

**DEVELOPMENT AND APPLICATION OF MATH TEACHING-
LEARNING MATERIALS: PERSPECTIVE OF PRIMARY
SECTION TEACHERS FROM ENGLISH MEDIUM SCHOOLS**

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A thesis submitted to the BRAC Institute of Educational Development in partial
fulfillment of the requirements for the degree of
Master of Education in Educational Leadership & School Improvement

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Declaration

I, Julia Islam Sarker, declare that-

1. The thesis titled "Development and application of Math Teaching-learning materials: Perspectives of primary section teachers from English medium schools" is my own original work while completing my Master's in Education degree at BRAC University.
2. The thesis doesn't include anything that has already been published or authored by someone else, unless it is properly cited.
3. This thesis does not include material approved or filed for any other university degree or certificate.
4. I have acknowledged all main sources of help.

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Approval

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Ethics Statement

I, Julia Islam Sarker, hereby consciously assure that the thesis titled "Development and application of Math Teaching-learning materials: Perspectives of primary section teachers from English medium schools," the following have been fulfilled-

- This submitted thesis is my own original work, and the contained material has not been previously published or submitted elsewhere.
- All sources used in this manuscript are appropriately identified and cited. Text that is literally copied must be identified as such by using quote marks and providing suitable references.
- All the participants in this research willingly participated.
- The research participants' identities are confidential, protected, and will not be revealed at any point.
- The findings are suitably contextualized in relation to previous and present research.

Abstract

Integrating diverse teaching and learning materials in math classes is an effective strategy for developing students' conceptual understanding. Students construct knowledge through discovery as they engage with real-life objects. This study explores the application of teaching-learning materials in primary section math classes in English-medium school settings. The focused areas of this study are: teachers' perceptions of developing and integrating diverse materials; teachers' classroom practices; school guidelines and support; and, lastly, the challenges of implementing those materials. To conduct the research, a qualitative approach was employed. The data of this study were collected through in-depth interviews and classroom observations of 12 math teachers from 6 English-medium schools in Dhaka city. The analysis used an inductive thematic approach, which revealed that teachers consider using diverse materials the most important plan of action, as it can engage all types of learners and help contextualize math in real life. The teachers used mostly low-cost, no-cost, sensory, and easily available objects for lesson delivery and student engagement. Some schools have systematic guidelines for using Teaching-Learning-Materials in math classes and provide various forms of support, whereas the rest lack a strict policy. All schools arrange PDT to improve overall teaching practice, but very few focus on math capacity-building. However, implementing TLMs can be challenging, as they are time-consuming and resource constraints are common in newly established schools. Moreover, some teachers require pedagogical soundness about the strategic implementation of TLMs. This study proposes extensive, specialized teacher-training sessions on the strategic and effective use of TLMs in math classes. It also recommends establishing a common guideline for all English-medium schools so that teachers can follow the same direction and maintain a high teaching standard.

Keywords: Teaching-Learning materials; strategic application; English medium schools, Primary Math teachers

Dedication

This thesis is dedicated to my late father, Zohurul Islam Sarker; fatherly figure, Quazi Sajjad Ali Zahir, Bir Protik; and my husband, Reza Hafeez, for their constant support and encouragement throughout my educational journey.

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List of Acronyms

ADDIE	Analysis Design Development Implementation Evaluation
CIE	Cambridge International Education
CPA	Concrete Pictorial Abstract
DISA	Dhaka International Schools Association
GDD	Global Developmental Delay
IB-PYP	International Baccalaureate- Primary Years Programme
LCNC	Low-Cost No-Cost
MI	Multiple Intelligences
MNP	Math No Problem
PDT	Professional Development Training
SDT	Self-Determination Theory
TLMs	Teaching Learning Materials
ZPD	Zone of Proximal Development

Chapter-1

Introduction and Background

1.1 Introduction

Mathematical pedagogy has gradually changed throughout the centuries and has been shaped by evolving social demands, cognitive psychology, learning philosophy, and, lately, advanced technology. Subsequently, the pedagogical approach has shifted from traditional textbook-based rote memorization to experiential and interactive learning (Gowri et al., 2015). As young learners are not yet mature enough to understand abstract mathematical theories, they require concrete objects and hands-on resources to construct mathematical knowledge (Piaget, 1952). Through manipulative and learning aids, the children experience the real-world application of Mathematics (Moyer, 2001). Integrating diverse teaching-learning materials and strategies into the math curriculum design and teaching is an essential first step towards increased student engagement in classroom activities and a better conceptual understanding of the topics (Koparan, 2017). Moreover, it is well known that a teacher's perspective on pedagogical design is essential, as they select and implement effective study-related materials (Moyer, 2001). Hence, this study aims to explore teachers' perspectives on using teaching and learning materials, their classroom practices, and the challenges they face when incorporating those materials into their lesson delivery. The findings can help determine how to provide all students with effective learning materials and boost their learning outcomes in tough subjects like mathematics. Besides this, it can also recommend tailored solutions for teachers to deal with the issues.

1.2 Research Topic

The topic of this research is 'Development and application of Math Teaching-learning materials: Perspectives of primary section teachers from English medium schools'.

Employing various types of TLMs for math instruction is essential for teachers as students acquire compound knowledge while actively engaged with those materials (Kul et al., 2018). With real-life instructional materials, the learning process becomes interactive, leading to successful learning outcomes in the subject matter (Osei-Himah & Adu-Gyamfi, 2022).

My aim is to investigate how English-medium primary section math teachers conceptualize TLMs and their views on the strategic use of TLMs. Here, strategic implementation refers to the tactical and purposeful use of the material by teachers. My focus is on strategic use because the significance and success of TLMs depend on their premeditated implementation, such as selecting age-appropriate, well-planned TLMs for class activities (Kyeremeh et al., 2021, p. 19).

1.3 Statement of the Problem

Mathematics is a subject that requires students' critical thinking and problem-solving skills, and, as Khaleduzzaman (2020) stated, teachers are reluctant to implement hands-on strategies; instead, they prefer discussion and question-and-answer sessions. In line with Pia (2015), there is a shortage of skilled, certified math teachers in Bangladesh, which creates a barrier to the creation of an effective learning environment. She also noted that most teachers lack sufficient training to engage students in interactive lessons, leading to declining learning outcomes. Additionally, teachers have limited access to various TLMs and receive less support from organizations. Maleque et al. (2004) reported that teachers are reluctant to use diverse teaching aids in their classrooms and tend to rely on only a few tools in specific classes. As discussed by Gadanidis & Geiger (2010), such social and infrastructural barriers to teaching affect teachers' motivation to adopt innovative classroom practices.

Among the various international curriculum frameworks, the Cambridge Primary Mathematics recommends implementing multiple teaching strategies that incorporate TLMs (Cambridge Primary Mathematics, Cambridge, n.d.). IB-PYP is another international curriculum that proposes an inquiry-based, play-based pedagogy for learning through hands-on, exploratory approaches (International Baccalaureate Organization, 2018).

1.4 Purpose of the Study

The study investigates and identifies the factors that affect the selection and integration of lesson-appropriate teaching-learning aids in math classes, focusing on teachers' viewpoints from different English-medium schools in Dhaka district.

It also aims to identify and examine the underlying factors that make teachers struggle to engage in motivation-led practice when using teaching aids, with special attention to the barriers they face in the implementation process, and, importantly, to evaluate practical strategies to overcome them.

1.5 Research Questions

This study intends to investigate teachers' perspectives, teaching practices, and challenges of implementing TLMs in the math classes, which is directed by the following research questions-

1. What are the perceptions of English medium school teachers about developing and integrating diverse TLMs for math classes?
2. How do the primary teachers of English medium schools implement TLMs in the Mathematics classes?
3. What are the support and challenges of implementing TLMs in math classes?

1.6 Significance of the Study

The study is crucial because it will inform policymakers, school administrators, teachers, and stakeholders of the data on the variables that influence the usage of math teaching-learning aids. They can utilize that data to update education policy and tailor interventions. They can also initiate the provision of necessary training opportunities and resources to teachers, enabling them to use the teaching aids strategically. Based on the research findings, it is possible to identify current classroom practices and barriers, and then take measures to improve teachers' competency, class management, instructional methods, and strategies for integrating diverse materials. It can enhance students' engagement and class participation and improve their understanding of the subject. The process will upgrade the teaching and learning environment for challenging subjects like math. Besides these, the study will highlight teachers' perspectives on preparing and implementing diverse materials. The research will also examine whether there is a difference between male and female perceptions, thereby establishing gender equality.

This research will add to the body of literature already available on teaching mathematics, the application of teaching-learning materials, resource availability, school support, and teachers' efficacy in the primary section of English-medium schools in Dhaka. The observation data and research outputs will identify areas for improvement in existing teaching practices and promote an inclusive perspective on the factors that impact teaching practices in math classes.

Chapter-2

Literature Review and Conceptual Framework

2.1 Introduction

In this chapter, an overview of the available literature on TLMs in the context of Primary Years Mathematics has been presented, including theories related to their implementation, the Curriculum Frameworks of the associated English Medium schools, teachers' perceptions of TLMs, classroom practice, and the challenges of implementing TLMs. It also includes the research gap and the conceptual framework for this study. In doing so, I reviewed related literature, including online books, articles, and various documents.

2.2 Evolution of Mathematical Pedagogy

According to Gowri et al. (2015), Mathematical Pedagogy is the strategies, techniques, and processes of teaching math, which are constantly evolving. They posit that, from the mid-20th century to the present day, education has shifted from a teacher-driven approach to a learner-centered method. They also mentioned that, at present, math pedagogy incorporates technological tools, implements constructivist learning paradigms, prioritizes inclusivity, equity, and diversity, and emphasizes problem-solving and critical thinking skills. Furthermore, their study suggests that contemporary math pedagogy emphasizes learners' conceptual understanding, real-world application, data interpretation, and decision-making abilities through mathematics, as well as global collaboration and cross-disciplinary learning.

2.3 Teaching-Learning Material

Aravind (2015) states that, TLMs are tools that enhance teachers' instruction and provide learners with information through all the sense organs: auditory, visual, or combined stimulation during knowledge acquisition. In this study, he mentions that these materials make the content or

information more concrete and enhance the learning process, making it seem authentic, dynamic, and relevant. According to him, learners understand more quickly, retain more deeply, and acquire precise knowledge through active engagement with the materials. To emphasize the importance of TLMs, Aravind (2015) mentioned Edgar Dale's cone of experience as follows:

"I hear I forget,

I see I remember,

I do I understand"

Educational quality improves when learners are engaged in subgroups and educators incorporate tangible resources throughout the teaching and learning process (Osei-Himah & Adu-Gyamfi, 2022). Instructional materials or TLMs let students obtain knowledge using all five sense organs- ears, eyes, nose, tongue, and skin (Arthur, 2024).

In the formal learning environment, TLMs are employed to attain the educational goals specified in the learning trajectory (Kapur, 2019). Abdul-Wasiu et al. (2024) claim that math is the top core discipline studied in educational settings, but learners sometimes find it challenging to grasp mathematical concepts due to their theoretical or abstract nature. They describe how Teaching-Learning Materials are essential resources in math study, converting theoretical ideas into practical, relatable encounters with learners.

According to Aravind (2015), there are three categories of TLMs: i. Verbalism, ii. Teaching aids (Projected and non-projected) and iii. Direct Experience. He also proposes that low-cost, no-cost, and locally available materials can be used for creating those TLMs. TLMs include an extensive set of instructional tools, such as standardized materials (textbooks and workbooks), Visual aids (charts, flashcards, diagrams, and models), experiential learning kits (STEM kits and virtual lab),

digital learning tools (e-books, online simulations, and interactive whiteboards), and real-life materials (Dhungana, 2025).

