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CREATING A SPACE FOR STORIES AND STORYTELLING IN MATHEMATICS CLASSROOM: A PEDAGOGICAL ENQUIRY

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ABSTRACT

Storytelling has been a tool for teaching and learning across various disciplines, but rarely seen in mathematics. This research explores the effectiveness of storytelling as a pedagogical tool in mathematics education. The objective of the study is to try out the effect of storytelling as a pedagogical approach in mathematics learning at primary level and to study the effectiveness of storytelling in learning mathematics. To investigate this, the qualitative and descriptive methodologies have been used in this research. The self-made stories along with specific themes have been used as a tool to implement this with students of the schools, which have been selected by random sampling method. Effectiveness of the storytelling was evaluated through classroom observation that has been recorded in the form of verbatims by the students of the class during the storytelling session. The analysis based upon the eight themes and the literature reviews in this research supports the project's approach by highlighting the effectiveness of storytelling as a pedagogical approach in mathematics which enhances conceptual understanding, engagement, communication, reasoning, problem-solving skills, connection with real-life experiences, collaborative learning, motivation, and retention of concepts, which leads to the findings for the research. The findings reveals that storytelling can be an effective pedagogical tool in mathematics education, enhancing conceptual understanding, engagement among students and with the Teacher, communicating mathematically, reasoning and problem-solving skills, connecting with Real-Life Experiences, collaborative learning, motivation, retention and many more compared to those taught through traditional methods. The study highlights the need for research on a larger scale, exploring the long term effects and potential implementation of storytelling in various educational contexts. The storytelling into mathematics curriculum can make the class more enjoyable, interactive by providing a good learning environment. Ultimately, the Research work has proven to be highly effective by improving the overall education outcomes.

Keywords: Storytelling, Mathematics, Pedagogy, Education, Collaborative Learning, Children Experience

1. INTRODUCTION

Not only in the Indian knowledge tradition as ‘Drishtant’ but also in every civilization storytelling is considered as an effective tool of teaching and learning. Storytelling is not new for us as we all are used to listening to stories from our grandparents in childhood, even from friends, relatives and from any person in our daily life. 'Despite technological changes, storytelling remains a valuable and effective tool in classrooms'(Utsahi R.,2023). Children enjoy listening and reading stories. Storytelling is an interactive art of using words and actions to reveal the elements and image of a story while encouraging the listener's imagination. Storytelling is a powerful tool in education that can help in the engagement of students to develop their imagination and creativity, foster cultural understanding, improve their language skills,

encourage critical thinking and develop their empathy and emotional intelligence. Stories are built upon the human problems, conflicts and capabilities, and sometimes, the problems can be solved by mathematical thinking. Stories lead to discussion also, which indicates that stories can help to humanise mathematics, visualise maths concepts and create relatability. As a researcher and a pedagogue, we have wondered about the relationship between the stories and mathematics. Why and how can we use storytelling as a pedagogical approach in mathematics to develop critical thinking, problem solving and literacy skills among children? This question comes to our mind because we as pedagogues found that mathematics classrooms are often seen and experienced as dull, non-engaging cultures and overburdened during mathematical learning. Banerjee (2012) noted that 'In Indian classrooms, teaching and learning of mathematics mostly remained teacher-oriented and teacher-driven. As a result, students are rarely encouraged to contribute their own ideas'. The focus is mainly upon algorithms demonstrated by the teacher on blackboards and on assessing students on their abilities to follow the same procedure. As per Shirali & Ghosh (2012), 'mathematics is often seen as a difficult subject because of the significant gap between its content and the way it is taught'. All these factors have led to experiencing fear and anxiety towards mathematics for a student. In India, The National Curricular Framework, 2005 attempts to address these issues through its Position Paper on Teaching of mathematics (2006) by stating that "the main goal of mathematics education should be on 'mathematisation' of the child's thought processes" (p.01). It states that during all stages of schooling, mathematics teaching should aim at "engaging children's interest and offering a sense of success in solving problems" (NCF, 2005:16). Mathematics teaching should be able to foster the right attitude for solving problems and the students should be able to approach all types of problems in a systematic manner. Stories play a very important role in our lives. Stories are important not only from the individual's perspective but also for cultural promotion. From the beginning of human civilization, stories and storytelling have been used to spread culture and traditions far and wide. Bruner (1990, 1996) stated that 'human cognition is rooted in storytelling'. However, nowadays stories have also been explored as a pedagogical approach in mathematics. Many studies have stated the benefits of using stories in teaching of mathematics like, stories helps to give a contextual base for discussing mathematics. Paulo Freire supports problem-posing education. He emphasises upon teaching students to construct knowledge for them and stories help to provide problem solving and problem posing opportunities. Children can make sense of problems and related situations through the story characters and situations that are intrinsically interesting and embedded in the real-world. Similarly other than literature related skills, stories in the mathematics classroom can help in providing opportunities for making personal connections and catering to various instructional levels in the classroom. 'Children's literature provides students with deeply personal learning experiences, allowing them to engage with the story at their own levels of mathematical curiosity' (Jenner, 2002). History of storytelling informs us about the significance of storytelling that it helps in reaching all students including even those with specific disabilities. Storytelling has the potential to support mathematics learning of students having different requirements including students with disabilities, students with low self-efficacy for learning mathematics, students from different cultural backgrounds, different socioeconomic backgrounds and girls. Storytelling has been found helpful in special education as well. It carries Motivational, Attitudinal and Emotional effects. This helps in improving mathematical communication. 'By stories, the abstract concepts become easy to learn for students with reason instead of just rote memorization of the concept of maths, which allows children to learn organically'(Kumar M., 2023). Hence, we can say that if we want the learners to be confident problem solvers, who enjoy doing mathematics, the students must be able to actively participate and engage with mathematics. This study focuses on one such pedagogic resource, that is storytelling as a pedagogical approach in mathematics. This study aims to create a space for stories and storytelling in Mathematics Classroom and to understand the effect of storytelling as a pedagogical approach in mathematics.

