

Questioning in High School Mathematics Classes: An Investigation of its Influencing Factors

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ABSTRACT

Classroom talk, through questioning, is the most important tool in the development of students' critical thinking and problem-solving skills in mathematics classes. This study aimed to investigate the factors that influence the implementation of questions of high school mathematics teachers in their classes in Bukidnon. Using a descriptive-phenomenological approach, the study employed a semi-structured interview question which was conducted to nine (9) high school mathematics participants. Using the Collaizi's method, the responses were coded and analyzed. Findings revealed seven (7) significant and emerging themes on the factors influencing the implementation of classroom talk in the province of Bukidnon, namely: (1) Teacher's Expectations, (2) Teacher's Competence, (3) Students' Competence, (4) Learning Environment, (5) Communication and Language, (6) Time Element; and (7) Subject Content. These factors may influence the successful implementation of questioning in the mathematics classes and may affect the smooth flow of the discussion. Hence, teachers may consider them optimizing discussion in the classroom. Moreover, by promoting a safe and supportive atmosphere, teachers can maximize collaborative and productive learning experiences.

KEYWORDS: *Bukidnon; classroom talk; mathematics classes; qualitative*

INTRODUCTION

Mathematics education, through proper questioning, is a gateway for developing the critical thinking and problem-solving skills of the students. By encouraging students to engage in a meaningful talk and exposing them to questions by exposing students with higher order thinking skills, teachers' capacity of proper use of questioning plays a pivotal role to optimize learning experiences of the students to develop the skills. However, the implementation of this meaningful discussion and how teachers implement questioning techniques to students needs to be accompanied by considering several factors to use them effectively in the classroom. These may include, teacher's skills and capacity, time constraint, and students' disposition (Mahmud et al., 2019)

This investigation of factors that influence the utilization within the context of Bukidnon is an important undertaking, driven by the acknowledgment of the crucial role of the discussion in the teaching and learning process. The practices, issues, and concerns of 21st-century mathematics teachers in rural areas, particularly in the province, have been a subject of interest, with a focus on the factors that shape questioning in the classroom.

The interrelationships of categories of classroom talk in mathematics classes have also been a point of study, highlighting the importance of understanding the various factors that impact questioning practices, (Pagtulon-an & Tan, 2023). The need to examine these influencing factors stems to enhance the quality of mathematics education in the region. While the benefits of effective questions are well-documented, there is a scarce number of research specifically identifying the challenges and reasons on what influence teachers to implement questioning in high school mathematics classes.

Considering the existing literature and the unique educational landscape of Bukidnon, this study aimed to contribute to the understanding of the factors that influence the successful implementation of questioning in mathematics classes, providing valuable insights for the professional growth of educators to promote the successful integration of effective questioning techniques classes and the improvement of the overall learning experience in high school mathematics for students in this context.

Conceptual Framework

This study is anchored on the Sociocultural Theory of Human Learning by Lev Vygotsky. This theory proposes that knowledge and social interactions are constructed through the influence of social and cultural contexts, including family, friends, teachers, and peers (McLeod, 2023). Similarly, learning takes happens when people interact with each other, and social interaction in the community plays a central role in "making meaning" (Bates, 2019). This approach emphasizes the role of socialization and collaboration in the process of learning.

Building positive relationships between students and teachers can facilitate social engagement and active participation in learning tasks. When students feel valued and supported by their teachers, they are more likely to take risks in their learning and actively engage in class discussions and activities. Students also learn through observing, listening, and discussing their tasks with their peers and teachers (Drew, 2019). This theory also suggests that culture, language, mnemonics, and asking questions have a more significant influence on a student's or child's cognitive development than any intrinsic factors or universal human traits; so, students may have different approaches to learning based on their cultural background, which can affect how they engage in classroom discussions, participate in group work, and understand and apply new concepts (Masterclass, 2022).

Thus, this theory helps to explore the importance of classroom talk in mathematics classes and the factors which underlies it in a Philippine setting since it involves social interaction through posing questions specifically between the teacher and students. Knowing how these two stakeholders are initiating a classroom discursive regime to promote learning processes in the mathematics classroom would give an insight into how this factor be enhanced for proper utilization in implementing daily learning plans. Moreover, this theory guided the researcher to consider factors across the discipline of classroom talk and how these types manifest in mathematics classes.

As this study aimed at identifying the factors underlying it, this theory gave insights to explicate further the phenomenon in mathematics classes. It helped for a conclusive and proper optimization of the structure to design a recommendation to help develop a conceptual understanding of the students.

