Activities

S.No.	Topic	Diverse Fun Learning	Pictures
1.	Math Storytelling	Subtraction through visually appealing math stories.	
2.	Sensory Math Exploration	They count numbers by sorting beads from a sensory bin, cutting play dough into pieces according to specified numbers, and inserting finger fries into straws as a tactile counting exercise.	

3.	Interactive Games	Balls and different shapes	
4.	Creative arts Integration	Robots and trees with different shapes	

Additionally, based on the unique needs of hearing-impaired children, the following activities are particularly recommended for enhancing their comprehension of mathematical concepts:

- **Interactive Sensory Exploration:**

Tactile counting exercises using various materials like textured balls, cloth swatches, or clay to stimulate the senses and encourage number recognition and understanding.

- **Visual Math Storytelling:** Using storybooks or picture cards that illustrate subtraction and addition concepts, making the process visually engaging. This helps children understand math visually rather than through auditory instructions.

- **Games with Sound and Visual Cues:** These can include games where visual signals (such as flashing lights or colour-coded items) correspond to numbers or

operations, reinforcing learning through sight and association.

- **Hands-on Counting Activities:**

Activities like sorting items (e.g., coloured beads, toy blocks) or creating patterns with items help children with hearing impairment understand number relationships in a physical space.

- **Creative Arts-based Math Learning:**

Integrating drawing or crafting activities where children use shapes, sizes, and measurements (like cutting out specific lengths) to understand math concepts. These activities embody a process-oriented learning approach by engaging children in multisensory experiences that promote gradual mastery of foundational skills through exploration and active participation, which is crucial for learners with hearing impairment.

These activities above, have been chosen not only because they are engaging and fun, but also because

they have been proven to be effective in supporting the development of foundational mathematical concepts in children with hearing impairment.

Table 3 below presents the intervention schedule details, which

illustrate the daily sessions for the teaching programme. Each session incorporates sensory exploration, interactive games, and creative arts integration to reinforce learning objectives effectively.

Table 3
Intervention Schedule Details

Day	Session 1	Session 2
1	Pre-test	Pre-test
2	Sensory exploration: Sorting beads from a sensory bin, cutting play dough into pieces according to specified numbers, and inserting finger fries into straws as a tactile counting exercise.	Interactive games with balls and shapes
3	Creative arts integration: Robots and trees with different shapes	Review of previous concepts and reinforcement
4	Introduction to number concepts and counting	Storytelling with numbers
5	Sensory exploration by counting objects	Interactive counting games
6	Creative arts integration with counting	Review of counting concepts and reinforcement
7	Introduction to addition and subtraction	Storytelling with addition and subtraction
8	Sensory exploration with addition and subtraction	Interactive addition and subtraction games
9	Integrating creative arts with addition and subtraction	Review of addition and subtraction concepts and reinforcement
10	Introduction to number sequencing	Storytelling with number sequences
11	Sensory exploration with number sequencing	Interactive games for number sequencing
12	Creative arts integration with number sequencing	Review of number sequencing concepts and reinforcement
13	Introduction to number comparison	Storytelling with number comparison
14	Sensory exploration with number comparison	Interactive games for number comparison

15	Creative arts integration with number comparison	Review of number comparison concepts and reinforcement
16	Introduction to basic arithmetic	Storytelling with basic arithmetic
17	Sensory exploration with basic arithmetic	Interactive games for basic arithmetic
18	Creative arts integration with basic arithmetic	Review of basic arithmetic concepts and reinforcement
19	Counting and marking activities	Storytelling with counting and marking
20	Sensory exploration with counting and marking	Interactive games for counting and marking
21	Creative arts integration with counting and marking	Review of counting and marking concepts
22	Post-test	Post-test

DATA COLLECTION

The data collection procedure consisted of four phases: (i) subject selection, where preschool children, with hearing impairment (CWHI) were purposively assigned to either pre-test or post-test groups; (ii) administration of the pre-test, during which teacher-made tests were given to both the groups; (iii) treatment, involving six training sessions, each lasting two hours and conducted on alternating days over one week, based on the content of the training module and planned sessions; and (iv) administration of the post-test, where after completing all intervention sessions, the tests were re-administered to the post-test group to obtain their score.