2.4 Educational Philosophy and Learning Theories

My research is influenced by John Dewey's philosophy of pragmatism. Aggarwal (2010) noted that Dewey's philosophy of pragmatism has a greater impact on education, emphasizing Mathematics and Science, as it endorses a child-centered educational framework.

The flow of this study is shaped by Kolb's experiential learning theory, Piaget's theory of cognitive development, and Vygotsky's social constructivist theory. According to Kolb (1984), Knowledge acquisition is a process in which ideas are generated and refined through experience. Moreover, Piaget's cognitive learning theory focuses on how children individually construct their knowledge through logical exploration (Powell et al., n.d.). On the other hand, Vygotsky's social constructivist theory asserts that a learner's educational journey is greatly impacted by social contact and cultural elements (Powell et al., n.d.).

Based on the Constructivist Learning Theory, TLMs play an essential role in facilitating learners in creating their own knowledge (Bada, 2015; Boakye & Ampiah, 2017; Calik et al., 2006; Harris, 2005; as cited in Osei-Himah & Adu-Gyamfi, 2022). This theory is appropriate for creating a favorable and engaging academic realm as it focuses on employing basic, cost-effective TLMs (Osei-Himah & Adu-Gyamfi, 2022). Bada (2019, as cited in Osei-Himah & Adu-Gyamfi, 2022) reported that in this learning environment, several modalities of visualization are used, including multimedia, pictures, movies, audio files, cassettes, CD-ROMs, dictionaries, and textbooks.

2.4.1 Child-centered learning philosophy of Dewey

According to Aggarwal (2010), Dewey's child-centered educational framework suggests that students learn by doing in a realistic environment through 'discussion', 'questioning', 'inquiring', 'touching' and handling situations. Aggarwal (2010) also revealed that pragmatic theorists recommend evaluating all matters around us through personal observation and collaborative efforts. In this philosophy, the educators are regarded as the organizers of the learning process. Their role is vital as they are expected to fulfill rigorous responsibilities.

2.4.2 The process of knowledge acquisition by Kolb

Kolb (1984) described learning as a transforming process, constantly generated and regenerated, rather than a discrete thing to be obtained or conveyed. He also posits that children's transition from concrete to formal operations implies a shift from "relying on tangible reality" to "hypothetico-deductive" thinking. Kolb's theory supports the fact that when students interact with TLMs, they actually construct their math concepts through experience and real-life application.

2.4.3 Piaget's Cognitive developmental method

As stated by Sanghvi (2020), schemas are the fundamental elements of Piaget's cognitive-developmental theory of knowledge acquisition. He mentioned that, according to Piaget, students develop their own knowledge through active exploration of their surroundings, using sensory objects in hands-on activities. This cognitive framework suggests that children continuously adapt and integrate new knowledge through contact with natural objects (Sanghvi, 2020). According to Piaget's Formal Operational Stage, children begin to apply theoretical concepts and logical reasoning to problem-solving as they grow older (Powell et al., n.d.).

2.4.4 Vygotsky's social constructivist activities

Powell et al. (n.d.) noted that a classroom emphasizing collaboration can create a successful learning environment. They advocated for Vygotsky's Zone of Proximal Development (ZPD) theory, which holds that students learn best with manipulative, social collaboration, and assistance from teachers or peers. Besides the ZPD, Vygotsky highlighted scaffolding as a crucial learning process that can internalize the concept and support students as they set off to the higher level of comprehension.

2.5 Education System of the English Medium Sector in Bangladesh

Primary or elementary school serves as the cornerstone of all educational tiers, and its standards are largely influenced by the efficacy of pedagogical approaches within the school setting (Momen & Aich, 2025). In the Bangladeshi education system, there are three streams according to the medium of instruction: Mainstream Bangla medium (Public and Private), English medium, and Madrasa medium (Kamol, 2009; Rahman et al., 2010, as cited in Haque & Akter, 2013). The main focus of this study is the second category, English-medium schools; therefore, I will provide an overview of this educational system.

Following the liberation, in 1972, the government of Bangladesh shut down all English-medium schools influenced by national identity; however, private-run English-medium educational institutions have proliferated in Bangladesh since the 1980s, particularly in Dhaka (Banu and Sussex, 2001, as cited in Haque & Akter, 2013). These English-medium schools mainly follow four international curricula: i. Cambridge Assessment International Education (CAIE) or Cambridge International Examination (CIE), ii. Pearson Edexcel, iii. Oxford International and iv. International Baccalaureate (IB) (Rawdhatul Uloom International Madrasa, 2023). My study

intends to investigate the CIE and IB curriculum. The following segments will discuss the Math Curriculum Framework of these 2 types of schools.

2.5.1 Cambridge primary mathematics curriculum framework

Cambridge Primary Mathematics is designed for students aged 5 to 11, who are usually in the first six years of basic education. The fundamental principles and philosophy of this curriculum are: conceptual understanding, application and problem-solving, progression and coherence, and engagement and enjoyment. It is intended to be accessible, equitable, and engaging. It fosters an interactive, learner-centered methodology that facilitates active engagement, collaboration, problem-solving, and the practical application of knowledge. The content areas are Number (place value, operations, functions, decimals, percentages), Algebra (recognizing patterns, simple expressions, equations), Geometry (shapes, symmetry, position, movement), Measurement (length, mass, volume, time, and temperature), and Data handling (collecting, presenting, and interpreting data). This curriculum recommends multiple teaching strategies, including the use of manipulatives and visual aids, technological integration, differentiated teaching, real-world context, frequent formative assessment, and constructive feedback (*Cambridge Primary Mathematics Cambridge, n.d.*).

2.5.2 IB-PYP mathematics curriculum framework

The International Baccalaureate Primary Years Programme (IB-PYP) is a curricular framework for kids ages 3 to 12, aims to provide a well-rounded education. The key academic principle of IB-PYP is directly derived from Dewey's philosophy of learning, which holds that acquiring knowledge should be based on exploration and practical engagement with subject areas rather than simply memorizing facts. It suggests a play-based pedagogy that emphasizes hands-on,

exploratory learning. The success of such approaches relies upon teachers' ability to create a student-centered, engaging, and inquiry-driven instructional setting (Zeng, 2024). The PYP Mathematics curriculum elements are measurement, shape, and number, which focus on real-life application (Tarigan et al., 2019).

2.6 Teachers' Perception about TLMs

Koehler and Mishra (2009) proposed that teachers work within a diverse and adaptive learning atmosphere that needs continuous growth and adaptation of new knowledge. Teachers must expand their areas of competence, including the content of the topics, TLM application, and understanding of learners' cognitive and academic abilities (Kumazah & Tettey, 2020).

Momen and Aich (2025) found that almost all math teachers had a comprehensive grasp of instructional tools and their methodological advantages. They described TLMs as tools for *'Grabbing Students' Attention'* and *'Making Lessons Attractive'*; aids that support *'Long-Lasting Learning'*; reconcile the disparity between *'Abstract and Concrete'*; *'Essence of Joyful Learning'*; *'Learning through Visual Experience'* (Momen & Aich, 2025). As noted by Kumazah and Tettey (2020), though there is room for enhancement, teachers showed sufficient understanding as well as a favorable mindset about the implementation of TLM.

2.7 Teachers' Classroom Practices

Islam (2017) stated that teachers' expertise significantly impacts student success; hence, the overall effectiveness of the learning process is highly dependent on educators' teaching practices. He emphasizes that teachers must use interactive teaching strategies to enhance students' profound understanding.

2.7.1 Teachers' preparedness and teaching practices

Khaleduzzaman (2020) claims that there is a shortage of qualified and dedicated teachers, and despite the demand for curriculum, teachers are reluctant to incorporate teaching-learning aids into their classes. Islam (2017) observed a widespread absence of integrity and accountability among the teachers. Adaylarinin et al. (2017) reported that teachers refrain from using instructional resources due to insufficient expertise, undesirable approaches, barriers to integration, class management, budgetary limitations, and problems with preparing and implementing such materials. Roshid (2009) noted that teachers' preparedness is crucial for conducting a productive session; yet many educators attend their classes unprepared.

2.7.2 Gender biased practices

Islam (2017) observed that in most government primary schools, the sole male teacher is assigned outside responsibilities, which causes an excessive workload that adversely impacts their teaching pedagogy. He also mentioned that female teachers experience higher pressure than male teachers due to familial issues that affect their instructional methods. In his research, Islam (2017) found that female instructors excel in PD sessions and tests, but male instructors outperform them in classroom instruction in real-world settings.

2.8 Barriers to Developing and Implementing TLMs

Teachers are self-motivated to implement TLMs in the class activities, but they face many obstacles, including internal classroom challenges- heavy workload, lack of pedagogical knowledge, time constraints, teacher-student ratio; and external challenges- lack of school support, resource limitation, storage shortage, Govt. policy, etc. (Momen & Aich, 2025).

Resource constraint

A significant obstacle in teaching math is resource limitation and inadequate implementation of TLMs, which leads to inefficient class management and unsuccessful lesson delivery (Osei-Himah & Adu-Gyamfi, 2022). TLMs are expected to be accessible for educational purposes; however, studies indicate that many institutions lack sufficient materials for lesson delivery (Abubakar, 2020). Therefore, both learners' interest and their class participation decrease (Pia, 2015). In 2013, the study by Rashid and Ritu (as cited in Momen & Aich, 2025) found that educators in government and semi-government institutions had better opportunities for PDT and access to resources than their peers in other schools. Due to the high cost of certain materials and the lack of government financial support, private schools have more learning resources than public schools (Misra, 2013; as cited in Kumazah & Tetley, 2020).

Large class size

Momen and Aich (2025) argue that the number of students is a significant concern, as maintaining an efficient educational context within a packed classroom is challenging. Dr. Abdul Halim (as cited in Momen & Aich, 2025) mentioned in his comparative study that the proportion of teachers to students in Bangladesh is larger than that of West Bengal, resulting in diminished educational quality and academic excellence.

Substandard teacher quality

Pia (2015) argues that an inadequate number of experienced and qualified teacher is the major obstacle to student education. Khaleduzzaman (2020) claims that the percentage of certified math teachers is low, and most math teachers are recruited from other disciplines, who

acknowledge their lack of adequate subject knowledge and professional development opportunities. Islam (2017) argued that teachers are reluctant to get everything set for their classes, though trained teachers are more liable than their untrained colleagues; however, some use diverse teaching-learning materials in their lesson delivery, yet most of the tools are ineffective.

Teachers' inadequate pedagogical knowledge

Ahmed et al. (2004) propose that teachers' knowledge of teaching tools is crucial, as they may employ many resources ineffectively, resulting in unsuccessful learning outcomes. According to Salam and Cornwell (2009), teaching-learning aids are essential for enhancing lesson effectiveness, and the proficient utilization of additional instructional materials can improve the standard of instruction. However, determining the appropriate TLMs is a challenge for educators (Kodriyah et al., 2020, as cited in Osei-Himah & Adu-Gyamfi, 2022). Islam (2017) described that the institution and curriculum for teacher training must demonstrate how instructors would use various integrated teaching resources and strategies. Islam (2017) claims that current teachers' professional development programs (DPED, C-in Ed) could not achieve high-quality standards. Momen and Aich (2025) stated that, regardless of professional enhancement, the teachers' classroom practices differ from their PDT knowledge.