METHODOLOGY

Research Design

This study employed a descriptive-phenomenological research design, which involves collecting and analyzing data to describe the experiences of the mathematics teachers in implementing classroom talk in mathematics classes in Bukidnon. This design involves collecting data through interviews, observations, or surveys, and analyzing the data to identify common themes and patterns. The goal is to provide a detailed description of the experiences of the participants and to understand the meaning they attach to those experiences. This approach is particularly useful in exploring complex and subjective experiences, such as those related to teaching and learning (Langdridge, 2007).

Locale of the Study

This research was conducted in secondary schools in the province of Bukidnon. Also, it has three (3) Department of Education (DepEd) divisions: Division of Bukidnon, Division of Malaybalay City, and Division of Valencia City. The province is home to different ethnic groups with unique cultural backgrounds and orientations.

Sampling and Participants of the Study

A purposive sampling method combined with theoretical saturation has been used to identify the participants. Nine (9) mathematics teachers in secondary schools were interviewed; out of these 9 participants, four (4) are from small schools and remote areas, and five (5) are from the city high schools to guarantee the richness of the data being gathered.

Data Collection and Analysis

Coding, thematic analysis, and documentation were utilized to constructively answer the research question. Thematic analysis is a valuable method of analysis to comprehend experiences across a data set of thoughts or behaviors. Moreover, the said framework has generally six practices: i) familiarization of the data you gathered, ii) creation of the possible initial codes; iii) looking for the themes using the codes, iv) verifying themes, v) naming and defining themes, and lastly vi) generating the report. Specifically, the researcher used Colaizzi's descriptive phenomenological method to analyze qualitative findings from the participants' interview responses.

Method of Validation

Triangulation and member-check approaches were considered to validate and achieve the accuracy of the formulated themes to ensure the validity and trustworthiness of the data.

Ethical Considerations

To address the ethical issues in the qualitative phase, when conducting the study in the three divisions of DepEd in Bukidnon, a letter of permission was sent to the Division Superintendents with the attachments of the intention, the purpose of the study, and a copy of the research questions for interview/ focus group discussions (Kiger & Varpio, 2020; Braun & Clarke, 2012). The researcher obtained approval from the schools before conducting the interviews, ensuring that the teacher's responsibilities and duties were not compromised or interfered with.

RESULTS AND DISCUSSION

Factors Influencing the Implementation of Questioning in Mathematics Classes

Relevant research questions were asked for detailed accounts of the participants' experiences and perspectives. This focused on identifying the underlying factors influencing the implementation of classroom talk in high school mathematics classes in the Province of Bukidnon. The thematic analysis of the original transcripts revealed seven (7) significant themes which characterized the participants' answers and responses, namely: (1) Teachers' Beliefs towards teaching; (2) Teacher's Competence, (3) Students' Competence; (4) Learning Environment; (5) Communication and Language; (6) Time Element; and (7) Subject Content.

