Exploring Teachers' Experiences on the Construction and Use of Teaching Materials in Mathematics Classroom: A Narrative Inquiry

Lok Bahadur Basnet
Padmodaya Public Model Secondary School, Ghorahi, Dang, Nepal
Email: lokbahadurbasnet@gmail.com

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Abstract: Teachers' experience and knowledge with the construction and use of teaching materials influences the teacher's classroom activities. This study intended to explore mathematics teacher's experience on the construction and use of teaching materials in the classrooms. This study used a narrative inquiry approach to explore the use and construction of teaching materials in mathematics teaching, focusing on the experiences of mathematics teachers from secondary schools in Dang district of Nepal. The findings suggest that the experienced mathematics teachers used only text-books and whiteboards as teaching materials. They did not use additional teaching materials in their mathematics classrooms at the beginning of their careers. Further, with the help of in-service teacher training, the research participants got the knowledge and skills to construct and use teaching materials, like the prism models, pyramids, cones, and cylinders. Furthermore, the findings also suggested that the teachers do not use these teaching materials regularly due to poor classroom management and overwork load. The findings of this study can be helpful for mathematics teachers, teacher trainers, school administrations, and policymakers for meaningful mathematics teaching and learning.

Key Keywords: *Abstract nature, Explore, Knowledge, Mathematics teachers, Teaching materials*

Introduction

For the meaningful learning of mathematics, 'doing' is more important than 'reading'. For the 'doing' aspect of mathematics, it demands some related tools, materials, and context to start the topic. Past studies, such as Pradhan (2021), viewed that cultural artifacts and cultural activities may help teachers teach mathematics meaningfully and also help students understand mathematical concepts meaningfully. Furthermore, use of teaching materials helps students meaningful learning of mathematics (Sidhu, 1995). Therefore, mathematics teachers require awareness of constructions and uses of teaching materials for the meaningful and deep learning of mathematics. Mathematics teaching and learning can be joyful when teachers use instructional materials properly. Moreover, teaching materials enhance students' interest in

mathematics learning, understanding, and critical thinking (Behm & Lloyd, 2009). Therefore, teaching materials are essential for connecting new knowledge with prior knowledge.

The study of Bhattarai and Paudel (2018) argued that more than seventy percent of students have achieved only under twenty-eight percent of the tested curriculums in school-level mathematics, showing that many students still need to perform better in this subject. The main reasons for not liking mathematics are the inability to understand subject matters and not using related teaching materials in mathematics teaching (Gafoor & Kurukkan, 2015). From these findings, it can be noticed that teaching-learning activities cannot be done satisfactorily without use of proper teaching aids at school-level mathematics classrooms. Many students need help in the classroom for understanding mathematics meaningfully. Most of the students are having anxiety due to mathematics subjects which they have to study as one of the compulsory subjects in schools.

Students should learn mathematics concretely and meaningfully to apply mathematical knowledge and skills to real-life situations. For this, the role of the mathematics teacher is significant and should have different knowledge and skills in making instructional plans, applying teaching methods, evaluation systems, learning theories, and construction and use of teaching materials. Furthermore, teachers' knowledge and skills in the constructions and uses of teaching materials in mathematics classroom can bring 'aha' feeling in the students. With such experiences, mathematics classes can be more effective and interesting. So, this study intended to explore the experience of teachers on the construction and use of teaching materials in mathematics classes.

Methodology

A narrative inquiry is a research approach that focuses on the study of individuals' stories to understand the meaning-making processes, experiences and social constructions of reality. It is a qualitative research method that aims to explore mathematics teachers' experiences with teaching materials in mathematics classrooms based on their lived teaching experiences. It focuses on collecting, analyzing and interpreting stories to gain insight into individuals' experiences, perspectives, and meanings. To explain, analyze and interpret teacher's experiences on the construction and use of teaching materials in mathematics classrooms from diverse viewpoints of mathematics teachers of Dang district, I used a criterion-based selection strategy to choose the research participants (Roulston, 2010). For this, I selected one

secondary-level (grade 9 and 10) mathematics teacher, pseudonym Remant Bahadur, who has more than three decades of experience in mathematics teaching.