Teachers' workload and time management hurdles

Islam (2017) stated that certain primary school teachers in Bangladesh must carry out several additional responsibilities imposed by various national and local authorities, adversely impacting their pedagogy. Hossain (2013) also stated in his study that the amount of work teachers must do is excessive. Khaleduzzaman (2020) argues that excessive workload is an essential factor limiting teachers' ability to prepare and implement diverse math resources for engaging class

activities. Momen and Aich (2025) also stated that excessive work pressure negatively affects teachers' mental and physical well-being, thereby affecting learners' academic achievement. Pia (2015) identified that many educators assert inadequate time constraints and packed classrooms prevent the use of diverse teaching approaches. She also states that all challenges contribute to a decline in the quality of math education in Bangladesh, which requires improvements to boost instruction and comprehension.

2.9 Research Gap

Extensive focus on rural & Govt. primary schools

Almost all existing research focuses on resource-constrained, rural government schools. Urban private schools are often overlooked in research.

An insignificant study on English medium schools

There are very few studies on English-medium school class practices in Bangladesh.

Prioritizing the poorer community for research

The poorer community has been prioritized by the researcher, assuming that English-medium schools are resource-rich (Ehsan, 2023; Rahman, 2023).

Inadequate research on the English medium school teachers' perspective

There is also insufficient research on how English-medium school teachers perceive and evaluate the effectiveness of the materials they select.

Insufficient research on the primary level

In the literature review, I found that most research focuses on secondary and tertiary levels of math education, and there is very little on primary teachers' use of teaching aids, especially in math classes.

Limited research on gender differences

Although there is a gendered perception of the working environment, there is limited research on the different perspectives of male and female teachers on how they prepare lesson effective resources.

2.10 Conceptual Framework

The conceptual framework of this study is shaped by the literature I reviewed. My research is influenced by 'Dewey's philosophy of Pragmatism'. The flow of this study is shaped by 'Experiential Learning Theory by Kolb' along with 'Constructivist Theory of Piaget and Vygotsky. This conceptual framework suggests that the development and implementation of diverse TLMs in math class depend on teachers' perceptions, which shape their classroom practices. Moreover, teachers' classroom practices are influenced by school support, teacher-related factors, and the challenges of developing and implementing TLMs.

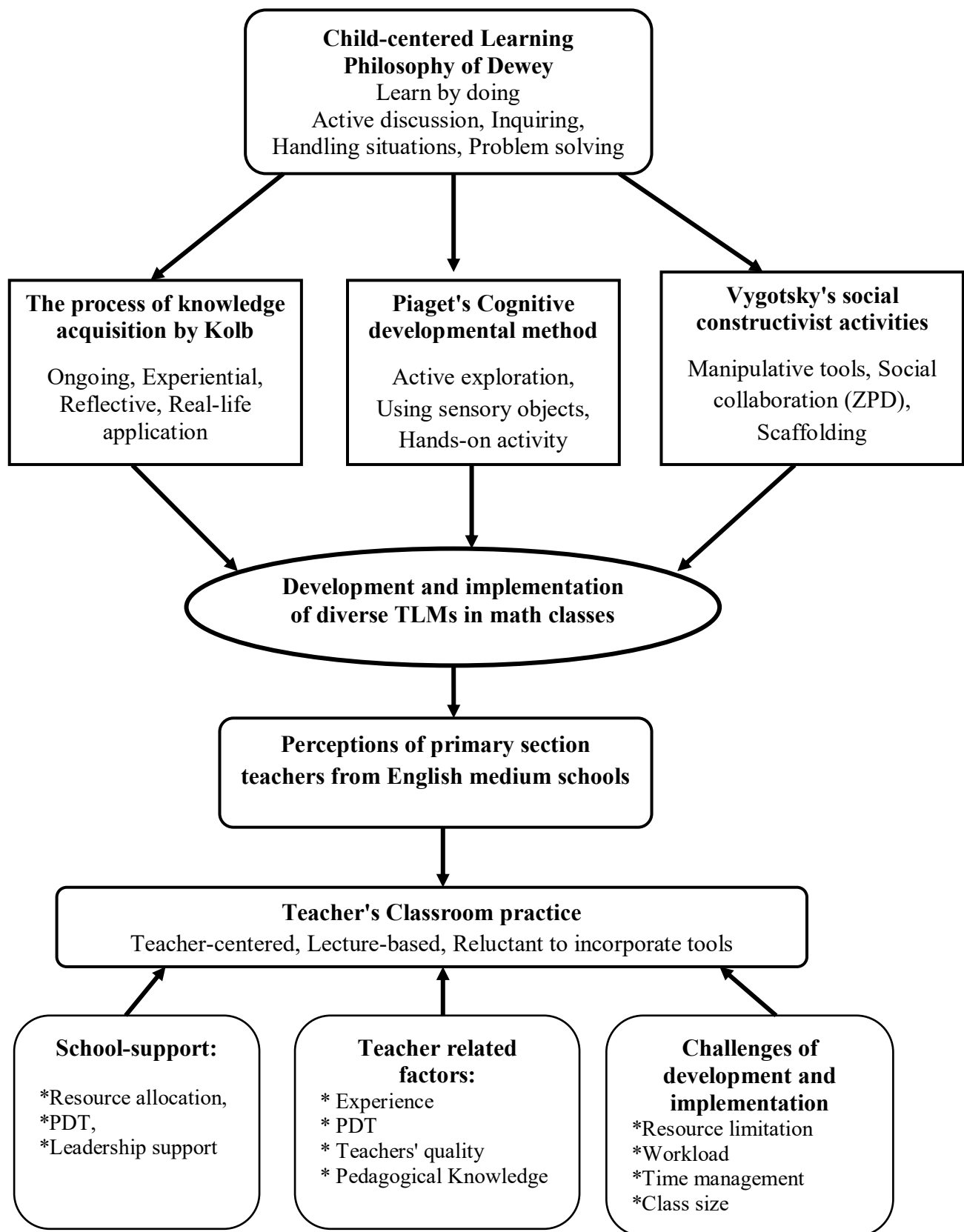


Figure 2.1: Conceptual Framework for "Perceptions of primary section Math teachers from English medium schools"

Chapter 3

Methodology

3.1 Overview

The following chapter describes how I designed my research in the primary section: math teachers' perceptions of their preparation for TLMs, classroom practices, school support, and the challenges they face. The subsequent segments contain my research approach, research sites and participants, sampling process, data collection process, data analysis, study limitations, ethical considerations, and trustworthiness.

3.2 Research Approach

The research approach of this study was qualitative, as my research problem required a comprehensive analysis. According to Creswell & Poth (2018), qualitative research is performed to investigate a multifaceted and in-depth understanding of a topic or issue. Since I explored teachers' perspectives in particular contexts, qualitative research enabled me to conduct an in-depth analysis of primary section teachers' beliefs and experiences, along with the challenges and barriers they usually encounter while preparing and implementing TLMs. Most importantly, this approach helped me identify and propose more innovative and practical strategies for math classes, based on teacher interviews and classroom observations. The study explored and identified influential factors that shape teachers' decisions to use teaching and learning materials in math classes.

3.3 Research Site

The study was conducted in a natural setting to understand teachers' viewpoints, practices, and experiences within the context. Among the typical characteristics of qualitative research, a natural setting is essential, as it is where participants encounter the issue and where researchers

can directly collect extensive information through conversation and observation (Creswell & Poth, 2018). The research sites for this study were English-medium schools in Dhaka city. From different English-medium school curricula, I chose 3 IB and 3 CIE Schools. While selecting the site, I considered the schools' years of establishment to see whether they affect classroom practices. So I categorized all the schools into: established (0 to 3 years), (4 to 10 years), and more than 10 years. For each category, I selected 1 IB school and 1 CIE school. I conducted this research only in the primary sections of those schools.

I worked as an IB-PYP teacher in Dhaka and attended several DISA-organized PDTs. As a result, I have social contact with teachers and heads of several schools, which has helped me gain access to my research site.

Table 3.1: Research Site

Type of schools	Criteria for Schools Category	Number of schools	Total schools
CIE	Est. $\leq$ 3 years	1	3
	Est. 4-10 years	1	
	Est. >10 years	1	
IB	Est. $\leq$ 3 years	1	3
	Est. 4-10 years	1	
	Est. >10 years	1	
Total			6

3.4 Sample and Sampling Procedure

Shaheen et al. (2016) propose that a researcher should choose data-enriched instances through purposive sampling to get thorough information and an accurate portrayal of the problem. In this study, I used a purposive sampling approach to obtain an in-depth view of classroom practice and teachers' perspectives on TLMs.

The participants in this study were the primary section teachers from 6 English-medium schools who teach math in Grade 1 and Grade 5. I chose these 2 grade levels purposefully. Since one is the early stage and the other is the very last stage of the primary section, I chose these 2 grade levels to see how differently the teachers prepare and implement the TLMs for the beginner and advanced students. Also, my objective was to understand the different points of view of those teachers who work closely with these particular age groups through interviews. Besides that, I intended to find out how gender diversity shaped teachers' opinions regarding TLMs and the influence of gender on decision-making. Still, none of those schools had male math teachers in the primary section. So I got zero male participants for this research.

The reason behind choosing 2 different curricula was to observe how diverse their classroom practices were. In total, I had 12 interviews and 12 classroom observations. Through the observations, I gained an overview of the practical application of TLMs in classroom settings, their impact on students' engagement, and, lastly, teachers' challenges in accessing and implementing them. I conducted classroom observations of the same teachers who participated in my interviews to assess how closely their points of view aligned with their actual classroom practices.

Table 3.2: *Sample and Sample Size*

Participants	Teaching grades	Female	Male	Total
CIE math teachers	Gr.1	3	0	6
	Gr.5	3	0	
IB-PYP teachers	Gr.1	3	0	6
	Gr.5	3	0	
Total Number of Teachers		12	0	12

3.5 Data Collection Methods

The qualitative data collection method was described by Marshall and Rossman (1999) as follows:

"Qualitative researchers typically rely on four methods for gathering information: (a) participation in the setting, (b) direct observation, (c) in-depth interviewing, and (d) analyzing documents and material culture. These methods form the core of qualitative inquiry-the staples of the diet."

For my qualitative study, I used multiple data sources, including teacher interviews and classroom observations.

3.5.1 In-depth interview with teachers

As stated by Marshall and Rossman (1999), a qualitative study depends significantly on in-depth interviews, which serve as a purposeful interaction. Through interviews, the researchers have strong ownership of the collected data, as they can ask targeted questions to get certain responses

(Creswell, 2012, p. 218). I preferred the interview as my first data collection method because it provided scope for a comprehensive analysis of the primary section math teachers' points of view, experiences, challenges, school support, and motivation. For interviews, the tool was a semi-structured interview guide. With this tool, participants were asked predetermined open-ended questions, probing questions, and a few follow-up questions to get specific answers. From the interview, I gathered rich, detailed information about the impacting factors using TLMs, the challenges in accessing diverse materials, and the support from the school authority.