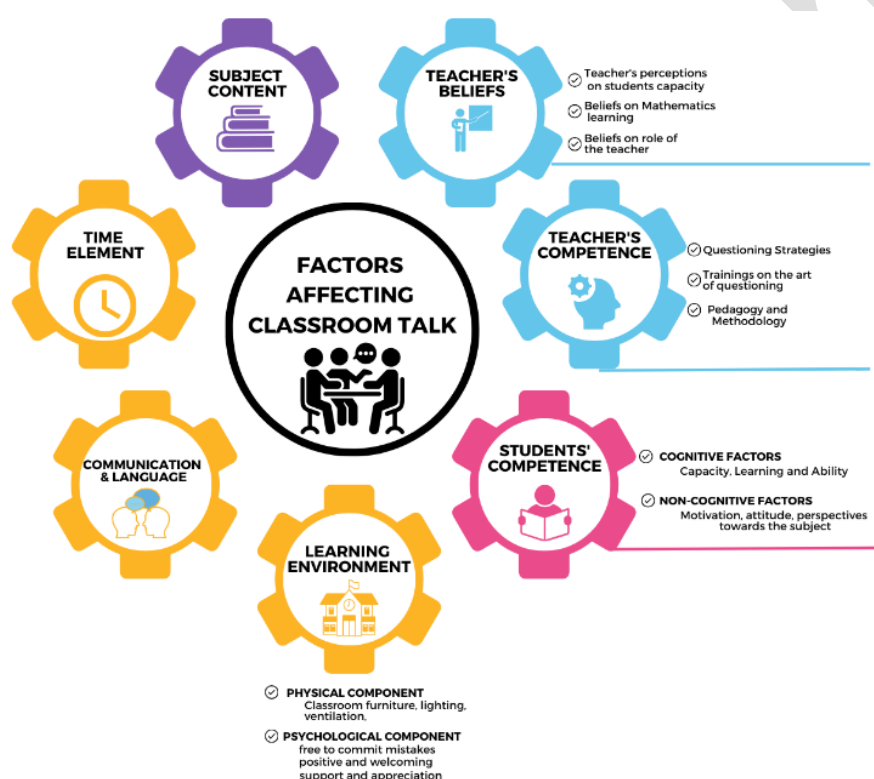


Figure 1. Factors that Influence the Implementation of Questioning in Mathematics Classes

Theme 1: Teacher's Beliefs

Teachers' beliefs in teaching are among the most significant contributors to teaching, assessing, and implementing the subject matter to the students. It is one of the most frequent themes pointed out by the participants in the interview that contributes to and influences the way they engage students in classroom talk in mathematics discussion. Beliefs serve as the guiding principle of the teacher on how they believe to be the best instructional practices. How they formulate questions, engage students in the classroom, assess or check students' knowledge, and how they implement the mathematics lesson in their classes. For the participants, how they view their students affects their decision-making in formulating questions.

Teachers believe that everyone can learn mathematics, regardless of their background or previous knowledge. They understand that each student has a unique way of learning. As such, they strive to provide a variety of teaching strategies and techniques to help their students understand mathematical concepts. They also believe that every student can succeed in mathematics with enough time, practice, and dedication.

By establishing and recognizing the teachers' beliefs, they can make sound decisions on various elements of their classroom instruction, such as questioning techniques, the implementation of subject matter, and student assessment. In the end, the teaching philosophy of an educator greatly influences their overall method of instructing and acquiring knowledge (Soccorsi, 2013). Further, Muijs and Reynolds (2015) argued that their viewpoints could significantly influence the academic success of a teacher. This suggests that the teacher's perspective is a critical factor in determining a student's success in their academic endeavors.

The beliefs of the teachers and their outlook toward students can greatly affect the implementation of questioning and classroom talk. It also follows how teachers handle classroom talk to the students. If teachers believe that when these groups of students can handle the questions they ask, they will allow presenting the questions to them. On the other hand, if teachers think that students can have difficulty answering the questions, some teachers will hesitate to present the questions to these students, thus, resulting from limiting students' opportunities to be involved in productive thinking and developing critical thinking skills in generating answers to the questions that supposedly been asked.

This finding has been highlighted in the study which concluded that teachers might believe that low-achieving students have limited thinking abilities and are incapable of completing tasks that require higher-order thinking skills (HOTS) (Mahmud, 2019). However, teachers must encourage all students to engage in HOTS-related assignments regardless of their academic level. The belief that HOTS development is only for high-achieving students should be corrected, as teaching and learning opportunities for HOTS should be available to all students.

The questions which teachers pose in class vary depending on how they perceive their students. Teachers who are confident in their students' ability to perform well frequently present more challenging, thought-provoking questions to their classes. However, less demanding teachers may present fewer challenging inquiries or fail to challenge their student's critical thinking. This may hinder students' ability to think and develop. Therefore, how teachers view their students can influence the questions they ask, impacting students' learning (Rosenthal & Jacobson, 1968). Additionally, a study argued that the way teachers perceive the nature of mathematics and how students learn it could significantly affect how they teach mathematics. Teachers' beliefs about these factors are crucial in shaping their instructional practices (Ngan & Nirmala Rao, 2003).

Furthermore, a study argued that it is essential to focus on both teachers' beliefs and practices in professional development to create long-lasting effects for quality teaching. Teachers' beliefs and practices are interconnected, and changes in one area can influence the other (Hunt et al, 2023). Also, teachers' attitudes and beliefs toward teaching math to students significantly impact their instructional practices, how they engage with their students' ideas, and how they evaluate their learning progress.

Theme 2: Teacher Competence

Teacher's Competence is the second emergent theme that influences teacher questioning practices in the classroom. The said main theme is characterized by the following subthemes: Teacher Capability, Teacher's Training, and Teaching Pedagogies (Appropriateness of Questions, Questioning Strategies of the Teacher, and Planning of Questions).

Teacher Capability. The participants emphasized that teacher competence in facilitating mathematics discussions is vital to improving student engagement and interaction in class. To achieve this, teachers should have subject matter expertise and pedagogical knowledge and create a supportive and inclusive learning environment.