DATA ANALYSIS

Each group's percentage, mean scores, and standard deviations were used for analysis and comparison

by computing the obtained data. Inter-group comparisons were done with descriptive statistics. T-tests were applied to test the hypotheses framed based on the set objectives. Additionally, the analysis aimed to assess the effectiveness of the process-oriented fun and learning activities in promoting foundational mathematical skills, considering the unique learning profiles of children with hearing impairment.

RESULT AND DISCUSSION

Objective 1

To study the effectiveness of conventional learning activities in enhancing the comprehension of mathematical concepts at the pre-test stage among preschool children with hearing impairment, a research question was framed: "To what extent does the effectiveness of conventional learning activities enhance the

comprehension of mathematical concepts among preschool children with hearing impairment during the pre-test stage?” The achievement test developed by the researcher was administered to 12 preschool children with hearing impairment before giving the Treatment. The data collected was then analysed. The maximum and minimum scores calculated were based on the number of items and the scoring keys used for the achievement test. For the present research, it was decided to study the effectiveness of conventional learning activities to enhance the comprehension of the mathematical concepts under three different levels, namely (i) minimum, (ii) moderate, and (iii) maximum. The range of scores is mentioned in Table 4. The researchers gave the pre-test range of scores in Table 4, that is, the effectiveness of conventional learning and mathematical concepts in the pre-test.

From Table 4, it is observed that out of 12 preschool children with hearing impairment involved in the study, 0 (0%) of them had minimum, 12 (100%) had moderate, 0 (0%) had maximum in the pre-test to know

the effectiveness of conventional learning activities to enhance the comprehension of a mathematical concept.

This suggests that the children’s understanding of the mathematical concepts was uniformly moderate before implementing conventional learning activities.

Objective 2

For the post-test, the researcher decided to study the effectiveness of conventional learning activities to enhance the comprehension of mathematical concepts among preschool children with hearing impairment to get the answer to the research question, “To what extent does the effectiveness of conventional fun learning activities enhance the comprehension of mathematical concepts among preschool children with hearing impairment during the post-test? The result was analysed under three different levels, namely (i) minimum, (ii) moderate, and (iii) maximum. The range of scores is mentioned in Table 5, that is, the effectiveness of conventional learning and mathematical concepts in the post-test.

Table 4
Effectiveness of Conventional Learning and Mathematical Concepts in Pre-test

Variable	Sample Size	Pre-test range of score		
		Minimum	Moderate	Maximum
Effectiveness of conventional learning	12	0 (0%)	12 (100%)	0 (0%)

Table 5
Effectiveness of Conventional Learning
and Mathematical Concepts in Post-test

Variable	Sample Size	Post-test range of score		
		Minimum	Moderate	Maximum
Effectiveness of conventional learning	12	0 (0%)	12 (100%)	0 (0%)

From Table 5, it is observed that out of 12 preschool children with hearing impairment involved in the study, 0 (0 %) of them had minimum, 12 (100%) had moderate, 0 (0%) had maximum in post-test to know the effectiveness of conventional learning activities to enhance the comprehension of a mathematical concept.

This outcome suggests that the conventional learning activities did not significantly change the children's comprehension levels.

Objective 3

To study the effectiveness of diverse, fun learning activities in enhancing the comprehension of mathematical concepts at the pre-test stage among preschool children with hearing impairment, a research question was framed—to what extent does the effectiveness of diverse, fun learning activities enhance the

comprehension of the mathematical concepts among preschool children with hearing impairment during the pre-test stage? The achievement test developed by the researcher was administered to 12 preschool children with hearing impairment before giving the treatment. The data was collected and then analysed. The maximum and minimum scores calculated were based on the number of items and the scoring keys used for the achievement test. For the present research, it was decided to study the effectiveness of diverse, fun learning activities to enhance the comprehension of mathematical concepts under three different levels, namely (i) minimum, (ii) moderate, and (iii) maximum. The range of scores is mentioned in Table 6, that is, the effectiveness of diverse, fun learning, and mathematical concepts in the pre-test.