During the interview, I started by building rapport, and my questions were like these: *How long have you been teaching, and which class do you prefer teaching? How do you feel about teaching students with different learning styles?*

To understand their teaching practice and implementation method, I asked them the following questions: *How do you conduct your class with students of different learning styles? Do you use any teaching-learning materials to cater to students' interests? If yes, how? What types of materials do you use for your class activities? How do you implement TLMs in your classroom settings? How do you ensure the appropriateness of the TLMs? How do you assess the effectiveness of the TLMs?*

To comprehend the influencing factors that drive them to prepare and implement TLMs, I asked them: *What are the things that motivate you to implement TLMs in your math classes?*

Another goal was to observe if the teachers' PDT had any impact on their teaching practices. So I asked them: *Did you attend any Professional Development Training? (If yes to the previous question) What training did you get?*

I also wanted to understand the challenges teachers face when accessing the resources and support they receive from the school to overcome those barriers by asking them this question: *Do you face any challenges while developing and integrating diverse materials for your lesson? If yes, what are those? What guidelines does your school provide to implement diverse materials in the classroom? What type of support do you get from school in accessing resources for TLMs?*

At last, to understand the teachers' perception about TLMs, they were asked: *"What is your perception about developing and integrating diverse teaching-learning materials?"*

As the teachers were proficient in English, they did not feel uncomfortable answering my questions prepared in English. As resources, I needed a consent form, the printed interview guide, a pen, and a notebook for taking instant notes. I also used my phone's voice recorder to record the interview with the participants' consent. Two schools did not allow recording, so I had to write the whole conversation right in front of them, which took longer than the others.

3.5.2 Class observation

In a qualitative study, observation is a significant method of data collection in which observers witness real-world practices through every sense possible, using a tool to write them down and record them for future reference (Creswell, 2013, p. 166). In this study, classroom observation was my other data collection method, which helped me experience teachers' actual classroom practices. This observation provided information on the types of materials, how those materials were incorporated into lesson delivery and class activities, along with the teacher's role in facilitating TLMs.

At the top of the observation guide, there was space for the teacher's gender and students' ages, along with basic information to capture demographic data. Then there was a table where, at the

very beginning, I observed all about the used TLMs. Here, I wanted to seek answers to the following questions: *What types of materials were used in the lesson? Did the materials cater to the different learning needs of the students? (If yes) How? (If no) Why?*

Next, I observed the teacher's role while implementing those materials by seeking answers to the following questions: *How did the teacher facilitate students' interaction with the materials (Pedagogical Approach)? How did the teacher assess students' conceptual understanding of the topic (Assessment strategy)?*

Students' engagement was also observed under these criteria- *Engagement with the materials (Students' interest and participation) and Demonstration of conceptual understanding (After using the TLMs).*

Finally, I wrote my post-observation reflection about the classroom environment and the major strengths and weaknesses of the materials used.

The observation focused on the use of TLMs and their impact on students' engagement and the classroom environment after their implementation. The observations allowed me to examine classroom practices by being present during class activities. The collected data answered my second research question, which sought to identify teachers' classroom practices using diverse materials. As resources, I needed an observation guide for individual classes and a notebook to keep field notes. None of the school authorities permitted me to take photos, so I could not collect any visual evidence.

3.6 Data Collection Procedure

3.6.1. The Process

My data collection process started with gaining access and authorization from the school authority. Then, the school administrators selected the teachers as participants in interviews and observations, ensuring informed consent. The interviews were held at quiet, comfortable places inside the school premises, chosen by the teachers. The audio-recorded interviews were later transcribed verbatim. The classroom observations of the interviewed teachers were conducted on the same day at the same schools to make the process time-effective. Thus, I could compare and contrast teachers' interview answers with their classroom practices.

3.6.2. Role of the Researcher

In this qualitative study, I initially designed the research, selected my school category and research site, obtained permission from the schools to participate in my study, and prepared the necessary tools. The chosen participants were statistically representative of the population as a whole. During data collection, I actively participated in the interview procedure by building rapport with the interviewees. My approach was respectful toward the participants and open to different opinions during the question-and-answer sessions. During the class observation, I was mindful of creating a safe environment without interrupting the class activities. During the observation, I took descriptive and reflective field notes. Throughout the research, I was the primary data collector, facilitator of meaning-making, and interpreter as I generated new knowledge.

3.7 Data Analysis

In this research, my data consisted of audio recordings of the interviews and written field notes from the observations. I employed an Inductive Thematic Analysis of the collected data to identify appropriate themes. Through thematic analysis, potential themes are identified, analyzed, and reported, and it substantially arranges and explains the information in detail (Braun & Clarke, 2006, p. 6). To analyze my data, I carried out the following approach:

Phase 1: Familiarizing with the data

At first, I transcribed the audio recordings word-for-word. Then I read the full transcript repeatedly to comprehend the interpretations and their pattern. For optimal reliability, I tried to familiarize myself with the transcribed data by verifying it against the recorded files.

Phase 2: Generate initial coding

After reading and re-reading, I organized my data by coding the transcripts. First, I highlighted different sets of data on the transcripts with different colours. Then I assigned codes to those sets of information based on my conceptual framework and the research questions. The following table is an example of how I generated the initial codes:

Table 3.3: Initial Codes

Transcribed segment	Assigned codes
Last year I had a GDD student and for him, we needed some texture based resources. But in our country, those types of materials are very expensive and not easily available. I believe if we had access to those materials he could learn better. (T1)	Limited access Financial constraints Inadequate PDT Newly established Unstable norms
My previous school used to arrange PDT but here as it is a newly started school they can't arrange sufficient training sessions. Moreover due to resource scarcity I need to take support from online. (T2)	Language barrier Lack of Student's interest
This school is a growing school and we did not have much training about the teaching learning materials. So it is quite difficult for me to find out the proper way to cater different style learners' interest. (T7)	
The students came from different schools and even from different curriculum. This is the third year of the school and the students are still getting their admission in the middle of the academic year. Many students are reluctant to do group work and some have less attention span. Some students are from Bangla medium schools. When we give our instruction in English, most of the time they do not understand. (T9)	

Phase 3: Searching for sub-themes

In this phase, I organized the coded data more precisely. I examined those thoroughly and then separated the assorted codes into particular sub-themes. The following table is an example of how I grouped the codes into sub-themes:

Table 3.4: *Searching for sub-themes*

Codes	Sub-themes
• Limited access • Financial constraints	Insufficient resources
• Inadequate PDT • Shortcoming in class-management skills	Lack of pedagogical soundness
• Newly established • Unstable norms	Developing infrastructure and identity formation stage
• Language barrier • Lack of student's interest	Students' inadequate engagement with the TLMs

Phase 4: Reviewing the themes and sub-themes

After grouping all the codes in my transcript into potential sub-themes, I began refining them. In this phase, I reviewed each sub-theme several times and grouped them into six themes: Teacher's perception, Influencing factors, Classroom practice, Challenges, and lastly, Support and guidelines. These themes were generated and categorized based on the conceptual framework's needs. For example-

Table 3.5: *Reviewing the themes and sub-themes*

Codes	Sub-themes	Themes
• Limited access • Financial constraints	Insufficient resources	Challenges
• Inadequate PDT • Classroom management	Lack of pedagogical soundness	

Phase 5: Defining and naming themes

At this point, I inspected the themes to spot the gaps in their meaning. I checked whether the themes accurately conveyed what I wanted to say. I improved those names by adding more information about the specific theme or by changing the names because,

“Names need to be concise, punchy, and immediately give the reader a sense of what the theme is about” (Braun & Clarke, 2006, p. 22).

In this phase, my target was to make the themes effective and to the point. For instance, one of my themes was ‘Challenges’, but it did not clearly state who faced those challenges or what they were. Therefore, I improved the theme to ‘Teachers’ challenges of developing and implementing math TLMs’.

Phase 6: Writing the report

In the final stage of data analysis, I included all my themes and sub-themes in Chapter 4. Then I meticulously wrote up my research findings, following the themes.

3.8 Ethical Issues and Concerns

As a researcher, I was careful to avoid causing participants distress and worked hard to remain neutral while collecting data. At the very beginning of the data collection process, I approached several schools to obtain access. In this regard, I sent a formal introductory letter containing the objective of this study, an approval letter from my university, and a set of consent forms and data collection tools to the principals of those schools. A few schools organized meetings with me after accepting my application, during which I had to explain the research topic, objective, and data-collection tools. On every data collection day, I obtained informed consent from each participant. Before interviews and class observation, I handed out printed copies of my consent form, which included detailed information about the study's purpose. I let them read it and also explained it verbally to clarify it.

In addition to these, some schools had a few provisions. In one school, all females (teachers, students, and staff) adhered to a strict religious dress code. Before the data collection process, the Vice-Principal asked me to cover my head. So when I went to that school for data collection, I wore a hijab the entire time to respect the school's norms and ensure ethical compliance. It facilitated rapport and trust with the teachers and the school administration. Besides this, two schools did not allow me to record the interviews, and one of them did not even allow phones on the school premises. I respected their terms and conditions and did not record the teachers' interviews. Instead, I briefly documented their answers on my printed interview guide right in front of them, and those interviews took longer than the others. After each class observation, I shared my findings with them for their approval and correctness.

I kept my personal bias and thoughts aside during the interviews and observations. I did not ask the participants any guided questions; instead, my questions were open-ended and probing. The

collected data was stored with utmost security, and all their information was used only for this study purpose. Participants' confidentiality and anonymity were ensured ethically by not disclosing their real names or school names. As a replacement for their names, I used T1, T2, and onward.

3.9 Trustworthiness and Rigor

My study progressed through the following sequence to ensure trustworthiness and rigor.

Audit trial: In this step, I reviewed several articles related to my study, detected the research gap I could address, and ultimately shaped my data collection method. This study required interviews to understand teachers' perspectives on TLMs, followed by classroom observations to examine their actual classroom practice. So I developed a semi-structured interview guide and a classroom observation guide as my data collection tools. Then I conducted a pilot interview with a primary school math teacher who was one of my classmates in M.Ed. From that interview, I found some missing options and time issues. Then I modified my interview guide accordingly.

Peer review: I selected one of my friends who completed her Master's thesis at my university for peer review. We discussed the course of study and data collection plan thoroughly, along with the possible findings. Besides that, my supervisor reviewed and provided feedback on my methodology.

Data triangulation: To increase the credibility of my collected data on teachers' perceptions and practices, I conducted an interview and a class observation. This cross-checking of data sources enhanced the validity of the information.

Member checking: Finally, for peer checking, I showed the participant all my written observation findings right after the observation. Also, I sent my transcribed data to them via email for verification.

3.10 Limitations of the Study

Initially, my research design included three observations per teacher. While collecting the data, I received single-visit authorizations for each school. As a result, I had to observe only one class per participant. Multiple class observations of each participant could be impactful and capture the full context of the teachers' teaching practices.

Moreover, none of the participating schools had male math teachers in the primary sections. Hence, I could not analyze or identify male and female perspectives about TLMs preparation and implementation.

Chapter-4

Results

4.1 Overview

This chapter presents the findings of the data analysis conducted in this research. For data triangulation, I conducted interviews and classroom observations with the primary section math teachers from English-medium schools. I employed an inductive thematic analysis of data collected from interviews and classroom observations. I organized the data into the following six themes, each with sub-themes.

Table 4.1: *Themes and sub-themes 1*

Theme 1: Teacher's Perception about TLMs	Theme 2: Classroom practices using TLMs	Theme 3: Measuring relevance and efficacy of the TLMs	Theme 4: Teacher- related factors that influence TLMs use	Theme 5: Challenges of using TLMs in math classes	Theme 6: Guideline and support for math TLMs use
• The most important plan of action • Tool for engaging all types of learners • The process of contextualizing math with real life • Sometimes considered as a challenging approach	• Use of TLMs in the class • Teacher's teaching strategy • Student's engagement	• Ensuring appropriateness • Assessing effectiveness	• Motivation • Experience and training	• Insufficient resource allocation • Initial school framework • Students' apathy • Teachers' lack of pedagogical soundness • Various allied constraints	• Implementation guideline • Resource allocation • PDT opportunity

4.2 Teachers' Perception about TLMs

The very first theme focuses on teachers' perspectives on using TLMs in math classes. Through interviews, all the teachers expressed their understanding of the importance of using TLMs in math classes and how they implement different materials to cater to students' needs. Their interpretations differ, but every teacher agreed that incorporating TLMs in math class is important for keeping students engaged and clarifying the concepts. Based on the perceptions of all the teachers, four sub-themes are prepared as follows: i) Using TLMs is accounted as the most important plan of action, ii) TLMs are regarded as the tools to engage all types of learners, iii) TLMs are contemplated as the process of contextualizing math with real life, and iv) Implementing TLMs is sometimes considered a challenging approach.