2. CONCEPTUAL FRAMEWORK: UNDERSTANDING LITERATURE

The present research is grounded in the constructivist paradigm, which emphasizes learning as an active, contextualized process of constructing knowledge rather than acquiring it passively. The integration of storytelling into mathematics education aligns with social constructivist theories that advocate for student-centered, culturally responsive, and context-rich pedagogies (Vygotsky, as cited in Denistone Trochta, 2003). This framework positions storytelling not merely as a tool for engagement but as a scaffolding mechanism for meaning-making, creativity, and cognitive development in mathematical learning. At the core of this framework lies the transformative potential of storytelling to demystify mathematics and humanize its teaching. Traditional approaches often emphasize rote learning and algorithmic memorization, which alienate students from real-world relevance and cultural context (Sowmya, 2022;

Kumar, 2023). In contrast, storytelling embeds mathematical problems in narrative contexts, promoting conceptual understanding, logical reasoning, and problem-solving abilities (Nepal & Shrestha, 2022). Storytelling enables students to visualize abstract concepts, relate them to familiar situations, and engage affectively with the content (Junkin, 2019). The framework identifies three key constructs:

Cognitive Engagement: Storytelling facilitates the internalization of mathematical ideas by transforming abstract symbols into meaningful scenarios. Students use imagination to map story elements onto mathematical operations, enabling a deeper understanding and retention (Singh, 2018). Cognitive indicators include conceptual understanding, pattern recognition, and mathematical reasoning.

Cultural and Linguistic Relevance: By incorporating students' cultural contexts, languages, and everyday experiences, storytelling bridges the gap between mathematical content and learners' realities. It validates students' identities and fosters a sense of inclusion and belonging (Monterey & Terrell, 2018; Desai, 2023). This construct is particularly crucial in multicultural classrooms where traditional textbooks fail to reflect diverse narratives.

Transformative Pedagogy and Agency: The role of the teacher shifts from an authoritative transmitter of knowledge to a facilitator of dialogue, reflection, and exploration (Freire, as cited in Nepal & Shrestha, 2022). Students, in turn, transition from passive recipients to active participants who co-construct knowledge, create stories, and solve problems collaboratively (Butterworth & Lo Cicero, 2001). Storytelling empowers students with mathematical agency by enabling them to express and justify their thinking.

The framework assumes that the integration of storytelling in math classrooms will lead to increased student motivation, reduced math anxiety, and improved learning outcomes. Teachers' reflective practices, creativity, and sensitivity to story selection are mediating factors in the success of this pedagogical intervention (Gayatri, 2023; Utsahi, 2023). This framework views storytelling as a multidimensional pedagogical strategy that fosters engagement, cultural resonance, and critical thinking in mathematics education. By weaving narratives into instruction, educators can make mathematics not only accessible but also joyful, meaningful, and socially relevant.

2.1. OBJECTIVES OF THE STUDY

- To understand the nature and role of Storytelling.
- To apply storytelling in learning mathematics.
- To map the effect of storytelling as a pedagogical approach in mathematics in learning.
- To theorise storytelling as a pedagogical tool in mathematics learning.