Table 6
Effectiveness of Diverse, Fun Learning,
and Mathematical Concepts in Pre-test

Variable	Sample Size	Pre-test range of score		
		Minimum	Moderate	Maximum
Effectiveness of conventional learning	12	0 (0%)	12 (100%)	0 (0%)

From Table 6, it is observed that out of 12 preschool children with hearing impairment involved in the study, 0 (0 %) of them had minimum, 12 (100%) had moderate, 0 (0%) had maximum in the pre-test to know the effectiveness of diverse, fun learning activities to enhance the comprehension of a mathematical concept.

This outcome suggests that the children’s understanding of the mathematical concept was consistently moderate across the group before introducing the diverse, fun learning activities.

Objective 4

For the post-test, the researcher decided to study the effectiveness of diverse, fun learning activities to enhance the comprehension of mathematical concepts among preschool children with hearing impairment; the research question framed “To what extent does the effectiveness of diverse, fun learning activities enhance the comprehension of mathematical concepts among preschool children with hearing impairment during the post-test? The result was analysed under three different levels, namely (i) minimum,

(ii) moderate, and (iii) maximum. The range of scores is mentioned in Table 7, that is, the effectiveness of diverse, fun learning and mathematical concepts in the post-test.

From Table 7, it is observed that out of 12 preschool children with hearing impairment involved in the study, 0 (0%) of them had minimum, 0 (0%) had moderate, 12 (100%) had maximum in post-test, to know the effectiveness of diverse, fun learning activities to enhance the comprehension of a mathematical concept.

Thus, achievement at the maximum level indicates that the diverse, fun learning activities greatly enhanced the children’s understanding of the mathematical concept.

In particular, the fun learning activities that were most effective included:

- Sensory-based exploration with the mathematical objects, which helped the children with hearing impairments engage more deeply with numerical concepts.
- Interactive games with shapes and patterns allowed the children to explore spatial and geometric concepts in a fun, hands-on way.

Table 7
Effectiveness of Diverse, Fun Learning, and Mathematical Concepts in Post-test

Variable	Sample Size	Post-test range of score		
		Minimum	Moderate	Maximum
Effectiveness of conventional learning	12	0 (0%)	12 (100%)	0 (0%)

Creative arts integration, including drawing and modelling with clay, provided visual and tactile experiences that made abstract mathematical concepts more accessible.

These activities were particularly effective because they engaged multiple senses, providing children with a more immersive experience that helped translate abstract concepts into tangible, easily understood ideas.

Hypothesis 1

To compare the effectiveness of conventional learning methods and diverse, fun learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment during the pre-test. To this line, at the beginning of the study, the assumption drawn by the researcher was that “there exists no significant

difference between conventional learning methods and diverse, fun learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment during the pre-test.” As it was comparative, the paired test was applied to see whether a significant difference exists between the conventional method and diverse learning activities. The calculated values of the mean (\bar{x}), standard deviation (S.D.), ‘t’, and ‘p’ are shown in Table 8, that is, ‘t’ test analysis: Enhancing Comprehension in Mathematics Before the Treatment.

The obtained mean and S.D. of the conventional learning method were 9.42 and 1.24. Similarly, the mean and S.D. of diverse, fun learning were 9.5 and 1.24. To determine whether the observed difference in mean value, 9.42 of the conventional learning method and 9.5 of diverse fun

Table 8
‘t’ test analysis: Enhancing Comprehension in Mathematics Before the Treatment

Parameter	Type of Intervention	N	Mean	Std. Deviation	df	‘t’	p (2-tail)	Table value at 0.05	Significance at 0.05	Ho
Academic Achievement in Mathematics in Pre-test	Conventional learning method	12	9.42	1.24	22	0.1644	0.8709	2.074)	Not Significant	Retained
	Diverse fun learning	12	9.5	1.24						

learning, was statistically significant, the paired test was applied using SPSS. Assuming equal variances, the obtained value is 0.1644. The corresponding 'p' (2-tail) value at the degree of freedom 22 is 0.8709. This 'p' value is less than the table value at a significant level of 0.05. This suggested that the obtained value could be more statistically significant. Hence, the null hypothesis, "no significant difference exists between conventional learning methods and diverse, fun learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment during the pre-test," was retained. This indicates that the effectiveness of conventional learning methods in enhancing the comprehension of mathematical concepts among children with hearing impairment is similar to that of diverse, fun learning activities during the pre-test.

Hypothesis 2

To examine and compare the effectiveness of conventional learning methods and diverse, fun learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment during the post-test. To this line, at the beginning of the study, the assumption drawn by the researcher was that "there exists no significant difference between conventional learning methods and diverse, fun learning activities in enhancing the comprehension of mathematical concepts among preschool children with hearing impairment during the post-test." As it was comparative, a paired test was applied to see whether a significant difference exists between the conventional learning method and diverse learning activities. The calculated values of the mean (x), standard deviation (S.D.),

Table 9
't' test analysis: Enhancing Comprehension in Mathematics after the Treatment

Parameter	Type of Intervention	N	Mean	Std. Deviation	df	't'	p (2-tail)	Table value at 0.05	Significance at 0.05	Ho
Academic Achievement in Mathematics in Post-test	Conventional learning method	12	9.42	1.24	22	7.8819	7.5222	2.074	Not Significant	Retained
	Diverse fun learning	12	9.5	1.24						

‘t’, and ‘p’ are shown in Table 9, that is, ‘t’ test analysis—enhancing Comprehension in Mathematics after the Treatment.

The obtained mean and standard deviation (S.D.) for the conventional learning method were 11.08 and 1.38, respectively. Similarly, the mean and S.D. for the diverse, fun learning activities were 16.83 and 1.64, respectively. To determine whether the observed difference in mean values (11.08 for conventional learning and 16.83 for diverse fun learning) was statistically significant, a paired t-test was conducted using SPSS. Assuming equal variances, the obtained value was 7.8819. The corresponding ‘p’ value (two-tailed) at a degree of freedom of 22 was 7.5222. This ‘p’ value was more significant than the table at a significance level of 0.05, indicating that the obtained value is statistically significant. As a result, the null hypothesis stating “there is no significant difference between conventional learning methods and diverse, fun learning activities in enhancing the comprehension of mathematical concepts among the preschool children with hearing impairment during the post-test” was rejected. The alternative hypothesis was accepted, indicating a significant difference between the two methods.

The diverse, fun learning method (16.83) was more significant than the mean of the conventional learning method (11.08). Therefore, the diverse, fun learning method is significantly more effective than the traditional one in enhancing

the comprehension of mathematical concepts among preschool children with hearing impairment during the post-test. Activities incorporating the sensory exploration and visual cues were particularly successful, as they aligned with the learning preferences of hearing-impaired children, allowing them to engage with concepts through tactile and visual means. Visual storytelling and creative arts further enhanced engagement by providing visual contexts that reinforced learning. In contrast, traditional auditory-based methods were less effective, highlighting the importance of multisensory approaches in education for hearing-impaired children.

CONCLUSION

Comprehension of mathematical concepts is vital for preschool children with hearing impairment because it is the basis for cognitive development and problem-solving skills. Early arithmetic competency improves children’s understanding and interactions with the outside world and promotes the self-reliance and confidence of children (Fisher *et al.*, 2012). It also helps with language development by encouraging organised thoughts and identifying patterns. Additionally, mastering arithmetic skills at an early age is beneficial for academic achievement and improved prospects for further education and employment. (Kelly C.A. (2006).