4.2.1 Using TLMs is accounted as the most important plan of action

Every participant considers implementing TLMs as an important learning process for building mathematical concepts. They mentioned that using different materials helps clarify the concept, make learning more fun, keep learners engaged and motivated, and achieve learning objectives.

One of the teachers said,

"TLMs are important to make the learning fun for the students. When I incorporate different types of materials in math lessons, it is easier to make the concept clear, and the students enjoy the whole class." (T4)

Another teacher believed that using TLMs could help her achieve the learning objectives for a particular topic. She said,

"I think using TLMs in math classes is the most important process to achieve the students' learning objectives. Students are evolving very quickly and are now more technology-based. So the teachers should incorporate TLMs according to the students' interests and the requirements of the lesson objectives." (T1)

According to a teacher, TLMs motivate her students to be engaged in the classroom. That teacher said,

"TLMs are absolutely necessary to make my math classes interesting and engaging. It always keeps my students motivated." (T8)

Some teachers claimed that TLMs help to increase students' curiosity and interaction. One of them said,

"Using TLMs is very helpful, as it always makes my students curious and inquisitive. I believe it is the most essential part of teaching math." (T11)

Another teacher said,

"When I think about making the class more interactive, I always integrate diverse resources in my math lesson plan. These kinds of materials tend to work better compared to just the books and the copies." (T5)

4.2.2 TLMs are regarded as the tools to engage all types of learners

All the participants in my interviews believe that there are different types of students, and their needs also differ. They informed me that they deal with both advanced learners and slow learners. Some are visual learners, some are auditory learners, and some are kinesthetic learners. Some learners also have a shorter attention span. So the teachers use diverse materials to make their lessons engaging and keep every student focused.

One teacher talked about how she engages different types of students using different materials,

“Each individual is different. There are some advanced learners and some slow learners in my class. For the students who struggle with math concepts, I use different kinds of TLMs to make them understand the topics. For expert students, I also prepare additional resources in order to keep them engaged and create opportunities to enhance their thinking skills.” (T2)

Another teacher talked about the students with shorter attention spans,

“It's tough to keep the attention of the children these days because we are not as colourful or as interactive as YouTube videos. So I constantly try to use TLMs in order to cater to diverse learning needs.” (T5)

One participant stated her teaching strategy for students with different learning styles,

“I prefer differentiated teaching strategies in every math class. In my class, there are some visual learners, some auditory learners, and some kinesthetic learners. So I try to incorporate different types of TLMs for different learning style students in my lesson plan so that the learners can find it more interesting and engaging.” (T6)

One of the teachers feels a sense of accomplishment when students of all types get involved in class activities using the TLMs. She claims,

“It's rewarding, because if I somehow manage all the odds and incorporate different teaching and learning materials, all types of students can easily understand the topic with joy. Seeing their learning outcome gives me a sense of accomplishment.” (T8)

4.2.3 TLMs are contemplated as the process of contextualizing math with real life

The participating teachers in my study regarded implementing TLMs as a means of connecting with the practical world. They claim that learning math with real-life objects can help students recognize real-world problems. They noted that this can give them first-hand experience and help them better understand their math concept.

One of the participants said,

“In our time, we had to memorize everything without even understanding how and where the memorized data worked. Now I don't want my students to learn without understanding. When I implement TLMs in math classes, my students can easily connect the concepts with the real world, and it stays life-long with them.” (T4)

Another participant said,

“Actually, I prefer hands-on activities most, and I keep some real resources. I also prefer the digital devices and the screening time for a few minutes since they need to visualize and understand the whole thing to get the concept clear.”(T6)

One teacher expressed,

“I feel like math should never be boring to the students. Using TLMs really works like magic. Learners get first-hand experience when they work with real-world materials to understand a topic.” (T10)

4.2.4 Implementing TLMs is sometimes considered a challenging approach

Some teachers stated that, though TLMs are important in math classes, they also pose some challenges. They mentioned that preparing TLMs every day is time-consuming; there are no specific implementation guidelines from the schools, such as how often they should be used or how to integrate them into the lesson, and, most importantly, resources are not always readily available.

One teacher claimed,

“We don't always use particular books for class activities; rather, we depend on hands-on activities. At times, the parents find it difficult to get a clear idea about the learning process and it's not easy for us to prepare that many resources every day.” (T3)

Another teacher told,

“I think that the schools should have some recommendations for using TLMs, because preparing TLMs is eventually time-consuming and it needs resource allocation.” (T7)

One participant mentioned why she considered TLMs implementation as a challenge,

“It's challenging because catering to the interests of students of different abilities in small and packed classrooms is difficult. For that, we need wide and spacious classrooms and, most importantly, available resources.” (T8)

4.3 Teacher-related Factors that Influence the Use of TLMs

In this part, I aimed to gather information through interviews on the driving factors that influence teachers' innovation-led implementation of TLMs in math classes. That is why I inquired about

the reasons teachers chose to use TLMs, as well as their experience and exposure to PDTs. Hence, I collected teacher-related data and arranged them under the following sub-themes:

4.3.1 Teachers' motivation to incorporate diverse TLMs

The teachers are from both IB schools and CIE schools. Despite their curriculum differences, everyone tries to incorporate TLMs in their lesson plans. They are mostly self-motivated, but their school's appreciation and students' feedback also encourage them to integrate diverse learning materials into class activities. About the motivating factors, one of the teachers explained,

"The school has some requirements about using TLMs that we have to fulfill. However, apart from that, I am self-motivated, and I love preparing relevant resources for my class activities. So it's not just the school or IB requirement, it is also something that I enjoy."(T5)

Another teacher said,

"I love to see my students engaged in the classroom. Their involvement with the study materials and the school's appreciation are the aspects that lead me to incorporate TLMs. The most important factor is my self-motivation. I feel a sense of accomplishment if my students perform well." (T9)

The response of another interviewee about the encouraging factor is,

"Students' feedback makes me motivated. When they like any class activity using the TLMs, it is clearly visible on their faces. I try to understand what makes them interested from their feedback and from my observation. Along with that, the school also inspires us to develop relevant resources, and they guide us." (T10)

4.3.2 Teacher's experience and PDTs

Teachers' years of experience and exposure to PDTs are important factors in my study. My objective is to determine whether their experience and training affect their perception of TLM usage. So I collected that demographic information and learned that, out of 12 teachers, 5 have 2 to 15 years of experience, 3 have 10 to 15 years, and 4 have 0 to 5 years.

From my organized data in Table 4.2, I noticed that T3 and T4 are the most experienced teachers, but they did not attend the most training sessions. Both of them have 21 years of experience, along with 10 and 12 PDT opportunities. However, their classroom practices differ. T3 used a limited number of TLMs, and her class was teacher-centered and lecture-based. On the other hand, T4 used a wide range of diverse materials aligned with learning objectives. Her class was interactive, collaborative, and student-centered. From their class observations, I recorded my post-observation reflections as follows:

Post-Observation Reflection of T3:

The teacher's teaching strategy was mainly lecture-based. The teacher used the board to introduce the task and provided verbal instructions for the class to continue. Students got only papers and copies to develop and demonstrate their conceptual understanding. The students' engagement was not interactive, and they were bored. They struggled to understand the topic - Multiplication. The class was teacher-centered and mostly traditional. Through the TLMs, the

students' learning objective was somehow achieved. The teacher used only the board and paper to cater to students' interests.

Post-Observation Reflection of T4:

The class was well planned and organized. Different types of learners got TLMs according to their needs in 3 centers. Students enjoyed it, and their conceptual understanding was developed fully. The TLMs align with learning objectives. The teacher incorporated interactive approaches like hands-on activities, group work, and collaborative learning through online games. The students were involved in resource management for a sense of ownership. The TLMs were relevant and accessible. Students' understanding was assessed through Q/A in the wrap-up session.

In addition to the above findings, the most interesting fact I have noticed is from the least experienced teacher. It is T10 who has been working as a teacher for barely 1 year and has attended only 2 training sessions arranged by her school. Here is my reflection:

Post-Observation Reflection of T10:

The class was taken in a well-equipped Math Lab. The used materials addressed the needs of visual, kinesthetic, and logical-mathematical smart learners. The class was inclusive, and all students were enthusiastically engaged throughout. Both the teacher and the teaching assistant worked as facilitators during the class. Students' conceptual understanding was developed and

demonstrated through hands-on activities. The teacher used manipulatives to support concept development and online games related to the topic as a closing activity.

Table 4.2: *Teachers' experience and PDT 1*

Experience category	Teacher	Years of experience	Number of PDTs
15-21 years	• T1 • T3 • T4 • T5 • T6	18 years 21 years 21 years 20 years 16 years	25 12 10 10 8
10-15 years	-----	-----	-----
5-10 years	• T2 • T7 • T12	8 years 7 years 9 years	5 2 4
0-5 years	• T8 • T9 • T10 • T11	2 years 2.5 years 1 year 3 years	3 4 2 2

4.4 Teaching Practices Using TLMs

I observed all the interviewee math teachers' classes to explore their classroom practices, teaching strategies, roles as teachers, classroom environments, and, lastly, students' engagement using TLMs. From the observations, my objective was to scrutinize the following:

- The types of TLMs used in the class activity
- How the TLMs were used in the lesson
- How the materials cater to different learning needs
- How the teacher introduced and explained the use of the materials
- How the teacher facilitated student interaction with the materials
- How the teacher assessed student understanding using the materials
- How the students' engagement with the materials was
- How the students demonstrated their conceptual understanding after using the TLM

Besides the observation, I also had some questions for the interview participants. During the interview, I asked the teachers about the strategies they use to deliberately implement TLMs in their classrooms. They shared how they usually use different TLMs to cater to students' interests, and the types of materials they use to prepare them. Therefore, I arranged the collected data from both the interview and observation into three sub-themes: i) Use of TLMs for math classes, ii) Teaching strategies while implementing TLMs in the classes, and iii) Student engagement with the TLMs.

4.4.1 Use of TLMs for math classes

During classroom observations, I noticed teachers using diverse types of TLMs. Almost everyone used natural and LCNC materials. Some of them used digital tools for class activities.