3. METHODOLOGY

Methodology has been defined as "A way of thinking about and studying social reality"(Strauss & Corbin 1998, p.3). We have used qualitative methodology for this study. "The qualitative methodology begins with the assumptions, a worldwide, the possible use of theoretical lens, and the study of research problems inquiring into the meaningful individuals or groups ascribe to a social or human problem"(Creswell, 2007, pg. 37). The qualitative methodology used in the study helped us to explore the effect of storytelling as a pedagogical tool in depth. We have used stories as pedagogy in mathematics learning to engage students in the mathematics classroom. That's why our research requires understanding the outcomes in the form of dialogues, engagement, and active participation which requires a qualitative approach rather than a quantitative one. The approach helps in capturing the complex nature of classroom processes that emerge among the participants. The qualitative approach has been taken to build an understanding about the engagement of students with mathematics in the classroom. Additionally, study also used descriptive methodology which refers to an approach in research that focuses on describing and summarising characteristics, behaviours, or phenomena without manipulating variables or establishing causal relationships. This allows us to experience the lived world of the participant, while they experience the engagement with mathematics. Studying the engagement of students in a storytelling mathematics classroom is not a simple task and the flexibility of the quality of approach enabled us to probe the evolution of deeper meaning through our continued interaction with the students and with the students themselves. In this study the phenomenon was the engagement of students with mathematics, who were taught mathematics using the pedagogic resource of storytelling. We have divided our field work in three major phases.

In the first phase, we have observed all four schools and their classrooms, student engagement with mathematical learning, teaching pedagogy and the nature of resources available in schools and the milieu and ethos of the students.

In the second phase, we have made 3 self-stories covering the themes; Number and Number operation and Measurement with sub themes; Multiplication by array multiplication method and repeated addition under number and number operation theme and Time under measurement theme. The brief of these stories are mentioned in the Table-1 below with their respective themes having Motu and Patlu as protagonists.

4. CHOICE OF PROTAGONIST

In the first phase of fieldwork and during the discussion with students, many Students shared that they are very fond of watching cartoon series on television. One cartoon that we found as the favourite one among the majority of students was Motu and Patlu. Motu and Patlu are seen as the famous cartoon characters among the Indian students. "Motu Patlu" is a beloved comic series that originated in the different Indian languages and later evolved into an animated show. It captivates a wide audience of Indian children aged 4 to 10 years. The series revolves around the escapades of two friends, Motu and Patlu. Children relate to Motu's appetite and Patlu's cleverness, envisioning themselves in their adventures and seeing the duo as their heroes who can tackle any obstacle. Alongside Motu and Patlu, there are other quirky characters in their neighbourhood and school, adding depth to the storyline. The charm of "Motu Patlu" lies in its ability to tap into Indian children's imagination and curiosity. That's why we have chosen Motu and Patlu as Indian protagonists within the stories.

5. DEVELOPMENT OF STORIES.

Everybody loves a good story to read and listen to. We have made some stories earlier for other purposes also. Armed with these skills, we've been able to craft stories that are not only entertaining but also convey important lessons and concepts, making learning a more enjoyable and impactful experience for children in the classroom. During the observation in the first phase, we discovered that students had a strong affinity for cartoon series. So, we decided to create a series of stories, each episode embedded with mathematical concepts, tailored for each session. By incorporating familiar characters, students felt connected, making the stories a part of their lives. We crafted stories for grade 3 students, using the protagonist as a template. Here the protagonists are Motu and Patlu. These both are the main characters of the story who are getting opportunities to get a lot of critical thinking opportunities in the stories. Where Patlu and Motu are helping each other, in order to understand the concept, which promotes peer or collaborative learning also. The stories introduced new challenges in every session, seamlessly integrating maths discussions. We aligned the content with NCERT syllabus and utilised NCERT published books for preparation. Each mathematical objective became a plot point, with associated tasks for students to solve. While teaching multiplication and measurement, specific objectives like array multiplication method, repeated addition and time were woven into the storyline respectively in the separate stories.

Table -1 Stories and It's Brief

<table>
<tr><th colspan="2">Story-1</th><th>Brief of the story</th></tr>
<tr><td>Title</td><td>Motu Patlu's stick-stack challenge</td><td rowspan="3">In the story, Motu is encountering with the sticks in the story and putting those sticks one by one and was trying to find why the results are coming in this way, he was confused in this then the Patlu came and make Motu understand that, what is happening with those sticks arrangements which is following a pattern. In between there are some questions in the story to interact with the students. The response and the Patlu’s interaction with the class, makes the base to understand the multiplication by array multiplication and repeated addition. After the story there are some questions related to multiplication where Motu is counting the things by using the method he learnt in the class. Here students are supposed to help the Motu in solving these sums. There were some open ended questions to reflect upon the method of multiplication in this way.</td></tr>
<tr><td>Theme</td><td>number and number operation</td></tr>
<tr><td>Maths Concepts</td><td>multiplication by array multiplication and repeated addition</td></tr>
<tr><td colspan="2">Story-2</td><td>Brief of the story</td></tr>
</table>