A lack of higher knowledge on effective questioning strategies among teachers may result in them asking questions that do not effectively contribute to motivating their students' thinking (Mustapha et al., 2010). It further explained that participation is encouraged by positive traits exhibited by lecturers, while negative traits such as poor teaching skills and with not-so-approachable characteristics can lessen participation. Additionally, they observed that impatience from the lecturers or classmates could discourage some students from participating in classroom discussions. Teachers must ensure that classroom dialogue is conducted respectfully, fostering a sense of safety and inclusivity among students (Fassinger, 2000).

Effective teachers who possess strong pedagogical skills, personal motivation, and beliefs that prioritize inclusive and interactive learning can create an engaging classroom environment. By fostering a culture of questioning and exchange of ideas, students are encouraged to actively participate and deepen their understanding of mathematics. This approach promotes student engagement, collaborative learning, and a more inclusive educational experience.

Training of Teachers on the Art of Questioning. Most teacher-participants have yet to receive training in the art of questioning, impacting the quality and effectiveness of their questions in the classroom. This lack of training can result in missed opportunities for promoting critical thinking and student engagement.

It was found that the pedagogy and methodological knowledge of the teacher in questioning can greatly affect student engagement in mathematics classrooms. The participants pointed out that how the teacher asks questions and structures their lessons can significantly affect how well the students engage in the discussion. The findings corroborated the result of Mahmud et al. (2019) which indicated that teachers need more knowledge and understanding of implementing high-level questioning strategies in mathematics classes to implement such questions. This limitation leads to a need for more high-level questioning in the classroom and a tendency to focus on lower-level thinking skills.

Teachers recognized the significance of questioning in mathematics instruction and were seeking training and seminars to improve their questioning skills. They are looking for formal training and seminars on effective questioning techniques that they could implement in their classrooms to enhance learning outcomes and benefit their students.

Developing effective questioning skills involves several elements, such as formulating questions, connecting questions to real-world scenarios, planning questions, and utilizing appropriate questioning techniques. When teachers relate theoretical concepts to real-life

examples and initiate class discussions, it encourages students to engage and participate actively. By providing opportunities for students to apply their knowledge in the classroom and relate it to real-life situations, teachers can help them make connections and deepen their understanding of the subject matter (Susak, 2016).

While it is true that the classroom environment can be dynamic and unpredictable, planning questions ahead of time can still be beneficial for teachers in the mathematics classroom. Additionally, it can help teachers anticipate possible misconceptions or challenges that students may face and prepare appropriate questions to address those issues. While it may not always be possible to stick to a pre-planned set of questions, having a plan in place can still be a valuable tool for teachers to use in guiding their instruction. Teacher may encourage to plan some questions before the lessons to ensure the optimization of classroom engagement and discussion during mathematics classes. Though it is not necessary to be planned in structure, it should be designed properly so that it can be presented logically during the discussion. these questions are not necessarily long, but should direct the instruction to a more productive direction in each lesson (Long, 1980).

Theme 3: Students' Competence

The participants emphasized that the student's capability to respond and engage in classroom discussions greatly influences the types of questions teachers ask. In well-performing classes, teachers can pose challenging questions that encourage critical thinking, connections, and further explanations from students. In contrast, in lower-performing classes, teachers may be unable to do so at some time. This theme is classified into two categories: students' cognitive and non-cognitive factors. Student cognitive factors include their ability and capacity to actively participate in classroom interaction, share and contribute ideas, and their preferred learning styles. On the other hand, students' non-cognitive factors refer to their motivation, confidence, and overall attitude toward mathematics.

Cognitive factors. A student's cognitive abilities and capacities play a significant role in their participation in classroom interactions. The following excerpts display the importance of cognitive factors for the part of the teacher to construct classroom talk in their mathematics classes.

Teachers face a challenge in planning questions that can engage students in productive discussions in mathematics class, considering the diversity in students' cultural backgrounds and learning styles, especially in Bukidnon. This requires a thoughtful approach to crafting questions that provide equal opportunities for all students to participate and contribute their ideas.

Non-cognitive factors. Students' motivation, attitude, and confidence are important factors in successfully implementing classroom talk. These non-cognitive factors can significantly influence students' willingness to participate in class discussions, engage with the material, and take ownership of their learning. The following actual responses of the participants reflect the non-cognitive aspect of the students:

Teachers should create a positive and supportive classroom environment that fosters student motivation, confidence, and a positive attitude toward mathematics. This can be done by providing opportunities for student-centered learning, recognizing and praising student efforts and accomplishments, and scaffolding and support for struggling students. By doing so,

teachers can encourage productive classroom talk and help students become more engaged and successful in their math learning.