My first observed class was Grade-1 and the taught topic was ‘Skip counting by 5’. I observed that the teacher used popsicle sticks, beads, a number line, plastic cups, dried beans, and a number chart. The resources met the needs of visual, auditory, and kinesthetic learners. The TLMs were relevant, age-appropriate, and aligned with the lesson objective. Every student had access to all the material. The class teacher explained,

“Mostly I use Low-Cost, No-Cost materials and try to collect all the natural products, because through those natural textures, the students feel the 5 senses. Those are safe for the kids as well. This is why I used those Popsicle sticks and Rajma beans today.”(T1)

Two Grade-1 teachers from different schools taught the topic ‘Place Value’. Both of them used enough materials. The TLMs were relevant, age-appropriate, accessible, and aligned with learning objectives. One of the teachers introduced the topic 'Place Value' using LCNC objects and showed a video. Another teacher used classroom objects and played an online game. One of them said,

“Usually I try to use LCNC (Low-Cost-No-Cost) resources like flashcards, wooden blocks, worksheets, word puzzles, and I try to get students to prepare their things.” (T4)

The other teacher said,

“I used flash cards, charts, worksheets, an abacus, and real-life objects like straw and plastic cups, and also showed a video to teach students place value.” (T7)

In a Grade-5 class, the teacher introduced both natural objects and electronic devices (Tab) to introduce the topic: ‘Types of Graph’. The TLMs were relevant and age-appropriate, and the teacher integrated them strategically. The resources were aligned with learning objectives. To

cater to students' interests, the teacher used a variety of materials to support visual, auditory, and kinesthetic learners. About integrating different types of TLMs, she said,

“Sometimes I use craps also, for example, if I teach students about unhealthy living, I ask them to bring empty packets of juice, cookies, and chips to use for discussion and hands-on activities. Today, you've also seen that I used tooth picks, threads, popsicle sticks, plastic paper, and those kinds of objects.” (T5)

4.4.2 Teaching strategies while implementing TLMs in the class

The teachers incorporated various teaching strategies, such as differentiation, station teaching, the CPA approach, and hands-on activities. Some of the teachers applied practical management strategies, involving students in TLM management, to foster a sense of ownership. I observed a class where the teacher used diverse materials to create a differentiated, student-centered, activity-based classroom environment. The teacher facilitated students' interest through strategic planning and integration. The approach was interactive, and the teacher implemented a practical management strategy. The teacher said about the strategies she usually employs in her math classes,

“I do differentiation. You can see that I have different groups, which are flexible based on students' abilities. Whenever their grouping is done, I keep different resources and student agencies, through which they can choose the resources they want.” (T1)

I observed a teacher-centered class in which she used only verbal instruction and discussion. However, she mentioned an approach named CPA, which she usually practices,

“Most of the time, I keep manipulative as a teaching strategy. I have another method called the CPA approach, which stands for Concrete Pictorial Abstract. So I give concrete materials to the

students, then show them the pictures, the Pictorial, and lastly comes my connection, the Abstract.” (T2)

In my observation, I noticed a Grade-1 teacher incorporating interactive approaches such as hands-on activities, group work, and collaborative learning through online games. Students' understanding was assessed through Q/A in the wrap-up session. She mentioned her regular teaching strategy,

“I try to understand students’ ability and how much they know about the topic. Then I assign tasks based on their choices. I also use hands-on activities like manipulatives and play online games or stories on the smart board.” (T4)

4.4.3 Students' engagement with the TLMs

T1 used various types of LCNC materials, classroom objects, and papers. From her class observation, I found that all the students were engaged throughout the period and enthusiastically participated in the class activities. The classroom environment was positive, supportive, collaborative, and inclusive. The classroom was station-based, inquiry-based, and student-driven. Students were engaged in pair work, a hands-on activity, and individual writing. Students were also involved in resource management to get a sense of ownership.

T5 also used diverse TLMs aligned with learning objectives, creating a blended learning environment. Her students used both natural objects and digital TLMs, like online platforms (Tab with software). The class was student-centered, collaborative, inclusive, and station-based. Students were active and enthusiastic throughout the period.

T9 took her class to an equipped math lab, and she used the school's stored, costly equipment. Those materials catered to the interests of the visual and kinesthetic learners. Students were

engaged throughout the period and developed a deep conceptual understanding of the topic, as demonstrated through group block activities. The class was inquiry-based and student-centered. The environment was collaborative and inclusive. Students' engagement was noticeably interactive.

T6 used classroom and natural resources and involved every student in class activities. The class was student-centered, collaborative, and inclusive. Students measured their classroom objects in groups and individually. They were active and enthusiastic throughout the period.

Not all the classes were the same. Some teachers relied solely on books, copies, and a whiteboard for class activities, and there was rarely any student involvement throughout the learning process. In the T3 class, it was not interactive, and the students were bored. They struggled to understand the Multiplication topic. Students' learning objective was somewhat achieved.

Another class was conducted by T8, where she used a minimal number of TLMs. The class was lecture-based and traditional. Throughout the period, students did only individual copy work. The student's engagement was not up to the mark.

4.5 Measuring Relevance and Efficacy of the TLMs

Through my interviews, I inquired about how the teachers ensured appropriateness and assessed the effectiveness of the TLMs used in their math classes. In this part of the interview, the teacher shared how they assess the applicability of the TLMs during development and implementation. They also informed me of their unique methods for evaluating the effectiveness of the materials they implemented. So I organized the information on this theme into two sub-themes: Ensuring

appropriateness when preparing the TLMs and ways of assessing the effectiveness of the TLMs used.

4.5.1 Ensuring appropriateness while preparing the TLMs

All participants agreed that they consider age-appropriateness, relevancy, and accessibility of the materials during the planning period to ensure appropriateness. One of the participants shared how she usually prepares her TLMs,

"While preparing the materials, I keep in mind whether it is age-appropriate and relevant to the topic or not. Again, if I include any object that students can't access in class, then there is no point in implementing TLMs. We, the teachers, need to think of the materials which will really improve students' understanding as well as their scores." (T8)

Some teachers rely on technology and their coordinator's advice while planning their class activities. One of them said,

"Before planning my lesson, I always use AI platforms for ideas, and I make sure the materials are relevant to the topic and accessible for the students. Also, we have a Math coordinator. For any kind of suggestion and clarification, I just discuss with her." (T9)

Another technologically dependent teacher said,

"First, I research the relevance of the materials online. Then I prepare my resources, which are appropriate and accessible." (T3)

One of the teachers plans according to the students' needs. She said,

"I take prior knowledge of the students to understand what resources are needed. Then I develop and implement age-appropriate teaching aids." (T11)

I got a distinctive point of view from a teacher, who claimed,

"When I select any material, first I see whether it has any real-world application or not. When students can connect their learning using those objects with real life, it ensures the appropriateness of the materials." (10)

4.5.2 Assessing effectiveness of the used TLMs

During the interview, the participants explained how they determined the effectiveness of the materials they used for teaching math. They mostly observed students' engagement, performance, and learning outcomes, and to evaluate these, the teachers used students' reflections and feedback on the materials.

One participant said,

"During the class, we observe students' engagement and keep anecdotal records. Then we ask them about the topic. Their responses actually reflect how much they understood, and how much these materials are working for them. Mostly, we keep formative assessments. We also keep some self-assessments, peer-assessments, and group-assessments." (T6)

Another participant responded,

"I always take feedback and reflection about the class and the materials used, especially from the slow learners. Every day during the recap session, I use exit tickets, short question-and-answer sessions and online or offline quizzes to assess their understanding. If I find most of the students understood the topic, then I realize that the materials used were effective." (T9)

One of the teachers claimed,

"Assessing effectiveness is kind of easy for me. Students' enthusiasm in the class activities, their performance in the assessment, their feedback about the materials, and parents' feedback help me to evaluate the effectiveness of the resources I use." (10)

Another teacher stated,

"I mostly observe students' engagement and learning outcomes in the class activities. If they are productively engaged and they perform well, then I understand that those objects worked well." (T12)

4.6 Guideline and Support for TLMs Use

This theme discusses the direction and support teachers receive during TLM implementation.

Here, I presented the three sub-themes: Guideline, Resource allocation, and PDT opportunities by the schools.

4.6.1 TLMs implementation guidelines from schools

Teachers from IB schools are very familiar with this sub-theme. They receive systematic guidelines and various forms of assistance from schools for implementing TLMs. Among them, a teacher explained the support system of her school,

"Actually, whenever we prepare our lesson plans, our planners are being checked, and the coordinator gives us guidelines about the planned resources. Obviously, those resources should be age-appropriate, students' safety should be ensured while using those materials, and last but not least, we have to keep in mind that the learning objective has to be fulfilled through those resources." (T1)

Another delighted teacher expressed,

"This year, we are really happy that the school appointed a new teacher coach. She's working on comprehensive teacher development. Each week, we have a session with her where she shares different teaching strategies and the strategic use of TLMs for math classes. She also evaluates us, provides essential feedback, and suggests training according to our individual needs." (T2)

Some schools do not have strict regulations for integrating various resources into math lessons, but their authorities suggest using low- or no-cost materials for topic introduction. One of the teachers from those schools said,

"Our school does not have any hard and fast rules to implement diverse materials. But the authority gave us moral support to use relevant materials to introduce new topics. We have a wonderful leadership team that always guides us to keep alignment with the Cambridge curriculum." (T8)

Another teacher shared,

"Our school does not force us to implement diverse materials. They only encourage us to use LCNC materials when it's necessary." (T12)

4.6.2 Resource allocation process of the schools

In my study, almost all the schools are very supportive in terms of resource allocation. One of the PYP teachers from a renowned and well-established IB school said,

"When our school bought MNP books for the library, they bought the MNP resources as well. There, they have all the manipulatives, the dice, the place-value counters; everything we need. The school has already purchased the license from the MNP publisher." (T2)

Another IB-PYP teacher of a very recently founded school stated that,

"My school is supportive in this matter. You know that ours is a very new school and we have a minimal number of students. So I personally buy different materials, the school keeps a record of my expenses for resources and they return the money after a while." (T4)

Again, one teacher of an IB school, which was built almost 10 years ago, expressed this way,

"That's another interesting part. The school is always appreciative of our hard work and encourages us to make our work more innovative and to use more resources. But in terms of providing the resources, they have boundaries, because they have some budgetary limitations." (T6)

One of the CIE schools has 3 designated, well-equipped math labs for the primary, junior, and senior sections. A grade 1 teacher of this school mentioned,

"Our school is very supportive. We have easy access to the well-equipped Math Lab. The school also provides extra resources if they are required for integration." (T9)

Another CIE school teacher explained the process of resource allocation by the school,

“The school is very supportive in terms of accessing resources. If we need any resources, we fill out a requisition form listing the items we need, and the school provides them. Though it is time-consuming, they still try to support us. And if we want to use any online platform, the school gives us access to the school Wi-Fi and the smart boards.” (T8)

4.6.3 PDT opportunity provided by the schools

One teacher expressed how the school supports their math capacity building,

“We are following the Singapore math curriculum, MNP. We are really blessed that we had an MNP training organized by the school last year, where we learned about effective learning strategies using TLMs.” (T1)

Some schools organize specialized training for their teachers. In this regard, one teacher said,

“Here in this school, I got the opportunities to get IB training as well as play-based learning training and conceptual Teaching-learning Methodology training.” (T6)

Another teacher said,

“Actually, I did not get the opportunity to attend much training. I got only 2 training sessions, and those are- SPEED- Classroom Management training and training about preparing lesson plans.” (T7)

According to a less experienced math teacher,

“Our school organizes PDT to enrich our knowledge. We have an experience program arranged by the school. In this program, we visit our Uttara campus to experience other expert teachers' classes. This program is very helpful. Besides this, I am a new teacher, and I could attend only 2

training sessions; one is the Math Buddy Training and another is Time Management Training."
(T10)

My last research site was a very recently founded school. From this school, the interviewee expressed the school's support for PDT like this,

"You already know that our school started its journey just 7 months back. So they are working hard to establish good practice. The school arranged an in-house training for us." (T12)

4.7 Challenges of Using TLMs in Math Classes

In the development and implementation phases, almost all participating teachers faced multifaceted obstacles that I recorded during the interview sessions. The newly established school teachers faced resource scarcity, inadequate PDTs, students' lack of interest in the class, and numerous accompanying barriers. From my collected data, I categorized the challenges into the following five sub-themes.