Title	Motu Patlu and the multiplying shoes	In this story , Motu and Patlu decided to work together on shoe making. Where they interact with many animals to sell their shoes. But every time they encounter a problem, whether it's about the size, or the number of shoes where feet are more, to fulfil the demand of each animal they are making more and more shoes. At last they met with an Insect, a rain worm who has many feet and it became ready to take a pair of shoes every day. To calculate the number of shoes the student has to use either repeat addition or multiplication directly. Similarly there were another situation where a rabbit came to buy shoes, now as the number of rabbits increases, how many shoes they have to make. Similarly, to calculate the number of shoes for 11 rabbits, they need to multiply the number of feet with the number of rabbits to get the number of shoes. And can be extended with larger numbers to calculate. In which multiplication needs to be done.
Theme	Number and number operation	
Maths Concepts	Multiplication	
Story-3		**Brief of the story**
Title	Motu Patlu's clock and tick tock	This story, it's about a situation where Motu and Patlu have their exams in the coming week, and during the interaction between Motu and Patlu and between Motu and his parents, they are talking about many concepts related to the measurement theme like telling about hours in a day and calculating how much time is left in a day if it's 10 am in the morning etc. Parents and Motu are trying to make Patlu understand the value of time throughout the story. Story also encounters the approximation of time for completing a task by Patlu, to understand the importance of knowing approximation. After the story there were some questions related to the story.
Theme	Time, week days, months name. Hours in a day, months in a year, days in a week, after and before the maths, to understand the duration, approximation of time	
Maths Concepts	Measurement	

In the third phase, we have entered the classroom as facilitators with self-made stories. All the stories mentioned above have the protagonists Motu And Patlu. We have chosen 130 students with 54 boys and 76 girls in the range of 8-10 years of grade 3, Total 4 Government primary school in Delhi, India through Random sampling, which is the method used to select a subset of individuals from the larger population in such a way that each member of the population has an equal chance of being chosen. Non-Verbal cues could not be recorded because of the absence of cameras. The names of students used in the research are their pseudo identities.

6. PROCEDURE

- **Participant Selection:** Participants were selected from grade 3 students who were part of the study and were taught mathematics using storytelling as the pedagogic resource.
- **Introduction of Storytelling Sessions:** Mathematics was taught using storytelling as the pedagogical tool. In each class, story characters and plot background were introduced, and narrated the story aligned with the respective learning objectives.
- **Engagement Techniques:** To enhance engagement, rough sketches of protagonists Motu and Patlu were drawn on the blackboard, creating a familiar atmosphere. Story recapitulation from the previous session helped absent students catch up, while feedback was given on the previous day's work. The current session commenced with the introduction of the new story and associated mathematical tasks.
- **Data Collection:** Data was collected through participatory observation, where we were actively involved in the classroom setting. Students' responses, classroom discussions, and reflections on the story, characters, and encountered problems were recorded.
- **Analysis:** Data collected was analysed by organising emergent themes to understand the effectiveness of student engagement with mathematics through storytelling as a pedagogical tool.

7. CREATING A SPACE FOR STORYTELLING

Earlier while interacting with the students and by observing them in the classroom in the first phase of the research, we observed that students are afraid of maths and avoid maths lessons. Also they were unable to find mathematics in their daily life. They were unable to relate those concepts with their own experiences and the maths was just a subject which can be done step by step by following algorithms only, which was not only making the students uninterested, non-engaging but also treating maths as a rigid and non-favourite subject. They were not having opportunities to explore the variety of methods to solve the sums, and exploring the beauty of mathematics in their own life. We wonder about the questions, why were the students not able to develop a deeper understanding of mathematics? What's the reason behind that? We realised that, it was because of the way students have been taught as the subject only. It's important to recognize that mathematics is not about solving equations, it's about problem solving, critical thinking and Creativity. To study the effectiveness of storytelling as a pedagogical tool for teaching mathematics, we have used the basis mentioned below in the following table. (Nepal K. & Shrestha I. M., 2022, Sowmya H. S., 2022, Butterworth S. & Cicero A. M., 2001, Samantha F.J., 2019 and Keshavan P.,2019)

Table 2 Themes and Its Description

Theme of analysis	Description of the theme
Conceptual understanding	The depth of comprehension of mathematical concepts, rather than just memorising facts and procedures.
Engagement among students and with the Teacher	The degree to which students are involved, interested, and actively participating in mathematical activities and discussions during class.
Communicating mathematically	The proficiency in expressing mathematical ideas, reasoning, and problem-solving strategies effectively through various forms of communication, such as oral, written, and visual.
Reasoning and problem solving skills	The capability of students to ask thoughtful questions, analyse information, make logical deductions, and construct valid arguments in mathematical contexts.
Connecting with Real-Life Experiences	The extent to which mathematical concepts are linked to real-world situations or examples, facilitating easier understanding and relevance.
Collaborative learning	Collaborative learning is an educational approach in which students work together in groups to achieve common learning goals. It involves active participation, shared responsibility, and mutual engagement among learners.
Motivation	The drive, interest, and enthusiasm of students towards learning mathematics, which can be influenced by factors such as relevance, challenge, and intrinsic rewards.
Retention	The ability of students to remember and apply mathematical concepts and procedure over time, indicating long term understanding and memory retention.

