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Linguistic practices in mathematics classrooms: A needs analysis toward translingual mathematics education

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ABSTRACT

This study explored the linguistic practices and perceived effectiveness of translanguaging pedagogy in mathematics education. It involved five Grade 7 Mathematics teachers and ten selected students who participated in interviews, offering insights into translanguaging practices and language-related challenges in learning mathematics. Additionally, 454 students were surveyed to assess their perceptions of using English as the primary language of instruction. Using an exploratory sequential research design (ESRD), it analysed teachers' linguistic practices and their effectiveness, students' language backgrounds, and their perspectives on English as the medium of instruction (EMI). Consistent with other studies, the findings reveal that the teachers integrate both Filipino and English in Mathematics classroom discussions and considers this approach more effective than using either language alone. Additionally, while students generally believe that EMI enhances their math skills, they oppose the notion that mathematics should be taught exclusively in English. The analysis highlights critical needs, such as providing teacher training in effective translanguaging strategies, improving bilingual resources, and developing tools to better capture students' perceptions and experiences with translanguaging in math. This study lays the foundation for research aimed at enhancing mathematics education through customized linguistic strategies, fostering an inclusive learning environment that bridges language gaps and boosts student achievement.

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Introduction

The relationship between language and learning is becoming more widely acknowledged as a crucial component of academic achievement. This is particularly true for courses like mathematics, where language skills may have a significant influence on the intricacy of concepts and problem-solving techniques (Flores & Urrutia, 2022). However, in bilingual and multilingual settings, the interplay between language and mathematics becomes even more significant, as students and teachers navigate linguistic diversity to foster understanding.

By its very nature, mathematics requires accurate understanding and communication of abstract concepts. Learning mathematics need the capacity to comprehend and apply mathematical language (Riccomini et al., 2015). However, this provide serious difficulties for students, especially Filipinos for whom English, which is the teaching language in Philippine Mathematics education, is a second language. Students find it more difficult to answer problems, follow directions, and participate completely in the classroom discussion as they have trouble comprehending the terminologies the teacher use (Mulwa, 2015). Students, especially those for whom the teaching language is a second language, find it more difficult to follow directions, and participate completely in the classroom discussion (Mulwa, 2015). These poses hindrance on students' comprehension and engagement, limiting their ability to develop critical mathematical skills.

Teachers, on the other hand, play a pivotal role in bridging the gap between mathematical concepts and student understanding (Yang et al., 2021). Strong subject-matter knowledge is necessary for effective mathematics teaching, but so is the capacity to communicate concepts in an understandable manner. Teachers' capacity to explain topics and assist students in learning may be greatly impacted by their pedagogical communication (Jourdain & Sharma, 2016). However, many teachers in the Philippine secondary education still rely on monolingual teaching approaches, which may inadvertently exclude students who are less proficient in the language of instruction (Martinez & Martin, 2024). Thus, it is critical to determine teachers' language practices and assess the challenges posed by these practices.

Hence, through a needs analysis, this study conducted a thorough investigation of both students' and teachers' linguistic practices and challenges in the mathematics education context. Specifically, this study addressed the following questions: (1) What is/are the teachers' linguistic practices in teaching Mathematics? (2) What is the teachers' perception on the effectiveness of their linguistic practices in teaching Mathematics? (3) How may the linguistic demographics of the students in Mathematics be described in terms of: classroom interaction and solving Mathematics problems? (4) What is the students' perception on the use of English as a medium of instruction (EMI) in Mathematics?

The need for needs analysis

The Philippines is a linguistically diverse nation, with over 170 languages spoken across its regions (Mojarro, 2021). The Department of Education (DepEd) has recognized this diversity through the implementation of the Mother Tongue-Based Multilingual Education (MTB-MLE) policy under the K-12 curriculum (DepEd, 2012). MTB-MLE mandates the use of students' first languages as the primary medium of instruction in early grades, gradually transitioning to English as the medium of instruction for mathematics, science, and English subjects starting from Grade 4 onward. While this policy aims to strengthen foundational learning by leveraging students' linguistic strengths, challenges emerge in subjects like mathematics: problems in early primary level where technical terms often lack direct equivalents in local languages (Lartec et al., 2014); and problems in secondary education level where English is used as primary teaching language in Mathematics (Malaki et al., 2022). These challenges create a gap between policy intentions and classroom realities, highlighting the need for a deeper understanding of how language affects mathematics teaching and learning.

Hence, a needs analysis is crucial for identifying these gaps. This will enable educators and researchers to systematically examine the linguistic practices used in mathematics classrooms, assess their alignment with student needs, and uncover barriers to effective instruction. For instance, students in bilingual settings often struggle to comprehend mathematical terms and processes when these are taught exclusively in languages they may not have full mastery (Jourdain & Sharma, 2016). Teachers, on the other hand, face difficulties in balancing the demands of MTB-MLE with curriculum requirements (Cabansag, 2016). Through needs analysis, these challenges can be documented, analyzed, and addressed through tailored interventions.

Moreover, the results of a needs analysis can inform teacher training programs within the Philippine education system. The current framework emphasizes the importance of equipping teachers with the skills to navigate multilingual classrooms. However, many teachers report limited training in implementing MTB-MLE effectively, particularly in mathematics (Abrea, Robles & Ortua 2020; Cabansag, 2016). Data gathered in this needs analysis can guide the design of professional development programs, focusing on strategies like translanguaging, which allows for the fluid use of multiple languages to enhance understanding.

In addition, the DepEd's thrust for quality education, encapsulated in the Sulong EduKalidad initiative, emphasizes the importance of addressing its four pillars, namely: K to 12 curriculum review and update; improving the learning environment; teachers' upskilling and reskilling; and engagement of stakeholders for support and collaboration (DepEd, 2020). Understanding the linguistic needs of mathematics classrooms supports this vision by ensuring that language policies are grounded in classroom realities, hitting all pillars of the Sulong EduKalidad.

Hence, this needs analysis is indispensable for understanding the linguistic practices and challenges in mathematics classrooms, particularly in the Philippine context. Since the country is multilingual, many students speak Filipino or regional languages at home, while mathematics is taught in English. This language gap can hinder learning, especially for those who are not proficient in English. This study then provides a systematic approach to addressing the interplay between language and mathematics education, enabling educators to create strategies that align with students' linguistic realities. By anchoring this analysis within the Philippine education framework, it becomes possible to bridge the gap between policy and practice, ultimately fostering a more inclusive and effective learning environment for Filipino students.

Method

Research design

This study employs an Exploratory Sequential Research Design (ESRD), a mixed methods approach commonly used in educational research to explore complex phenomena from multiple perspectives. ESRD follows a two-phase process that begins with qualitative data collection and analysis, which informs the development of quantitative instruments or further exploration in the second phase. The ESRD approach is well-established in educational research for its ability to combine the depth of qualitative insights with the breadth of quantitative data, offering a robust framework for investigating complex issues such as language use in mathematics education (Creswell & Clark, 2017). Through this design, the study aims to uncover valuable insights that will inform the development of effective, linguistically inclusive teaching strategies in mathematics classrooms.