4.7.1 Insufficient resource allocation

Most of the newly established schools had funding crises. However, a couple of well-established schools also found it difficult to provide full access to the required resources. One teacher from an established school mentioned,

"Last year, I had a GDD student, and for him, we needed some texture-based resources. But in our country, those types of materials are very expensive and hard to obtain. I believe if we had access to those materials, he could learn better." (T1)

Another teacher said,

"Our school has a resourceful Math Lab where we take the whole class to use the topic-related resources to introduce any topic. Sometimes a new topic needs 2 consecutive days. That time, I

had to divide the class into 2 parts and take them to the math lab. It is surely time-consuming, and I need to check with all the classes and all the sections to find a slot for the lab." (T10)

One participant from a newly established school stated,

"Ours is a new school, and it has a funding crisis. So, due to limited access to the resources I need, I had to take support from online." (T3)

Another participant claimed,

"I always carry my resources, and at the same time, the school is a growing school, and they cannot cater to us with all the resources we demand. I'm getting 30% of the resources from the school, and I need to buy the rest 70%. I do it because I want my students to experience a wonderful learning environment. Unfortunately, not everyone has the money to buy their own supplies. It's a big challenge. And that's why not all teachers always feel like going for making new resources or preparing lesson plans in a diverse way." (T6)

4.7.2 Initial school framework

Some of the developing schools are in the identity formation stage. Teachers from newly established schools said they are struggling due to developing infrastructure and unstable norms.

One of the interviewees said,

"I like station teaching. But right now I can't do it because I only have 3 students in my class. So I can't give those TLMS to work in pairs or in different groups. That is the reason I have to follow a traditional method of lecture-based teaching." (T3)

One teacher said about the unstable norms of her school,

"This is the third year of the school, and the school is still accepting new students' admission in the middle of the academic year. The students are from different schools and from different curricula. Most of them are not familiar with activity-based learning centers or working with learning materials. This is hindering the flow of my teaching." (T9)

Another teacher told about the developing infrastructure,

"In small schools and classrooms like ours, it is very tough to plan different activities for the slow learners." (T12)

4.7.3 Students' apathy towards the TLMs

According to some teachers, language barriers and students' lack of interest in the TLMs lead to students' indifference toward class activities. Regarding this issue, one teacher mentioned,

"Many students are reluctant to do group work, and some have a shorter attention span. Even some students are from Bangla medium schools. When we give our instructions in English, most of the time they do not understand." (T9)

Another teacher informed,

"Like every batch, the students' needs keep on changing. So based on their needs and based on their learning abilities, I have to come up with ideas and use the materials in a way that will cater to their learning needs." (T5)

4.7.4 Teachers' lack of pedagogical soundness

In the interview sessions, some of the teachers highlighted that, due to insufficient PDT opportunities, they lack pedagogical soundness. One interviewee said,

"My previous school used to arrange PDT, but here, as it is a newly started school, they can't arrange adequate training sessions." (T3)

Another interviewee stated,

"This school is a growing school, and we did not have much training about the teaching-learning materials. So it is quite difficult for me to find appropriate TLMs for class activities and the proper way to cater to different styles of learners' interests." (T7)

4.7.5 Various allied constraints faced by the teachers

Many teachers shared the challenges they face during the development and implementation phases. One teacher from an IB school said,

"In this newly established school, the parents are also new, and they have very limited ideas about the IB curriculum. If I ask them to bring any study-related object from home, they find it difficult to understand how to help their children productively. Parents' support is almost zero here." (T3)

Another teacher of a newly established school expressed,

"Students' needs are always changing in every batch. So based on their requirements and learning abilities, I have to come up with new ideas to use the TLMs in the classes." (T5)

One more IB teacher who faces challenges while developing the TLMs said,

"Preparing resources for all the other sections of the same grade level, is a big challenge for the teachers. Since IB requires collaboration with each teacher, even single-subject teachers, it can be difficult. The reason is that, sometimes, if the idea is not properly conveyed to the other teachers, they might not approve or appreciate it." (T6)

A participant from a well-equipped CIE school informed, *"You know we have a designated and resourceful math lab for the primary section, which I can use once a week to introduce a new math topic. I don't even need to prepare many resources. But sometimes it is challenging to use those lab resources in regular classroom activities because we cannot bring them into the classroom. Moreover, the lab is always occupied by other sections and classes. That is why it is hard to use any TLMs for the other classes."* (T9)

Another CIE school participant said,

"Integrating TLMs is time-consuming. It takes me a lot of time to think of the perfect object for my lesson. Also, I need to think of the slow learners." (T12)

4.8 Summary

This Chapter analyzed the perceptions of English-medium math teachers regarding the development and implementation of diverse teaching and learning materials for class activities. It also presented the teachers' classroom practices, the ways they measure the relevance and effectiveness of the TLMs, teacher-related factors that influence their practices, the challenges of implementation, and guidelines and support for using those materials in math class. To them, implementing TLMs in lessons was the most important plan of action and an effective tool for active student engagement. These materials are considered tools for connecting with the real world, but they can be challenging due to time constraints and resource unavailability. Teachers' perceptions shaped their classroom practice, which was directly related to their use of TLMs, teaching strategies, and students' engagement. Again, it is necessary to measure relevance and

efficacy by ensuring appropriateness and assessing the effectiveness of the materials. Besides these, teacher-related factors, such as motivation, appreciation, students' feedback, experience, and opportunities to participate in PDTs, influenced their application of these materials. While integrating TLMs into their math lessons, the teachers faced challenges, including insufficient resource allocation, school norms, students' apathy, teachers' lack of pedagogical knowledge, and other related constraints. These challenges could be overcome through the implementation of TLMs' guidelines, sufficient resource allocation, and exposure to PDTs. Finally, the paper asserts that using TLMs is not proof of success; what really makes educational experiences better is systematically integrating these resources alongside specific educational targets, supported by school-level backing and practical methodology.

Chapter-5

Discussion and Conclusion

5.1 Introduction

The purpose of this chapter is to discuss the findings of my research questions, describe my observations and reflections, and eventually suggest my recommendations for further study on this specific field.

5.2 Discussion

This segment is held under the research questions in my study, and illustrates the findings from the interviews and class observations of English-medium math teachers. I comprehended teachers' perceptions and found that they perceive TLMs as an important plan of action, but during the integration of the materials into class activities, their practices differ. Here, the

challenges teachers face and the range of school support are the core reasons for the contrast between teachers' perceptions and practices. The following sections will explore my research results by comparing previous study findings and determining rationales.

5.2.1 What are the perceptions of English medium school teachers about developing and integrating diverse TLMs for math classes?

At the very beginning of my research, I intended to know how the teachers conceptualize the implementation of TLMs in math classes. From the responses of the participating teachers, it has been identified that their perceptions of using TLMs are almost similar, positive, and constructive. Every teacher considers implementing TLMs for lesson delivery as a valuable 'plan of action' or an important learning process for building math concepts. In the interviews, the teachers informed that they believe TLMs make learning fun, increase students' curiosity, keep learners engaged and motivated, and ultimately help to achieve learning objectives. This perception aligns with Self-Determination Theory (SDT) by Ryan and Deci (2000), which indicates that intrinsic motivation intensifies learners' curiosity because it is interesting and engaging. Moreover, Bruner (1961) claims that when students engage with different objects, they can acquire the mathematical concept through discovery.

Furthermore, the participating teachers' opinion "The learning style of each student is different" and "TLMs are the tools to engage all types of learners" resonates with the Theory of Multiple Intelligences by Howard Gardner (1991). Alongside this, the teachers presume integrating TLMs

for math concept building as a means of connecting with the practical world through first-hand experience, which reflects Kolb's (1984) Experiential Learning Theory.

Under this question, I also aimed to understand the factors that drive teachers' innovation-led implementation of diverse TLMs in math classes. In the interviews, all the teachers agreed that they are mostly self-motivated while implementing diverse materials. Alongside appreciation for the school administration, students' engagement and enhanced performance give teachers a sense of accomplishment, an intrinsic motivation that aligns with Self-Determination Theory (SDT) by Ryan & Deci (2000). Besides that, students' engagement and their enhanced performance indicate that TLMs regulate students' cognitive growth and create a constructivist classroom environment (Vygotsky, 1978).

5.2.2 How do the primary teachers of English medium schools implement TLMs in the Mathematics classes?

At this stage, my aim was to observe the classroom practices of English-medium teachers as they integrated TLMs into math classes, and I found that the teachers used diverse types of materials. The majority of the teachers used natural and LCNC materials, and some of them used digital tools for class activities. According to Meyer et al. (2014), students' learning objectives can be acquired by using versatile teaching approaches and accessible tools that meet individual students' needs. Besides that, natural objects, such as LCNC materials, act as "sensory aids" that guide learners by connecting mathematical concepts to real-world applications (Vygotsky, 1978).

The resources used by the participating teachers were relevant and age-appropriate. Those met the needs of visual, auditory, and kinesthetic learners and also focused on MI. In this regard, Gardner (2011) suggested that teachers should use diverse materials to address the students' multiple intelligences. The study shows that the teachers strategically integrated the materials, aligning them with learning objectives to cater to students' interests.

The teachers who used diverse TLMs in their classes incorporated miscellaneous teaching strategies, such as differentiation, station teaching, the CPA approach, hands-on activities, group work, and collaborative learning through online games. These learning engagements are social processes that involve students' collaboration and active participation (Vygotsky, 1978). Student agency and practical management strategies were also noticed, which involved students in resource management to foster a sense of ownership. As noted by Deci & Ryan (2000), learners demonstrate greater interest and dedication when the teachers include them in the learning process and prioritize students' choice and voice.

In classroom observations, I also witnessed that the teachers who used TLMs for class activities ran student-centered, activity-based classes; whereas in a couple of teacher-centered classes, the teachers employed only verbal instruction and discussion. Dewey (1916) posits that students learn best when they are actively involved in a student-centered classroom. In this research, the students' engagement with diverse TLMs was noticeably participatory. Students, who had a wide range of learning resources, were engaged throughout the period and enthusiastically participated in the class activities. This created a blended learning environment, and the students developed a deeper conceptual understanding of the topic.

My other focus was to study how teachers ensure appropriateness and assess the effectiveness of the TLMs they employ. The teachers informed that they ensure the appropriateness of the resources diligently while preparing them. At first, they take into account students' prior knowledge to understand their needs, as this is an essential aspect that determines how best students learn (Ausubel, 1968). During the planning period, they consider the age appropriateness, relevance, and accessibility of the materials. Additionally, they assess the effectiveness of those TLMs by observing students' engagement and performance with those resources, along with their reflection and feedback about the materials (Schön, 1983). This whole process resonates with the ADDIE model by Branson et al. (1975), which involves the following five phases: Analysis, Design, Development, Implementation, and Evaluation.