Conceptual Understanding: "There are several ways in which storytelling can enhance intercultural and communication"(Nepal K. & Shrestha I.M.,2022,p.31). Through stories students are encouraged to explore mathematical connections in their day to day activities, promoting conceptual understanding and engagement. The impact of incorporating storytelling technique into mathematics instruction and its effect on student attitude, motivation and understanding of mathematical concepts. We observed that the use of storytelling in mathematics has shown a positive impact on conceptual understanding. When a student, Rahul said

"Patlu ke pas 14 ghnte kaise bache, agr Abhi 10 bje h to?" (How patlu has still 14 hours left , if it is 10 am right now ?).

Other students help him to understand by counting from 11 to 24 (12 hours +12 hours) because the hour hand moves twice in a day, which means two complete rotations of 12 hours, and proved by themselves how there are 14 hours from 10 am till the end of the day. Here the students were constructing their own knowledge by themselves which is supported by constructivists like Paulo Freire, Vygotsky etc. This promotes mathematical conversation as well as

conceptual understanding and engagement in reasoning by involving in problem solving skills. Mathematics education has been characterised by rote memorization and passive learning which fails to stimulate the student's curiosity. By understanding the above problem, they teach themselves the concept that a day includes 24 hours, which is better than just telling the concept only. We observed that stories empower students to make connections between abstract concepts and concrete experience thereby enhancing their understanding. In another story, where students were exploring the sense of infinity in a situation where the rain worm is a continuous buyer of the shoes of Motu and Patlu. Some of them were trying to find how many shoes it took from them and were repeatedly adding 2 for this. Because the worm was taking 2 shoes everyday. They reached for the response when two of them said

"mam ye to kabhi khatam hi nahi hoga na" (Ma'am, it will never end).

Where they understand the concept of infinity unintentionally by exploring the problem without much involvement from the teacher.

Engagement among Students and with the Teacher: The stories have significantly increased engagement levels in the classroom. 'Storytelling enhances student engagement and learning outcomes'(Samantha F.J.,2019). "Social constructivist approach to mathematics education emphasised the importance of active engagement, discussion and knowledge construction within a social context , by promoting engagement, motivation and cognitive development: storytelling has the potential to transform mathematics education and create a new discourse on pedagogical thoughtfulness"(Nepal K. & Shrestha I.M.,2022,p.31). We observed the increasing level of student engagement through active participation, when they were playing an active role in the class where they were responding in the class and two-way dialogue was happening in the class. During the story session they feel connected with the story and gradually the mathematics class becomes interesting, when Motu was playing with the sticks one of them tried the same using pen and pencils they have and when Patlu came and helped Motu to understand how simple it was to understand. Jai started laughing and said

"Patlu ne to Motu ka sawal ek minute me hal kar diya, me bhi Patlu banunga" (Patlu solved Motu's query in a minute, Now I will also become Patlu).

We observed that when the concepts were taught without stories, some felt engaged but some did not. Even when they were given the sums to do, one of them Zoya said

"mam ye Humare level ka kaam nahi hai" (mam this work is not as per our level).

But the story is for everyone, they all listen to the story including the students who were labelled as low attainment students. And they not only listened but they all were engaged there in the classroom and answered the question too. Bhanu and zoya, who were mischievous among all the students, we observed them they never disturb any student during those story session, and they came to me by saying,

"ma'am aaj bahut maja aya class me" (It was a lot of fun in today's class ma'am).

They started engaging in the classroom with us as well as the students. Storytelling fosters engagement by making maths more interesting and meaningful, encouraging creative thinking, and changing students' perceptions of maths as a dry subject. We observed that they started engaging in the classroom and also with their immediate environment like finding numbers of things using array multiplication that they have learnt in a story. For example, finding the number of blocks in doors and number of petals in a flower pot by counting the number of flowers in it. They were engaged with various methods in solving those sums. The engagement increases because they are now able to comprehend the question correctly. This makes the concept not only easy but also an interactive and interesting concept.

Communicating mathematically: 'By engaging with narratives students are promoted to explain their reasoning, justify their solution and communicate their ideas effectively'(Samantha F.J.,2019). Through the stories, students were not only listening but also communicating mathematically. They discussed and solved problems related to the stories, such as figuring out mathematical operations, calculating durations, making sense of numerical relationships, and applying various methods learned to solve the problems they get from the stories. Nancy said

"14 ghante khel Liya ek din me, bache 10 ghante, usme soega bhi, khaega bhi to padhega Kab ye ?" (He played for 14 hours in a day, there are only 10 hours remaining in which he has to sleep , eat , when will he study?).

And they started laughing over it. Where they were engaging and enjoying these dialogues. Here they are relating with the nothingness concept, like no further hours will be left here for Patlu. They were not only engaging in the class but also were talking mathematically here by retention of their previous knowledge about the incident and were able to relate it with their own daily life. Next day again when Nancy came and said "she found blocks in her door where she says that her gate has two divisions and one side has 6 blocks". So she arranged the stick in the same manner 6 horizontal and 2 vertical and reached at the answer 12. Similarly one of them came with the question for the flower in a flower pot in his home. Here they were not only solving the answer but forming the question for themselves where mathematical thinking is necessary and were also communicating mathematically. Storytelling promotes communication of mathematical ideas, encourages students to explain their reasoning, and helps in articulating mathematical concepts in their own words. They way they were helping each other, sharing their views on each other as well commenting upon the protagonist, they were unknowingly getting involved in mathematical communication, they were using mathematical language while articulating their own views in the classroom.

Reasoning and Problem-Solving Skills: 'Stories promote creativity and artistry that give opportunity for independent learning, critical thinking, perception and analysis'(Somya H.S.,2022). 'By engaging with narratives, students are promoted to explain their reasoning, justify their solution and communicate their ideas effectively'(Samantha F.J.,2019). The stories prompted students to apply reasoning and problem-solving skills. Stories actually help in logical thinking and spatial reasoning along with application of concepts to real life and enhancing problem solving skills. Students found different ways to solve the problems presented in the stories, such as using mental calculations, making virtual icons, repeated addition, and multiplying. This variety of approaches demonstrates their enhanced problem-solving abilities. While crafting the question by themselves, students get engaged in logico mathematical thinking, where they are analysing their own environment on the basis of the story. Storytelling challenges students to analyse information, make connections, and apply knowledge creatively, thus enhancing problem-solving skills. In the story Protagonist were struggling with the number of shoes and size of shoes according to the given varied situations in the story. There were some dialogues between Motu and Patlu with the other animals which was creating interest in the class and encouraged the students to know about the further story. At the end when the protagonists met with rain worms who have multiple feet and got ready to take 2 shoes everyday from them. Aryan said

“mam lekin kbhi to ye bhi lena bnd krega kbtk lega ye bhi " (mam but someday, it will also stop buying this too, for how long will it take?).

and then Jai said “to kya hua uske phle wale joote ghis bhi jaenge" (so what , the shoes it wore before will get worn out).

Here they were actually communicating and analysing the situation logically to solve the problem. In the same story, Similar thing was happening with the number of rabbits and number of the shoes to sell, which was calculated by the children in the given question at the end of the story. Students who were able to do this quickly, we asked them to calculate for a cow, then octopus and so on to explore more. Is it the same as the rabbit situation for cows? For octopus? Why? They get engaged in the question . They themselves found that by concluding by a statement. Jai said

“mam ye to same hoga kyunki iske bhi 4 hi par hai' cow ke pr octopus ka nhi hoga sane kyuki 8 pair hai ' (ma'am this will be the same , because it also has 4 legs but this will not be same for octopus because it has 8 feet).

and Vivek said

“mam ye to 4 ka table ho gya or ginjai me 2 ka table chal raha tha, mtlb agr hum janawron ke joote ginenge to yhi do table aenge" (ma'am this becomes the table of 4, while calculating for millipede, there was the table of 2 which means if we count the number of shoes for animals , these two tables will occur only).

And then we discussed the octopus, they discussed the table of 8. By this discussion they themselves concluded that the number of legs are associated with tables and the tables are nothing but the repetitive addition of the number itself.

Connecting with Real-Life Experiences: The stories effectively connected mathematical concepts with real-life experiences. When Stories are built upon real life situations this gives students insight about relating it there in their own life. 'Stories help in application of concepts to real life also'(Somya H.S.,2022). Storytelling encourages creative thinking and changes how both teacher and student view the maths that can be seen everywhere in real life to make it more enjoyable'(Nepal K. & Shrestha I.M.,2022). We observed that through a story, students become able to relate the concept with their real life. As when Ruhi was sharing her experience,

"Mera bhai bhi aisa hi hai, use samjh hi nahi aata, wo bhi sare din aise hi nikal deta hai" (My brother is also the same, he never understood this, he also wasted her day in the same way).

We asked her,

"to use kya samajh nahi aata ?" (What doesn't he understand?).

She said,

"use nhi pta na din me kitne ghante hote h, aaj batungi use jake '' (he doesn't know about the number of hours in a day , I will tell him today).

Here, we observed that students relate concepts like time management to their daily routines. When she was sharing her own experience on the value of time relating to an incident that happened in her own life, she was actually relating the mathematical concept of approximation of time to her own real life experience. So, storytelling connects maths to student's lives, helping them see maths in everyday activities, cultural contexts, and through diverse perspectives. They also started counting objects at home for exploring array multiplication, and exploring the sense of infinity, showcasing an understanding of how maths applies to their lives. Students also discussed concepts like infinity, sense of patterns, and repetitive addition in real-world contexts.

Collaborative Learning: 'Storytelling fosters a collaborative learning environment, where ideas are shared and explored. This collaborative approach not only enhances student's engagement but also cultivates essential skills such as teamwork, communication and problem solving'(Samantha F.J.,2019). We observed in the class that the stories encouraged collaborative learning among students. They worked together to help the protagonists (Motu and Patlu) in solving mathematical problems. Students exchanged ideas, provided suggestions, and even corrected each other's mistakes, discussing solutions with peers fostering a sense of collaboration and teamwork. Jai said during a story,

"Motu Patlu ki class me bhut mja ata hai, inhe roj hamari class me like ana, or ab to Motu intelligent bn gya, hum mtlb aj Patlu ki help kar rahe hai" (It's really enjoyable during the class of Motu and patlu, bring them daily in our class, and now the Motu become intelligent, which means we are here to help Patlu today).

This not only shows that this student has successfully built his interest in the classroom but also a sense of collaboration in himself. Stories gave them space to think in their own way to solve the sum to help the protagonist Motu in another story and were feeling like they are doing the sum to help the protagonist rather by taking it as a burden upon themselves that was appreciable and helpful in developing the reasoning and problem solving skills. Also when one of them was having an issue to solve the sum they started helping each other and by saying to me that,

“mai iska Patlu bn jata hu" (I become the Patlu for him/her).

This shows the encouraged students to learn in collaboration and by helping each other. Storytelling sessions promote collaborative learning and communication skill development as students engage with narratives they are encouraged to discuss, analyse and reflect upon the mathematical concepts. They were eagerly wanting to help each other by becoming someone's Patlu or Motu. Storytelling promotes collaborative learning by encouraging students to share ideas, discuss concepts, and engage in reflective thinking.

Motivation: 'By storytelling, the motivated behaviour of students, instruments having indicators like persistence , direction, continued motivation and performance were observed'(Keshavan P., 2019). "Conceptual, emotional, motivational, engaging, interesting and logical ideas are developed by telling stories in mathematical connection with students day to day activities, storytelling in mathematics enhances students' interest and motivation"(Nepal K. & Shrestha I.M., 2022, p.31). Interestingly, we generally hope that teachers should be the one who would begin to encourage mathematics problems through stories. But the study found no guidance was necessary. They were all motivated by themselves. When we were telling the story they felt connected with the story and gradually the mathematics class became interesting with the curiosity to know, what will happen next? Many of the students used to say

“me bhi Patlu banunga ab” (I will also become Patlu).

They motivate themselves to solve the sum to become Patlu. Even some of them were able and ready to solve the confusion of Motu. And when the Motu got the way to solve the sum in two ways they were amazed and then Bhanu said

"mam aisa bhi koi tareeka hota h kya? dandiyon se solve kr diya to, humne toh kabhi socha hi nahi, me bhi aise solve karunga ab" (Ma'am, we don't even imagine, if there was such a way? He solved the sum using sticks, I will also solve it the same way).

Then, they tried to solve the questions unintentionally even when they were doing wrong but still they got motivated to at least give a try like Motu, during the story they were ready to give him suggestions for doing it in the correct way. They were applying the mathematical operation on their own. We saw that they were giving different ways for solving the sum. We observed that some were doing by making virtual icons or images in their notebook and counting by one, some were doing it by repeated addition, some were giving me answers by multiplying rather than 2 among the students, Jai and Govind who were calculating the answer mentally without pen and paper. The main thing is everybody was trying to do it. We observed, stories acted as a motivational tool for learning mathematics. Students showed increasing motivation to solve problems, explore different methods, and actively participate in class discussions. They were curious, excited, and willing to take on challenges, as seen in their eagerness to help Motu and Patlu. We also observed the motivation among the students which was not the external one but it was intrinsic motivation among themselves. Students become encouraged without any pressure by external support, reinforcement etc. They were the ones who were coming forward to interact in the classroom by themselves. Through this effective result with respect to motivation, it was found that storytelling motivates students to learn maths by making it enjoyable, inspiring curiosity, and fostering a positive attitude towards mathematics. Now, they were not seen as afraid of maths class as they were observed in the starting days of the observation during the first phase.

Retention of Concepts: 'By situating mathematical problems with familiar context, stories empower students to make connections between abstract concepts and concrete experiences. Thereby, enhancing their understanding and retention'(Samantha F.J.,2019). We observed that the interactive nature of the stories, combined with the problem-solving tasks, helped in the retention of mathematical concepts. Students solved problems and recalled and applied these concepts in subsequent sessions. For instance, they linked concepts from previous stories to new situations and applied mathematical thinking independently. Like for multiplying some were verifying their answer by using Array multiplication method, which was learnt in previous class. According to the reference and observation, we can say that stories help in the retention of maths concepts by providing meaningful experiences, contextualising concepts, and making connections between abstract ideas and concrete examples. Ruhi was seen relating the story with her real life and trying to apply that knowledge further. She understands how this concept of the value of time is necessary to know for her brother, this is actually the importance of time under measurement theme in mathematics to be aware of time and its approximation to plan our day accordingly. Because the number of hours will be the same forever, it's an universal truth, but how we are using this time can vary from one person to another. Here she was retaining the concept and relating with real life situations. From whatever we have discussed above, we came to the conclusion that now we can tell how effective stories and storytelling are in teaching mathematics and how we can use it as a pedagogy in mathematics classes.