Narrative Generation

I conducted one-on-one interview according to his time and preferred place. According to the participant's convenience, I conducted the interview at his home during leisure time. I conducted the interviews with the participant teacher four times to take valid information about his experience of constructing and using teaching materials in mathematics classroom. Each interview lasted for about thirty minutes on average. It took ten days to complete the interviews to construct a story of research participant in constructing and using teaching materials in his classroom. I audio recorded the interviews and transcribed each of them verbatim to ensure the validity of transcribed data from participant's interview (Creswell, 2007). I shared thetranscription summary the participant. According to participant teacher, I corrected the interview transcripts based on his feedback with the updated information.

Narrating Procedure

I transcribed the interviews to keep the teacher's voice unchanged; emphasizing the speaker's experiences (Wells, 2011). For this, I transcribed the recording of the participant's voice on the same day living in a quiet place at home. To transcribe the narrative story of t the participant, I made two columns on notebook: on the left column, I wrote questions that asked during the interviews according to themes, and on the right column, I wrote responses of the participant to the respective questions during the interview (Creswell, 2009). The only things removed from the transcriptions were personal identifiers and expressed breaks (i.e., ye dam, kyare, um, like, uh, or faltered/duplicated words). I utilized spacing to help with the natural flow of reading the talk. I used pseudonym for the research participant, address, and school name, and audio records removed after transcribing the stories for confidentiality. A few days later, I read the transcripts from time to time for a more individualized interview, so that it helped me in the next follow up interview. Then, I prepared additional questions for the following discussion so that I could clarify, amend, or add to anything or remove unnecessary things and made a summary from starting to assist the next sequential interview.

Meaning Making of Narrative

Conducting the narrative inquiry study and meaning-making of narratives helped me understand and communicate new ideas. Because I allowed the participant to tell his stories in the construction and use of teaching materials in his mathematics classroom in the usual ways;

moreover, each interview had its particular components. I created themes of stories by reading the transcript time and again until I was able to grasp a structure or pattern of his expereinces (Harris, 2000). For experience-centered narrative analysis, I utilized three approaches: first, I created broad themes, gave analytical explanations, and finally, used inductive and deductive interpretation of these themes.

Entrance with Remant's Story

Remant said that he is from a simple middle class family, studying grade one through Bachelor's Degree in a public school and a public university campus. He completed his primary level education from Bahundada Teraute Primary School, lower secondary education from Rajhena School, secondary level education from Padmodaya Public Model High School, Bharatpur Dang. Then he completed his Proficiency Certificate Level (PCL) and Bachelor's Degree from Mahendra Multiple Campus of Tribhuvan University at Bharatpur Dang. He started his teaching profession at one of the government schools of Rukum distinct in 1992 while he was studying for Bachelor's Degree. He has been teaching mathematics at the secondary level at Siddarth Academy, Ratanpur Dang for 15 years.

While studying in grade three, he shared his dim memories, a group of novice teachers showed objects while teaching mathematics. He also recalled making himself and his friends' pity games by novice teachers. They used to use the abacus, and he used to use Khari and shilaut to write. He said, "When I was in grade 4, I had observed making wooden pirga, by a carpenter. The carpenter fixed the centre and radius with the help of nails and rope". His father was also a carpenter who used to make wooden doors and windows, and he used to observe his father's works. When he joined the PCL, he studied mathematics as a measure subject. Even at the PCL level, his mathematics teachers did not use any solid materials in any topics and did not connect formal mathematics with real-life situations. His teachers used only the chalk-and-talk method while teaching mathematics at this level. In his Bachelor's first year, a novice teacher taught him mathematics, and sometimes he made wrong figures on the boards, and students made corrections. Due to the unsatisfaction of teaching method of the novice teacher, all students left the class, and the teacher used to call them to join the class. In his Bachelor's second year, an experienced teacher taught him mathematics using the talk-and-chalk method. He did not use any solid teaching materials or relate math to the real context. His experienced teacher also did not teach mathematics satisfactorily.