5.2.3 What are the supports and challenges of implementing TLMs in math classes?

Support:

i) Guidelines

In my study, I found that some of my participatory research schools provide systematic guidelines and various forms of assistance to the teachers for implementing TLMs. One of those schools has a teacher coach, and the other has subject coordinators who always support teachers' professional growth. They evaluate the teachers, provide essential feedback, suggest training tailored to individual needs, and upskill them. Regarding the role of instructional leadership,

Bush (2014) stated that they serve as the connection between legislation and implementation, providing educators with the tailored feedback and personal development they need to successfully adopt innovative tools. Such individualized assistance addresses educators' particular difficulties with developing and implementing TLMs, which is better than general instruction (Knight, 2007). The rest of the schools in my study do not have strict regulations for integrating various resources into math lessons, but their authorities suggest using LCNC materials for topic introduction. On this point, Vavrus et al. (2011) claim that educational institutions may overcome budgetary constraints and provide learners with an engaging, compatible, and interactive class by readily available TLMs.

ii) Resource allocation

One of the schools has 3 designated, well-equipped math labs for the primary, junior, and senior sections. With these kinds of tailored resources, educators can stop simply passing out information and start helping students discover by exploring (Afolabi et al., 2013). A couple of schools provide all the resources, but the rest of the school teachers buy resources personally or submit requisition forms, which is a prolonged process. Wohlstetter et al. (2015) noted that if the procurement procedure is overly drawn out, lesson delivery is hindered.

iii) Teacher training

In the interviews, some of the teachers reported that their schools organize specialized training sessions to support math capacity building, such as MNP, play-based learning training, conceptual Teaching-learning Methodology training, and Math Buddy Training. Regarding MNP training, which is specifically based on CPA strategy, Leong et al. (2015) described that they provide educators with the specific "instructional resources" required to help learners understand

complex ideas. Valtonen et al. (2017) contend that a successful teaching application requires tailored training, such as Math Buddy.

Challenges:

i) School-related

This study found that nearly all the teacher participants frequently faced heterogeneous challenges both in the TLMs development and implementation phases. Not only do emerging schools face resource constraints, but even a few distinguished schools struggle to obtain full access to the resources they need, a finding that echoes the study by Olibie et al. (2013). Moreover, the fledgling institutions are facing multifaceted obstacles due to their developing infrastructure and unstable norms. As per the teachers' statement, there are no specific implementation guidelines from schools for using TLMs, such as how often they should be used or how to integrate them into lessons. This finding aligns with Fullan's (2007) study, which indicates that there are insufficient institutional norms and implementation guidelines, and that the process depends on teachers' personal initiative rather than on the overall school culture. In the interview, some of my participants stated that catering to the interests of students with different abilities in small, crowded classrooms is very difficult. This mirrored the work of Pelgrum (2001), who mentioned 'infrastructure' as the most frequently cited barrier among educators worldwide.

ii) Student-related

A few teachers reported that the language barrier and students' lack of interest in TLMs led to students' indifference towards class activities. They found that some students from Bangla-medium schools had difficulty following English instructions, which aligns with the findings of

Akter and Mitul (2020). According to them, this language barrier poses challenges for both educators and learners and ultimately disrupts the flow of lesson delivery. My interviewees also pointed out that, due to short attention spans, some students are indifferent towards the integrated TLMs.

iii) Teacher-related

However, some teachers feel that implementing TLMs on a daily basis is challenging, as it is time-consuming and requires significant effort to execute a plan. Regarding the daily implementation of TLMs, Okyere-Kwakye et al. (2016) noted that several educators view it as merely another obligation that interferes with course fulfillment. In addition, some teachers lack pedagogical soundness due to insufficient exposure to PDT and struggle to identify appropriate TLMs for students. This finding aligns with the study by Mishra and Koehler (2006), which noted that using resources can be intimidating when teachers lack sufficient pedagogical knowledge.

5.3 Conclusion

In this study, I explored Primary section math teachers' perceptions of implementing and integrating TLMs across diverse classroom settings, their classroom practices, and the school support and challenges they face. Hence, for data collection and triangulation, I applied a qualitative methodology, interviewing 12 teachers from 6 English-medium schools in Dhaka city and observing their classrooms. My research findings suggest that all participating teachers perceive integrating TLMs into the math lesson as an essential plan of action that increases student engagement and improves conceptual understanding.

In addition, teachers' classroom practices differed. Most of them applied a variety of teaching strategies and used miscellaneous TLMs along with manipulatives, while a few teachers relied on an instruction-led, teacher-centered approach due to resource constraints and a lack of school guidelines. Moreover, teachers' self-motivation, experience, and PDT played pivotal roles in shaping their teaching practices. Yet, teachers' years of experience did not always reflect their classroom practices: I observed the most effective use of TLMs by the least experienced teacher, whereas a lecture-based class was led by a teacher with 21 years of experience.

Furthermore, some schools regularly arrange tailored PDT sessions for teachers, appoint teacher-coaches and subject coordinators for comprehensive support, and provide all the resources; whereas other schools have supply deficiencies and lack implementation guidelines. However, my study identified notable barriers, including inadequate supply of materials, prolonged preparation time, teachers' insufficient pedagogical knowledge, learners' communication difficulties, and indifference towards class activities. In short, my research findings emphasize that abundance of resources and teachers' years of experience cannot fully assure effective implementation of TLMs or academic achievement; rather, their effectiveness depends on strategic integration aligned with specific learning targets.

5.4 Recommendations

On the basis of the research analysis, here are my recommendations for policymakers and school administrations:

- ***Need analysis: First***, all schools should assess how well teachers understand TLMs and identify areas for improvement to effectively and strategically implement them in math classes.

- ***Arranging extensive PDT on developing and implementing TLMs by the schools:*** Every school needs to arrange specialized teacher training sessions on step-by-step TLM implementation.
- ***Initiating the Teacher-Train-Teacher program:*** For fresh recruits, schools can arrange a Teacher-Train-Teacher program or workshop to guide novice teachers by experienced teachers until schools organize a specialized PDT.
- ***Establishing a common guideline for TLM implementation:*** All English-medium schools should establish a common guideline for the appropriate implementation of TLMs, so that teachers can follow a common direction and a uniform track to maintain teaching excellence.
- ***Ensuring resource allocation by schools:*** Schools should provide all necessary resources. This will help teachers feel less stressed about preparing and organizing TLMs every day, so they can focus more on integrating them effectively for better learning outcomes.
- ***Further research on a broader scale:*** My research was conducted only in 6 English-medium schools in Dhaka city. A nationwide study of existing English-medium schools could provide a comprehensive analysis of school practices, the scope, and the barriers to using TLMs.

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Appendices

A. Permission Letter

Date:

To

The Principal/ Head of Primary School

Subject: Application for access authorization to collect data for Master's Thesis

Dear Sir/Madam,

I hope this mail finds you well. I am a Master's student at BRAC-IED (Student ID: 23357002) and am conducting a thesis titled 'Development and application of Math Teaching-learning materials: Perspectives of primary section teachers from English medium schools'. This research has undergone and received full ethical approval from BRAC University.

The aim of my study is to explore:

- How teachers conceptualize and develop various instructional tools for Math classes
- Teachers' classroom practices and pedagogical approaches when implementing instructional tools across diverse classroom settings.
- The Challenges teachers face while implementing the tools, and the school support and guidelines they receive to overcome them.

The data collection methods will be-

- **Interview:** One Math teacher from Grade-1 and another from Grade-5
Duration: 30-35 minutes
- **Class Observation:** 3 class observations of each interview participant
Duration: Standard class time

Participation in this study is entirely voluntary, and teachers may discontinue or withdraw from the data collection process at any time. The name of the school and the teachers' names will be encoded on the paper and treated as highly confidential information. The collected data from

your institution will be used only for this research paper. I am available for a brief meeting if you have any further queries about my thesis.

I, therefore, humbly request you to allow me access to your institution for my data collection and help me to complete the research. Thank you for your time and consideration.

Sincerely,

Julia Islam Sarker

Master's student

Student ID - 23357002

Contact Number:

Email- juliaislam7@gmail.com

BRAC Institute of Educational Development, BRAC University

B. Consent Form

Teacher's Informed Consent Form for Research Participation

Research Topic:

Development and application of Math Teaching-learning materials: Perspectives of primary section teachers from English medium schools

This study aims:

- To explore how teachers conceptualize and develop various instructional tools for Math classes

- To observe teachers' classroom practices and pedagogical approaches while implementing those instructional tools in diverse classroom settings
- To identify the Challenges teachers face while implementing the tools, and the school support and guidelines they get to overcome the challenges

Data collection methods:

- **In-depth interview** (Duration: 30-35 minutes)
- **Class Observation** (Duration: Standard class time)

Condition for research participation:

- Participation will be entirely voluntary.
- After the interview or observation begins, participants may withdraw at any time without penalty or explanation.
- The researcher will be a non-participant observer, and there will be no disruption to the learning environment from the researcher's side.
- During the observation and interview, the information will be documented by voice recording with the participant's permission.
- Participants' confidentiality and anonymity of the shared information will be ensured ethically.
- There will be no risk for the teacher or the students.
- Real name and the name of the school will never be used in the research thesis, any presentations, or future publications.
- A unique pseudonym will be assigned to the participant and the school.
- Written notes will be taken about the usage of teaching-learning materials and teaching strategies.
- The recordings, transcripts, and field notes gathered from the interview and observation will be stored securely.

I read the provided information thoroughly and understand the conditions clearly. After reading the above points, I decided to participate in this research.

Participant's Name: _____

Signature & Date: _____

Researcher's Name: Julia Islam Sarker

Signature & Date: _____

Email- juliaislam7@gmail.com

C. Interview Guide for Primary Section Math Teachers

Development and strategic application of Math Teaching-learning materials:
Perspectives of primary section teachers from English medium schools

Semi-structured interview guide:

Date: _____

Time of interview: _____

School: _____

Grade Level: _____

Teacher: _____

Interviewer: Self

Place of the: _____

Duration: 30-35 minutes

Questions:

1. How long have you been teaching, and which class do you prefer teaching?
2. How do you feel about teaching students with different learning styles?
3. How do you conduct your class with students of different learning styles?
4. Do you use any Teaching and Learning materials to cater to students' interests? If yes, how?
5. What types of materials do you use for your class activities?
6. How do you implement TLMs in your classroom setting? (Teaching strategy)
7. How do you ensure the appropriateness of the TLMs?
8. How do you assess the effectiveness of the TLMs?
9. What are the things that motivate you to implement TLMs in your math classes?
10. Did you attend any Professional Development Training?
11. (If yes to the previous question) What training did you get?
12. Do you face any challenges while developing and integrating TLMs for your lesson? If yes, what are those?
13. What guidelines does your school provide to implement diverse materials in the classroom?
14. What type of support do you get from school in accessing resources for TLMs?
15. What is your perception about developing and integrating diverse teaching-learning materials for your lesson delivery?

D. Classroom Observation Guide for Primary Section Math Teachers

Development and strategic application of Math Teaching-learning materials:
Perspectives of primary section teachers from English medium schools

Date: _____ **Time:** _____ **Duration:** _____
School: _____ **Teacher:** _____ **Gender:** Male/Female
Grade: _____ **Subject:** Math **Topic:** _____ **Students' age:** _____

Note: Note: This observation guide will focus on the types and use of TLMs, the teacher's classroom practices, the classroom environment, and the students' participation.

Observation Notes:

Used TLMs:	Types of materials	
	<i>Did the materials cater to different learning needs of the students?</i>	Yes/ No
	<i>(If yes) How?</i> Or <i>(If no) Why?</i>	
Teacher's Role	Pedagogical Approach <i>(How did the teacher facilitate student interaction with the materials?)</i>	
	Assessment strategy <i>(How did the teacher assess the student's conceptual understanding of the topic?)</i>	
Students' Engagement	Engagement with the materials <i>(Students interest and participation)</i>	
	Demonstration of conceptual understanding <i>(After using the TLM)</i>	
Classroom Environment		

Post-Observation Reflection:

1. Major strengths or weakness of the used materials:
