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Analysis of Commercial Mathematics and Statistical & Probability Units in Mizoram's Class X Mathematics Textbook Using Revised Bloom's Taxonomy

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Abstract : This This study evaluates the cognitive levels of exercises in the Commercial Mathematics and Statistics & Probability units of the Class X Mathematics textbook prescribed by the Mizoram Board of School Education (MBSE) using Revised Bloom's Taxonomy (RBT). The analysis focuses on the distribution of Lower Order Thinking Skills (LOTS) and Higher Order Thinking Skills (HOTS) across textual questions. Findings reveal a dominance of LOTS (86.7% in Commercial Mathematics and 91.5% in Statistics & Probability), with minimal representation of HOTS (13.3% and 8.5%, respectively). The study highlights the need for curriculum redesign to incorporate more HOTS-based questions to foster critical thinking and creativity

IndexTerms **-** Revised Bloom's Taxonomy, Mathematics textbook, Cognitive levels, Higher Order Thinking Skills, Mizoram Board of School Education.

I.INTRODUCTION

Mathematics is frequently perceived by students as an uninteresting and overly complex subject, while educators often find it challenging to teach due to the high level of skill and proficiency required (Gafoor & Kurukkan, 2015; Jameel & Ali, 2016; Ma & Xu, 2004). Given its reputation as a difficult discipline, the role of textbooks in facilitating student learning becomes particularly significant (Gafoor & Kurukkan, 2015). Well-designed textbook exercises are essential for enhancing students' cognitive abilities and problem-solving skills (Allington, 2002).

Bloom's Taxonomy offers a structured approach to developing learning objectives that guide students from foundational knowledge to higher-order thinking. Initially created as an assessment framework, the taxonomy has since been widely adopted in education to support instructional design, learning progression, and evaluation methods.

The Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001) enhances the original model by integrating cognitive and knowledge-based dimensions, improving its applicability in educational settings. While the traditional taxonomy consisted of six cognitive levels—knowledge, comprehension, application, analysis, synthesis, and evaluation—the revised version redefines these as: Remember, Understand, Apply, Analyze, Evaluate, and Create.

In this study, the Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001) is utilized to analyze the Commercial Mathematics and Statistics & Probability sections of the Class X Mathematics textbook recommended by the Mizoram Board of School Education.

1.1 Rationale of the Research

In an era of rapid globalization and evolving educational demands, there is an urgent need to align curricula and textbooks with contemporary developments to meet emerging learning needs (Ramparsad, 2001). Mathematics education, in particular, plays a crucial role in fostering critical thinking and problem-solving skills, which are essential for students' academic and professional success (National Council of Teachers of Mathematics, 2020). However, the effectiveness of mathematics textbooks—a primary instructional resource—depends heavily on their content quality, pedagogical strategies, and alignment with curriculum objectives (Fan et al., 2018).

A critical gap exists in the systematic analysis of mathematics textbooks, particularly in the context of Mizoram, where limited research has been conducted on the nature and efficacy of textual questions in promoting mathematical proficiency. Textbook questions serve as a key mechanism for reinforcing learning, yet their design often lacks a structured approach to developing higher-order thinking skills (Hiebert & Wearne, 2003). This study seeks to address this gap by evaluating the cognitive levels of questions embedded in mathematics textbooks, thereby providing empirical insights for curriculum developers, educators, and policymakers.

1.2 Research Objectives:

1. Analyze the distribution of textual questions across RBT's (revised Bloom's Taxonomy) cognitive dimensions in Commercial Mathematics and Statistics & Probability units.
2. Compare the proportion of LOTS (Lower Order Thinking Skills) and HOTS (Higher Order Thinking Skills) in both units.

II. Review of Literature

Tanujaya et al. (2017) conducted a study on "Mathematics instruction, problems, challenges and opportunities: a case study in Manokwari Regency, Indonesia". Their study revealed that math textbooks often fail to promote students' critical thinking skills. An analysis based on Bloom's taxonomy showed that most textbook questions emphasized lower-order thinking skills: remembering (35.52%), understanding (41.35%), and applying (19.48%). Higher-order cognitive skills were significantly underrepresented.

Mita et al. (2021) studied on "Cognitive Level Analysis of Problems in Mathematics Textbook Class XII Revision 2018 Materials of Congress and Construction Based on the Revised Bloom Taxonomy". With reference to Bloom's Taxonomy, this study tries to describe the distribution of cognitive levels. Their findings indicated that the majority of questions focused on application (50%), followed by analysis (31.8%) and understanding (18.2%). Notably, the textbook lacked questions assessing remembering, evaluating, and creating, suggesting a limited emphasis on both foundational knowledge and higher-order thinking skills..

Alqudah (2022) studied on, "Analysis of Evaluative Questions in Eighth Grade Mathematics Textbook according to Bloom's Cognitive Domain Levels". The results showed a heavy focus on lower-order skills, with comprehension (38.97%) and recall (30.74%) being the most frequent. Application (11.93%) and analysis (11.84%) appeared moderately, while evaluation (5.33%) and synthesis (1.18%) were minimally represented. Overall, 69.71% of questions targeted lower cognitive levels, 11.93% intermediate, and only 18.36% higher-order thinking.

Atta et al. (2024) conducted a study on "An Investigation of The Connection of Bloom's Taxonomy to the Core Mathematics Curriculum for Senior High Schools in Ghana". This study aims to provide an overview of how Ghana's senior high school mathematics curriculum relates to Bloom's taxonomy. Their findings indicated a strong emphasis on lower-order cognitive skills, with understanding (33.3%), applying (29.8%), and remembering (18.1%) dominating the curriculum. Higher-order thinking skills accounted for only 18.8%, highlighting a need for greater integration of advanced cognitive challenges in math instruction.

III. Research Methodology

3.1 Method of Study

Document analysis, one of the qualitative research methods is employed in the study. Document analysis is defined as a qualitative research method used to analyse a number of written materials. The methods involved analysing the textbooks on the basis of general impressions followed by an in-depth study of the textbooks. In addition, within the content of the study, the Revised Blooms' Taxonomy is also used to analyse the level of end – of – chapter exercises

3.2 Sample

The sample of the study is Commercial Mathematics and Statistics & Probability units of Class X Mathematics Textbook named LEARNING MATHS, 2022 Mizoram Edition published by Frank Education Aids Pvt Ltd. prescribed by Mizoram Board of School Education.

Table 1: Frequency of exercise in each unit

Unit	Chapter	Topic
Commercial Mathematics	1	Installments
Statistics and Probability	17	Mean, Median and Mode of Grouped Data
	18	Probability
	19	Pictorial Representation of Data

3.3 Tools for Data Analysis

The analysis of textual questions was carried out by referring to the framework of the revised edition of Bloom's taxonomy (Anderson & Krathwohl, 2001).

Table 2: Coding for the frameworks in the revised Bloom's Taxonomy

Cognitive level	Description	Code
Level 1 (Remembering)	Retrieve relevant knowledge from memory (remembering, recognizing)	C1
Level 2 (Understanding)	Building meaning from the learning process, including oral, written, drawing communication (interpreting, summarizing)	C2
Level 3 (Applying)	In the situation at hand or in new situation, do or employ the procedure, method or formula (using, carrying out, implement)	C3
Level 4 (Analyzing)	Break down a substance into its component elements and figure out how they connect to one another (organizing, sorting, grouping, rearranging).	C4
Level 5 (Evaluating)	Make judgments/assessments based on criteria and standards (checking, judging, critiquing)	C5
Level 6 (Creating)	Combine parts to make a logical or functioning whole: element reorganization into a new structure (hypothesizing, designing, producing).	C6

IV. Analysis and Findings

4.1 Distribution of textual questions in Commercial Mathematics and Statistics & Probability units across RBT's cognitive dimensions.

Table 3: Distribution of the Unit I Exercises in the Six Levels of Cognitive Dimensions.

Chapter	Level of Cognitive Dimension						Total
	C1	C2	C3	C4	C5	C6	
1	-	-	13 (86.7%)	2 (13.3%)	-	-	15
Total	-	-	13	2	-	-	15
Percentage			86.7%	13.3%			100%

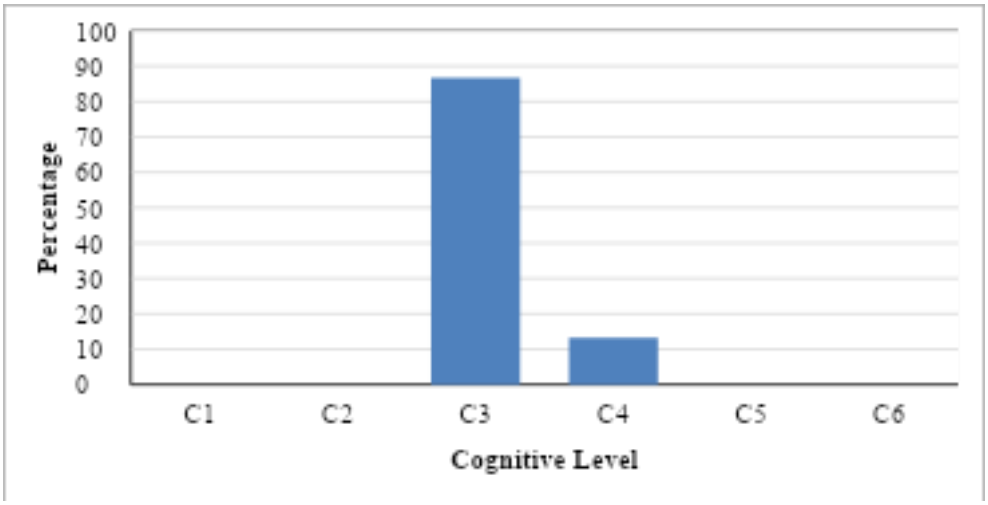

Figure 1: Percentages of Unit I Exercises in the Six Levels of Cognitive Dimensions.

Base on the Analysis of data vide Table 3 and Figure 1, the overwhelming majority of exercises (86.7%) focus on C3 (Applying) level. This suggests the unit prioritizes procedural fluency. Exercises in the C1 (Remembering) and C2 (Understanding) levels are absent; suggesting that core knowledge is presumed or covered elsewhere. The minimal presence of C4 (Analyzing) (13.3%) indicates scant emphasis on breaking down complex problems. Finally, no exercises target C5 (Evaluating) or C6 (Creating), which limits opportunities for critical thinking or creativity. The unit's design aligns with practical, skill-based learning but neglects deeper cognitive engagement.

Table 4: Distribution of the Unit VIII Exercises in the Six Levels of Cognitive Dimensions.

Chapter	Level of Cognitive Dimension						Total
	C1	C2	C3	C4	C5	C6	
17	4 (10.0%)	1 (2.5%)	31 (77.5%)	4 (10.0%)	-	-	40
18	2 (6.7%)	7 (23.3%)	18 (60.0%)	3 10.0%)	-	-	30
19	-	2 (16.7%)	10 (83.3%)	-	-	-	12
Total	6	10	59	7	-	-	82
Percentage	7.3%	12.3%	71.9%	8.5%			100%

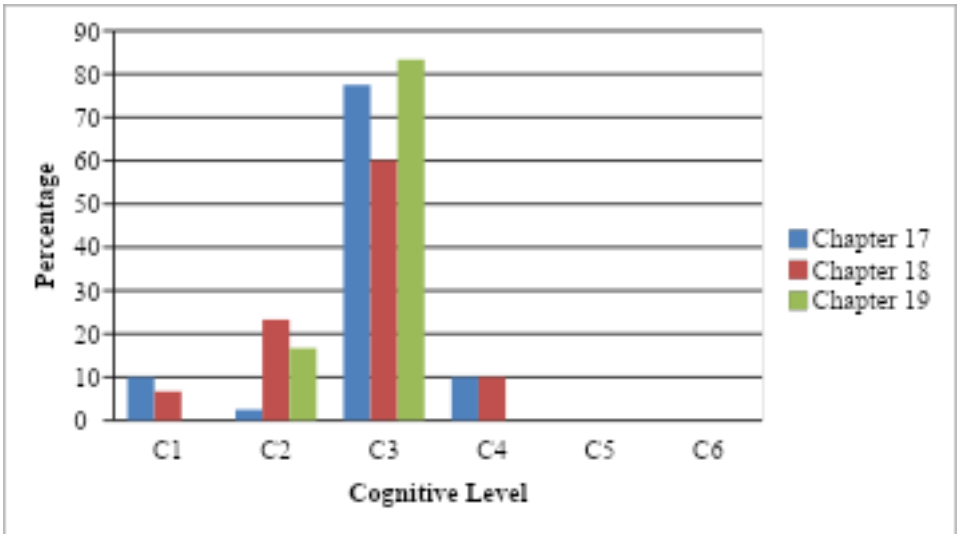

Figure 2: Percentages of the exercise in Unit VIII in the Six Levels of Cognitive Dimensions

The above Table 4 and Figure 2 highlight that in Chapter 17 (Mean, Median and Mode of grouped data) overwhelming majority of exercises (77.5%) fall under the C3 (Applying) level. This suggests that the chapter heavily emphasizes the practical use of formulas. The minimal representation of C4 (Analyzing) level (10.0%) and C2 (Understanding) level (2.5%) further highlights a potential imbalance in the cognitive demand of the exercises**.** The absence of exercises in C5 (Evaluating) and C6 (Creating) levels indicates a gap in fostering critical thinking and creativity. While, C1 (Remembering) level has a modest representation (10.0%).

Analysis of Chapter 18 (Probability) as shown in Table 4 shows a strong emphasis on C3 (Applying) level with the majority of exercises (60.0%) fall under the C3 level, indicating a focus on procedural fluency in solving probability problems. A notable proportions of exercises (23.3%) target C2 (Understanding) level. C4 (Analysis) level is marginally represented (10.0%), indicating minimal emphasis on interpreting or deconstructing probability scenarios. The chapter has low number of C1 (Remembering) exercises (6.7%). The absence of C5 (Evaluating) and C6 (Creating) level end of chapter questions suggests a gap in developing critical thinking, reasoning and creativity.

From the analysis of the above table, Table 4, it can be seen that in Chapter 19 (Pictorial Representation of Data) 83.3% of exercises focus on C3 (Applying) level, indicating a strong procedural emphasis. 16.7% of exercises belong to C2 (Understanding) level. While, C1 (Remembering), C4 (Analysis), C5 (Evaluating), and C6 (Creating) levels are complete absent among the exercise. This Chapter prioritizes procedural fluency in pie chart but neglects higher-order cognitive skills. While the focus on Applying level ensures foundational competence, the absence of Analysing, Evaluating, and Creating level tasks limits students' ability to think critically about data representation.

4.1 Distribution of textual questions in Commercial Mathematics and Statistics & Probability units across RBT's cognitive dimensions.

Table 5: Unit wise comparison of Thinking Skills Order in Mathematics Textbook

Sl No.	Unit	Lower Order Thinking Skills		Higher Order Thinking Skills	
		No. of items	Proportion	No. of items	Proportion
1	Commercial Mathematics	13	86.7%	2	13.3%
2	Statistics and Probability	75	91.5%	7	8.5%

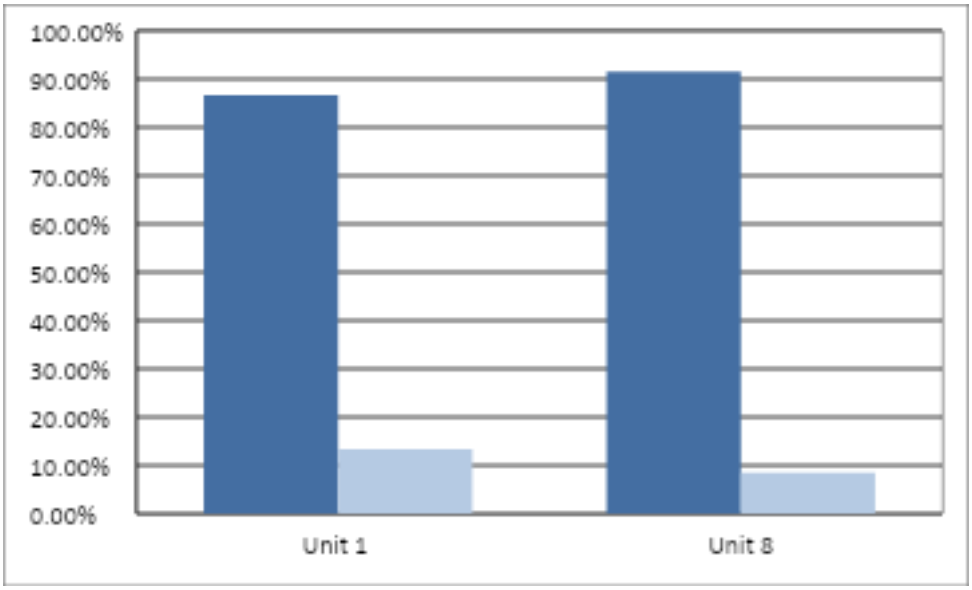

Figure 3: Distribution between HOTS and LOTS in both unit

The analysis of table, Table 5 reveals that Statistics and Probability has only 8.5% of end of chapter question belonging to HOTS, while 91.5% fall in LOTS category. Further, Commercial Mathematics also exhibit limited HOTS proportion which is 13.3% while 86.7% of its end of chapter question id of LOTS. This analysis reveals a clear imbalance in cognitive skill emphasis across both unit of Class X Mathematics textbook. Lower Order Thinking Skills (LOTS) dominate both Commercial Mathematics unit and Statistics and Probability unit with a large proportion.

V. CONCLUSION

The analysis of the Commercial Mathematics and Statistics & Probability units in the Class X Mathematics textbook prescribed by the Mizoram Board of School Education (MBSE) reveals a significant imbalance in cognitive demand. The findings indicate a strong dominance of Lower Order Thinking Skills (LOTS), particularly in the Applying (C3) category, which constitutes 86.7% of exercises in Commercial Mathematics and 91.5% in Statistics & Probability. Conversely, Higher Order Thinking Skills (HOTS), such as Analyzing (C4), Evaluating (C5), and Creating (C6), are severely underrepresented, with only 13.3% and 8.5% presence, respectively.

This heavy reliance on procedural tasks (C3) suggests that the textbook prioritizes rote memorization and formulaic problem-solving over critical thinking, creativity, and real-world application. The absence of Evaluating (C5) and Creating (C6) questions limits students' opportunities to engage in metacognition, argumentation, and innovative problem-solving, which are essential for 21st-century learning (Trilling & Fadel, 2009).

While the textbook effectively reinforces procedural fluency, its neglect of HOTS undermines holistic mathematical proficiency. Future revisions should align with global educational trends emphasizing analytical reasoning, evaluation, and innovation (NCTM, 2020).

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