After completing his Bachelor's Degree in 1992, one of the head teachers of a high school at Rukum district invited him to teach mathematics. On the first day of his class, the head teacher gave him a Vote Khari (a kind of clay chalk) to write on the black board. There were not any concrete teaching materials for teaching mathematics in the school. There were about 4-6 students studying optional mathematics. Remant used to teach them mathematics sometimes on the ground and sometimes in a garden. At the beginning of his teaching days, he used only chalk and board for teaching mathematics to his students. He did not use any concrete mathematical teaching materials. After some months, the district education office of Rukum organized a teacher training program for mathematics teachers. Remant also took part in that program. According to him, he learned how to make different instructional plans, use a proper teaching method according to the needs of a topic, and construct and use mathematical teaching materials. He also learned age finding game from a chart of the number. Nowadays, he makes students play this game.

After this training, he got a few ideas about the construction and usage of teaching materials for mathematics teaching. He began to make a solid triangle of paper to give the concept of different parts of the triangle. But, he did not know how to connect ideas of formal mathematics with real-life situations. After teaching in the Rukum district for some years, he came to Siddhartha Academy Dang in 2007. He taught compulsory mathematics and optional mathematics from grades 6 to grade 10. At Siddhartha Academy, he got a chance to participate in a one-week mathematical teaching materials construction and usage workshop by a professional trainer. In this workshop, he learned how to make and use solid objects like cylinders, cones, spheres, hemispheres, different types of pyramids and frustum, materials related to finding the volume of cones and cylinders, materials related to surface area and volume of the spheres and materials associated with factorizing algebraic expressions by making nets on the rigid card sheet. After that workshop, he began to teach his students using concrete teaching materials. While teaching mathematics using a concrete stage, semi-concrete stage, and abstract stage in a sequence, it is straightforward to concretize the ideas of mathematics, and students become pleased; they get a chance to touch and play with the teaching materials and develop conceptual understanding of mathematics.

He did not use a ready-made flex print chart because students saw the chart and forgot it later. According to him, rather than using a flex print chart, making students solid objects, their pictorial representation at last drawn conclusion or derive formulae is better. He further said if mathematics teachers created this learning environment for students, they would understand

mathematics meaningfully and would not forget the important concepts for long. He added that the use of materials in mathematics teaching makes students happy, innovative, and creative and builds their capacity for problem-solving. Remant also mentioned the importance of materials for teachers and learners to understand the subject matter in depth and meaningfully. According to him, basic-level mathematics teachers did not use any teaching materials while teaching mathematics. They do not relate mathematical ideas to real-life situations, so the students are not learning mathematics meaningfully. Remant Bahadur added that teaching mathematics to secondary-level students was complicated due to the lack of practical teaching-learning activities in mathematics at the primary level.

Remant and his students went to observe the exhibition of mathematical teaching materials at Ghorahi, organized by the Dang District Branch of Council for Mathematics Education. There was an opportunity to observe more than 100 items of teaching materials related to different topics of mathematics from the basic level to the secondary level. Remant requested the School Management Committee to manage mathematics lab in the school. The mathematics lab would help with a space for construction and store of teaching materials and arrange them according to grade levels and topics during the leisure periods.

According to Remant, at the beginning of his profession, he did not have ideas of planning, teaching methods, learning theories, child psychology, evaluation system, the art of questioning, and construction and usage of teaching materials. Remant further said that when he took part in workshops, different short-term trainings, self-experience in teaching, and observed the exhibitions of mathematical teaching materials, he got more ideas about the concepts mentioned above. Nowadays, Remant uses solid objects for teaching mensuration, like the model of cones, pyramids, prisms, cylinders, spheres, cubes, and cuboids. He said that it is challenging to complete the course on time due to the long mathematics course. While using these teaching materials takes a long time to complete the course rather than without using teaching materials. Due to the lack of math lab in school, there are problems managing teaching materials once used. Often novice teachers do not have ideas about using teaching materials, so they teach mathematics without using teaching materials.

Departure from Remant's Story

In Remant's narrative story, we noticed the sociocultural view of teaching and learning while constructing and using mathematical teaching materials in the mathematics classroom to build new knowledge. At the beginning of Remant's teaching profession, he was a traditional teacher

and did not see constructivism approach in his teaching. But now, he is, to some level, a free thinker mathematics teacher and is well known for the innovative and practical practice in his mathematics classroom because his behaviors do not conform to prevailing ideas or rules in the mathematics classroom while using teaching materials. The pragmatist teacher uses an experimental teaching method where students discover the truth themselves. Mathematics teachers must apply inductive and heuristic teaching methods for meaningful teaching and learning of mathematics. The use of various types of teaching material and learning environments may support it (Sharma et al., 2018). In Remant's narrative story, we noticed that he is also a pragmatist teacher.

Remant, to some extent, accepts that a good mathematics teacher constructs and uses context-based teaching materials and asks good questions to their pupils for energetic participation to strengthen meaningful understanding and engage them in fruitful discussion in the mathematics classroom. Remant frequently gives his students the concepts of mathematics by connecting previous knowledge with the help of relevant teaching materials. The study showed a notable enhancement in the acquisition of scientific conceptions due to the use of prior knowledge and materials which explicitly dealt with alternative student conceptions (Hewson & Hewson, 1983). In Remant's narrative story, we noticed that he is serious about enhancing his students' mathematical knowledge and skills. For this, he took part in many short-term training in mathematics, observed exhibitions of mathematical teaching materials, visited a maths lab, and tried establishing a math lab in his school. So, Remant got the knowledge and skills to make and use teaching materials through social interaction with his colleagues, seniors, and teacher trainers.

Through the narrative of Remant, I noticed that while using teaching materials in mathematics class, the students felt different that day and became more interested, curious, and happy in the classroom. Students remembered the subject matter for a long time, and while using teaching materials, he felt it was easy to teach. When teachers select and use the right teaching materials, math teaching and learning are enjoyable. Moreover, instructional resources foster students' interest in mathematical learning, comprehension, and critical thinking (Behm & Lloyd, 2009).

Findings and Discussion

Based on the Remant's narrative several findings can be drawn regarding the use of teaching materials in the mathematics classroom: Positive Effects of Using Teaching Materials in Mathematics Teaching: From the story of the research participant, I found that while using

teaching materials other than textbooks and boards, students were interested in learning mathematics and became creative and innovative. Students began to ask creative questions. Using teaching materials helped him learn mathematics by touching and seeing things. Further, using teaching materials helped teachers understand the subject matter himself. He also added that using teaching materials promotes sequential mathematics teaching and learning.

The study's findings indicated that ethnomathematics teaching materials helped students understand the volume of cylinders and hemispheres. The study also suggested using ethnomathematics teaching materials for other topics helped for the meaningful learning of mathematics (Pradhan, 2021; Unodiaku, 2013). The findings conclude that future teachers have favorable views and attitudes toward general teaching technologies and material development in mathematics teaching (Koparan, 2017). Moreover, teaching materials enhance interest in mathematics learning, understanding, and critical thinking (Behm & Lloyd, 2009). The above three studies support the findings of the current study that the use of teaching materials positively affects creative, innovative and meaningful teaching and learning of mathematics for both the teachers and students.

Teacher's Involvement in TPD Training and Other Mathematical Activities and Use of Teaching Materials: From the voice of the participant teacher, I found that teacher's professional development training, mathematics lab visits, and exhibition of mathematics teaching materials enhanced his knowledge and skills in the construction and use of teaching materials. Furhter, he knew how to use context-based teaching materials, and learned how to use the concrete, semi-concrete, and abstract stages in mathematics teaching from these mathematical activities.

The preparation of teaching techniques and materials is time-consuming and tedious. Teachers need to gain knowledge and skills in creating and using the materials. The mathematics lessons have the issues of inconsistency between the contents and periods of teaching in the curriculum, like in the other classes and challenging to finish the course on time if they use instructional materials in mathematics teaching (Aksan & Eryılmaz, 2011). The findings of this study agreed with some portions of the results of the current study that the teacher did not use teaching materials regularly due to time and resource contraints.

Barriers to Using Mathematical Teaching Materials: In order to regularly use mathematical teaching materials in the mathematics classroom for easy and joyful learning for the students,

it takes extra time to prepare these materials and to link them with the relevant topics. In addition, they have to teach many periods in school. Participant teacher said that managing his time was one reason not to use materials in mathematics as he thought. His other reason for not using teaching materials properly was that most of the mathematics classes did not have materials friendly due to immovable seating arrangements, and the large number of students in the classroom. The research participant added that lack of practical time in the mathematics curriculum, the exam-oriented teaching-learning culture in the school, and the lengthy mathematics curriculum were other reasons for not using the teaching materials in mathematics.

Frequently Used Manipulative Teaching Materials: In this Study, I found that after completing 'Teachers Professional Development Training', participant teacher used 2D and 3D manipulative teaching materials. In 2D manipulative teaching materials, he used factorization tiles to teach the factorization of a quadratic expression. He used tiles of squares and triangles to verify Pythagoras' theorem practically. He used 3D blocks for the factorization of cubic expression. Further, the participant teacher used models of cubes, cuboids, prisms, pyramids, cylinders, cones, and models of combined solids to teach their surface areas and volumes meaningfully and practically.

From the reporting of the participant teacher, I found that teacher's professional development training, mathematics lab visits, and exhibition of mathematical teaching materials provided him more knowledge and skills in the construction and usage of teaching materials. Further, using context-based teaching materials, he learned how to use the concrete, semi-concrete, and abstract stages in mathematics teaching from these mathematical activities. Past studies also found that mathematics lab and in-service teacher training programs helped teachers to select, construct, and use mathematical teaching materials in their classrooms (Edenfield, 2010; Kunwar, 2018; Subedi, 2001). In this context, classroom activities help students create their mathematical knowledge. Collectively, students construct their mathematical reality. It takes conscious effort and social interaction of learners in the classrooms and outside to learn mathematics. People engage with others and their environments to create meaning of their learning processes in mathematics. Thus social constructivism theory and above-mentioned literatures support the finding of the study that teaching materials and their uses may play a significant role in enhancing conceptual learning of mathematics.

Concluding Remarks

The study explored the experience of a mathematics teacher, Remant, in the construction and use of teaching materials in the mathematics classroom. The research used a narrative inquiry approach, which focuses on understanding individual's life stories and experiences. Remant, with over three decades of teaching experience, shared his learning journey and the changes he observed in his mathematics teaching practices. Initially, Remant did not have much exposure to teaching materials in mathematics. He recalled his early experiences as a student, where novice teachers used objects like abacus, Khari, and other concrete objects to teach mathematics. However, as he progressed to higher levels of education, he noticed a lack of solid materials and real-life connections in mathematics teaching. His interest in using teaching materials grew when he attended a teacher training program organized by the District Education Office. The training equipped him with knowledge of instructional planning, teaching methods, and the construction and usage of teaching materials. Remant started incorporating concrete teaching materials, like triangles made of paper into his lessons. Further, Remant attended a workshop on mathematical teaching materials at Siddhartha Academy. This workshop introduced him to various solid objects like cylinders, cones, spheres, and pyramids, which he began using in his teaching. He emphasized the importance of connecting mathematics with real-life situations and using hands-on materials to facilitate meaningful understanding of mathematics by his students. Remant mentioned that teaching mathematics without teaching materials was less effective and it did not engage students as much as it was engaging with the materials. He highlighted the need for a separate room (as a laboratory) to construct and store teaching materials. He suggested that teachers should focus on creating a conducive learning environment where students can touch and play with the materials. Through his narrative, Remant portrayed a sociocultural view of teaching and learning. He transformed himself from a traditional teacher to a pragmatist teacher who encourages student discovery and meaningful understanding of mathematical concepts, procedures, and applications. He emphasized the role of prior knowledge, relevant teaching materials, and good questioning techniques in enhancing students' mathematical knowledge and skills.

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