Some research articles found that students with high self-confidence in their mathematical abilities are more likely to believe in their potential for success and are willing to take on challenging tasks, which ultimately leads to higher academic achievement. Conversely, students with low self-confidence may avoid challenging tasks and struggle to succeed in mathematics due to a lack of belief in their abilities (Ramdani & Mursyid, 2022; Van der Bergh, 2013).

Theme 4: Learning Environment

The fourth emergent major theme is the learning environment. Teachers identified the factor of learning environment towards its influence on their instructional practices to engage students in a classroom talk ambiance in mathematics classes.

The researcher identified two categories of the learning environment: The physical component, which includes the classroom, ventilation, chairs, lighting, and the psychological component, which includes acceptability, a judgment-free classroom, a respectful environment, and positive and support from classmates and teachers.

Physical Component. The participants expressed their appreciation for classrooms with proper ventilation and a conducive learning environment, as these factors contributed to good discussions between teachers and students. Some of the participants' accounts regarding this concern are the following:

Classroom size impacts student involvement

"Because of the many students in the classroom, it is sometimes so sad and tiring when you throw questions, there is sometimes only one student who can relate and can answer but not always correct"

Teachers experienced unproductive discussions because of concerns about classroom ambiance, ventilation, and many students. Various factors can have a detrimental impact on the quality of a classroom discussion. These factors may include poor ventilation or a hot environment, incomplete or uncomfortable seating such as armchairs, and large class sizes, making it challenging for students to participate fully and stay engaged in the discussion. The lack of student engagement in the classroom is often associated with environmental factors, such as class size. This means that classrooms with many students may negatively impact students' ability to participate and engage in the learning process (Subramainam et al, 2017).

The school's physical environment is essential in interactions among teachers, students, student-teacher, and student-student (Fahlstrom, 2022). Further, the number of students in a class has a significant impact on the quality of attention that teachers can provide to each student, the degree of investigative work that can be accomplished, and the methods used for managing the classroom, especially for those students who are struggling with their studies (Handal et al., 2015). Also, findings concluded that smaller class sizes with fewer than thirty students increased participation, attributable to more significant opportunities for engagement and familiarity among classmates (Susak, 2016).

Psychological Component. The learning environment encompasses not only the physical component, but the participants' accounts also manifested a psychological component of the classroom that influenced their instructional practices in implementing the mathematics lesson. They argued that non-cognitive factors such as motivation, friendly environment, criticism-free and judgment-free, and productive-failure environment affect the classroom discussion to prosper and evolve into more successful questions into higher order thinking skills.

The level of participation in the classroom was found to be strongly influenced by the classroom environment. The students expressed that feeling reinforced, respected, and having a safe environment positively influenced their willingness to engage in the classroom discussion. Furthermore, they felt more comfortable engaging in a free-flowing, respectful interaction, which allowed for comments to build upon one another (Susak, 2016). It was added that students are more likely to participate in class when their teacher provides constructive feedback and support rather than criticizing, making fun of, or putting them down. Additionally, research suggests that students who receive significant emotional support from their teachers tend to display higher levels of social, emotional, and cognitive engagement in the classroom (Ansonga et al, 2017). This highlights teachers' important role in creating a positive and supportive classroom environment, which can enhance student engagement and ultimately lead to improved academic outcomes.

Theme 5: Communication and Language Concern

The participants recognized the importance of proper way of communication and appropriate language to be used in the classroom discussion to promote rich dialogue between teachers and students. If chosen properly, this might lead to minimal misunderstanding and clear interpretation of ideas may be expected that will lead to effective exchanging of ideas between the stakeholders.

Students who are not proficient in the language of instruction may need help comprehending the questions being asked, which can lead to a lack of engagement and participation. It is also crucial for teachers to be sensitive to the fact that students may need a wait time as they formulate their thoughts in a language that is not their first language and should create a supportive and respectful classroom climate to encourage participation.

The findings corroborated with the study which concluded that the students who needed a prior background in the language made it challenging for them to comprehend the instructions in mathematics classes (Mazana et al, 2019). Teachers who are aware of this language barrier can take steps to ensure that their questions are clear and concise and can also consider using vernacular translations to aid comprehension. The students expressed that they needed time to organize their thoughts and be able to express their opinions in English confidently. Since they tended to think in their native language, it took them longer to formulate and translate their ideas into English before sharing them in class (Susak, 2016).

Encouraging open-ended questions that suggest potential answers can also aid in promoting critical thinking and comprehension among students. Additionally, teachers should be mindful of their language when posing questions to students, ensuring that the vocabulary is accessible and understandable. If students misinterpret a question, the teacher may consider rephrasing it, but they should also allow students an opportunity to answer before doing so (Long, 1980).

Theme 6: Time Element

In the mathematics classroom, teachers consider the time allotted to them regarding their instructional questioning practices. They recognize that time is a crucial factor in the learning process and thus design the types of questions accordingly to make the most of the time available. Teachers may need to adjust their questioning techniques depending on the length of the class and the learning goals that need to be achieved. Hence, it affects the types of questions and the nature of classroom discussions in mathematics classes.

This finding is consistent with the research of Mahmud et al., (2019) which concluded that time constraint was identified as a significant barrier in executing questions that promote critical thinking to enhance the teaching of mathematics. The limitation of time hindered the ability of educators to utilize high-level oral questioning techniques during the teaching process effectively. Moreover, incomplete tasks or assignments before class can decrease teachers' focus on teaching and fewer opportunities to plan and prepare HOTS questions.

Theme 7: Subject Content

The complexity and difficulty of the lesson are factors of choosing the type of questions being asked by the teachers. If the lesson is challenging, the teacher may ask questions that can help students understand the lesson better. If the lesson is easy, the teacher may ask questions that can challenge the students and encourage critical thinking. It should guide the type of questions asked in mathematics class to ensure that the questions are relevant, engaging, and aligned with the learning objectives and outcomes of the lesson.

A study revealed that various pedagogical factors such as the course, topic, lecturer, and teaching style could impact student participation in class (Fawzia, 2002). Additionally, teachers may feel pressured to rush to cover the curriculum due to the high number of topics that must be covered in a school year, which can result in a more linear approach to teaching that is less effective in stimulating student thinking and a decrease in high-level oral questioning during math instruction.

CONCLUSION

Effective classroom talk and interaction requires careful consideration of factors such as teacher beliefs, teacher- and student competence, learning environment, communication and language, time, and subject content. These factors can significantly impact the implementation of classroom talk and ultimately affect the quality of students' learning experience. As the improvement of 21st century skills of students in mathematics also lies on how the teacher engages his or her students to present their ideas in the classroom, it is imperative to carefully plan the classroom structure of questions to optimize learning experience in mathematics classes. Moreover, the proper structure and order of questions, environment, students' disposition affect the initial preparation for higher order questions will successfully be implemented. Thus, teachers and educators should consider these factors to facilitate a more productive and engaging learning environment.

RECOMMENDATIONS

It is recommended that mathematics teachers may plan appropriate questions to be asked in the classes and implement them at the right time to optimize learning experiences and opportunities for the students to be engaged in a more productive learning environment. In the context of classroom culture, they may prioritize building a safe and inclusive environment for their students to foster more active and engaged participation. By creating a welcoming and supportive atmosphere, teachers can encourage students to feel comfortable sharing their ideas and asking questions, leading to a more productive and collaborative learning experience.

School administrators may consider optimizing the awareness of the factors that influence the utilization of talk in mathematics classes. Addressing these factors could lead to a more harmonious and positive learning environment for questioning and overall teaching and learning processes.

DepEd officials, program heads, and school administrators may provide training and seminar workshops for mathematics teachers on questioning. This can help enhance their communication and questioning skills, leading to more engaging and optimizing opportunities for the students to be involved in a productive learning environment.

Future research studies can expand the scope of their investigation by examining the structure of classroom talk in different regions of the country. This will help identify similarities and differences in classroom talk practices, leading to a better understanding of implementing effective classroom talk and, ultimately, improving the quality of education in the country.

Limitations of the Findings of the Study

As this research findings indicate possible factors that may influence the implementation of classroom talk in mathematics classes, it is important to acknowledge some limitations of the result. As the study utilized only high school mathematics teachers from the province of Bukidnon, it may not provide general detail of all the factors underpinning the utilization of classroom talk in mathematics classes. Moreover, it is important to acknowledge that this study relied solely on teacher interviews and their perceptions as a data source and some triangulation methods, which may have limited the scope of factors explored in the research. Other aspects of the learning process, such as classroom observations and other data collection methods, could reveal additional factors not captured in this study.

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