The research study concludes that the diverse, fun learning activities,

particularly those involving sensory exploration, visual storytelling, and interactive games have created a greater positive impact on comprehension skills of children with hearing impairment related to the mathematical concepts. At first, there was no difference in the efficacy of the two approaches. However, after the intervention period, diverse and fun learning activities significantly improved the comprehension skills of mathematical concepts in preschool children with hearing impairment. These activities allowed children to engage with numbers through tactile and visual means, which enhanced their understanding and concept retention. This outcome reinforces the idea that structured, multisensory, and play-based learning environments can address developmental delays in concept formation among hearing-impaired learners. Moreover, a process-oriented analysis showed that children with hearing impairment benefited from instructional strategies that were aligned with their visual and experiential learning preferences. This process-oriented approach helped address common learning constraints faced by children with hearing impairment, such as limited auditory access and delayed language acquisition. By leveraging visual, tactile, and play-based strategies, the intervention created meaningful learning experiences that matched their preferred learning styles.

Moreover, a process-oriented analysis showed a good impact

on children with hearing impairment, and they benefited from instructional strategies that were aligned with their visual and experiential learning preferences. Especially, teaching methods which incorporated visual aids such as picture charts, flashcards, and sign language to convey math concepts. Tactile manipulatives like counting beads, blocks, and textured objects enabled hands-on exploration of numbers and quantities, reinforcing abstract ideas through concrete experiences. Interactive games and structured play maintained engagement and supported concept retention by appealing to children's natural curiosity and motivation. These strategies directly addressed common learning constraints faced by children with hearing impairment, including limited auditory access, which restricts the reception of verbal instructions, and delayed language acquisition that impedes comprehension of abstract concepts. By leveraging visual, tactile, and play-based approaches, the intervention created meaningful, accessible learning experiences that matched the preferred learning styles of hearing-impaired preschoolers, effectively compensating for their auditory limitations and facilitating deeper understanding of mathematical ideas.

The present research study emphasises how crucial it is to provide dynamic and engaging

learning activities in educational programmes for children who have hearing loss. Incorporating multisensory activities like sensory exploration, visual storytelling, and interactive games into educational practices can significantly enhance learning outcomes. Comparing these exercises to standard techniques can improve learning outcomes by a large margin since they increase the comprehension of mathematical ideas. Therefore, educators and curriculum authors should consider including engaging, fun, and diverse learning activities in their teaching practices to assist the educational development of children with hearing impairment. The results of this study contribute to the growing body of evidence supporting differentiated instruction and underscore the need for specialised teacher training, to meet the cognitive and sensory needs of hearing-impaired preschoolers.

EDUCATIONAL IMPLICATION

Our research study highlights the importance and role of dynamic and captivating learning activities in the curriculum of children with hearing impairment, and it also focuses on how they help children to comprehend mathematical concepts clearly. The research findings demonstrate that, compared to traditional methods, participating in various diverse, fun learning activities significantly enhances mathematical

concept understanding. In order to support better learning outcomes, curriculum planners and instructors should give priority to utilising these interactive strategies. Children who participate in these activities may see improvements in all areas of development especially in their cognitive development, language learning, and problem-solving skills, which will boost their academic achievement and improve their prospects for higher education and work. These findings advocate for curriculum modifications at the preschool level that prioritise experiential, sensory-rich content delivery, especially for children with auditory disabilities. In addition to addressing the unique learning requirements of children with hearing loss, these strategies also compensate for their auditory limitations and promote learning through visual and hands-on experiences. This approach promotes a more welcoming and vibrant learning environment that is inclusive, child-centred, and developmentally appropriate. Future educational programmes must integrate teacher training on multisensory strategies, provide resource-rich classrooms, and evaluate learning processes, not just outcomes. Such systemic changes will ensure sustained improvements in concept acquisition and academic readiness among preschool children with hearing impairment.

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