8. SPACE FOR STORIES AND STORYTELLING AS TOOL OF PEDAGOGY

- Storytelling can be used as a pedagogy in mathematics. The project unequivocally demonstrates that storytelling can indeed be a powerful pedagogical tool in mathematics education. Through carefully crafted narratives, students were engaged, motivated, and actively involved in learning mathematical concepts. Stories provide a context for abstract ideas, making them more accessible and relatable to young learners.
- Storytelling makes the mathematics class interesting. The project's observations reveal a remarkable shift in students' perception of mathematics from mundane to fascinating. The use of storytelling injected excitement and curiosity into the mathematics class, turning it into an engaging adventure for students. Students eagerly anticipated the next instalment of the mathematical stories, demonstrating a newfound interest in the subject.
- Storytelling can become a part of mathematics lesson plan for the primary level. The project's success highlights the potential for integrating storytelling into the mathematics curriculum for primary-level students. The stories seamlessly fit into the lesson plans, providing a rich context for learning while covering key mathematical concepts. By incorporating stories, educators can enhance the effectiveness of their lesson plans, making maths more enjoyable and meaningful for young learners.

- The effectiveness of integrating stories into mathematics at the primary level is undeniable based on the project's findings. Students demonstrated improved conceptual understanding, as evidenced by their ability to apply mathematical concepts to real-life situations presented in the stories. Engagement and participation levels soared, leading to a more vibrant and interactive learning environment. The stories not only made maths enjoyable but also fostered a deeper connection between students and the subject matter.
- Stories contribute to a deeper understanding of abstract mathematical concepts among young students. Stories played a crucial role in bridging the gap between abstract mathematical concepts and students' everyday experiences. By contextualising maths within narratives, students were able to visualise and internalise complex ideas, leading to a deeper understanding. The narratives provided a framework for exploring mathematical concepts in a relatable and meaningful way, promoting critical thinking and problem-solving skills. Through stories, young students were empowered to make connections between theory and practice, laying a solid foundation for future mathematical learning.

9. CONCLUSION

The Research work "The effect of storytelling as a pedagogical approach in mathematics" has proven to be highly effective. It has enhanced student's conceptual understanding, engagement, problem-solving skills, and ability to connect maths with real life. Furthermore, it has promoted collaborative learning, motivation, and retention of concepts. The stories have transformed the mathematics class into an interactive, enjoyable, and intellectually stimulating environment, where students actively participate, communicate mathematically, and develop a deeper understanding of mathematical concepts. The analysis of the project's effectiveness in teaching mathematics through storytelling is further reinforced by the insights from the provided literature. The literature supports the project's approach by highlighting how the effect of storytelling as a pedagogical approach in mathematics enhances conceptual understanding, engagement, communication, reasoning, problem-solving skills, connection with real-life experiences, collaborative learning, motivation, and retention of concepts.

The project's success aligns with the research on the effectiveness of storytelling in mathematics education, indicating that this approach has the potential to transform maths education for the better. By exploring the nature of mathematics through storytelling and real-world application, educators can help alleviate fears by providing context and meaning to abstract concepts. Despite the project's undeniable success and the supportive evidence from the referenced articles, there arises a question of scalability and adaptability. While the benefits of using storytelling in mathematics education are clear, the implementation of such an approach on a larger scale may present challenges. One potential concern is the time and effort required to create quality mathematical stories that effectively align with curriculum standards. Crafting narratives that seamlessly integrate mathematical concepts while remaining engaging and relatable is a skill that not all educators may possess. Additionally, ensuring that these stories are culturally relevant and inclusive of diverse perspectives adds another layer of complexity. Another point of consideration is the variation in student responses to storytelling. While many students may thrive in this interactive and narrative-rich environment, others may require different approaches to learning mathematics. It is essential to recognize that students have diverse learning styles and preferences, and a one-size-fits-all approach may not cater to everyone. There might be institutional barriers to adopting storytelling as a pedagogical approach to mathematics education. Schools and educational systems often have established curricula and teaching methods, making it challenging to introduce innovative approaches. Lastly, there is the question of sustainability. While the initial enthusiasm and impact of storytelling in mathematics may be significant, maintaining this level of engagement and novelty over the long term could pose challenges.

In conclusion, while the benefits of using storytelling in mathematics education are evident, there are practical considerations and potential challenges that educators and policymakers must address. Further research and exploration into effective implementation strategies, teacher training, assessment methods, and long-term sustainability are essential for maximising the potential of the effect of storytelling as a pedagogical approach in mathematics.

CONFLICT OF INTERESTS

None.

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