Participants

This study focused on Grade 7 teachers and students, with a specific emphasis on those from Talavera National High School for the 2023-2024 school year. The participants in the Focus Group Discussion (FGD) consisted of five Grade 7 Mathematics teachers and ten Grade 7 students. The Grade 7 Mathematics teachers included in the study were selected based on their qualifications, ensuring they could provide valuable insights. Specifically, all five teachers hold a bachelor's degree in mathematics education and are all pursuing postgraduate studies. Their teaching experience, ranging from three (3) years to over a decade, allows them to share firsthand observations of students' language-related challenges in mathematics learning. Meanwhile, the Grade 7 students included in the study were selected based on specific qualifications to ensure diverse perspectives. The ten students were selected based on their participation and varying levels of English and Tagalog language use in solving mathematical problems. The students represented different academic performance levels, including high, average, and struggling learners, to provide a comprehensive understanding of how language affects mathematical comprehension. Their selection also considered their willingness to participate and share experiences, allowing the study to explore the role of translanguaging in making mathematical concepts more accessible and meaningful. The FGD aimed to explore how students utilized translanguaging strategies during problem-solving and classroom interactions. Additionally, the output of these ten students was analysed to understand how translanguaging influences their approach to solving mathematics problems.

In addition to the FGD, a survey was conducted with 454 Grade 7 students to gather data on the language used during classroom interactions and in solving mathematical problems. Students' perceptions on using English as a teaching language for mathematics were also investigated in the survey.

Assessments and measures

The study participants were interviewed using the interview protocol. To gain a comprehensive knowledge of the mathematics teachers' usage of translanguaging in the classroom, six questions were posed to them. The interviews were scheduled at a convenient time for the teachers, outside of class hours, to avoid class disruptions. Moreover, the interviews were conducted in the faculty meeting room to facilitate an unobtrusive, open discussion. With the participants' consent, the interviews were audio-recorded to ensure accurate documentation of responses. Additionally, field notes were taken to capture key observations and non-verbal cues. This systematic approach helped gather comprehensive insights into teachers' translanguaging practices in mathematics instruction. Meanwhile, the interview protocol for students also contains six questions which aimed to determine their classroom experiences in Mathematics class using translanguaging approach. Interviews were conducted in the school library and were scheduled after class hours to avoid interference with their academic activities. With parental consent and student approval, the interviews were audio-recorded to ensure accurate documentation of responses. Additionally, the researcher took notes to capture key insights and any non-verbal expressions. These interview protocols were checked and validated by different experts in the field of Mathematics and language. Data collection also included triangulation using different data sources such as field notes, analysis of students' work, and structured interview.

Meanwhile, the researcher used a 10-item survey questionnaire to find out how the students perceived the use of English as a medium of instruction in mathematics. The survey questionnaire developed was adapted and modified from the study conducted by (Noor, 2020). In order to determine the reliability of the modified questionnaire, the researcher conducted a reliability test to 26 Grade 7 students not included in the actual survey conducted and revealed a Cronbach's alpha of .810. This value indicates that the questionnaire developed has high level of internal consistency (Dalyanto et al., 2021) and suggests that the items in the questionnaire are consistently measuring the same underlying construct.

Data analysis

To ensure the accuracy and reliability of data interpretations, thematic analysis was employed to examine the responses from the interviews conducted. This method facilitated a structured understanding of the respondents' perspectives, allowing for the identification of key themes and patterns within their answers. Through thematic coding, meaningful insights were drawn from the participants' narratives, enabling a nuanced exploration of how language influences mathematics learning.

In order to find recurrent themes on the application of translanguaging in math classes, the interview responses were coded as part of the thematic analysis process. The coded responses were then grouped under the broader themes to provide an in-depth understanding of students' linguistic practices and challenges in the classroom.

On the other hand, the data collected through the survey questionnaire were analyzed using mean scores, providing a quantitative measure of students' perceptions and experiences. The survey questionnaire used a 4-point Likert scale: 4 (strongly agree), 3 (agree), 2 (disagree), and 1 (strongly disagree). Students' perceptions of English as a medium of teaching in mathematics were evaluated using this measure.

Results

A thorough explanation of the findings is given in this section, along with a detailed analysis of the conclusions drawn from both the qualitative and quantitative data. Through this discussion, the study aims to shed light on the key patterns and insights that emerged from the data, linking them directly to the research questions.

Teachers' linguistic practices in teaching mathematics

Interviews were conducted with five (5) math teachers who had varied numbers of years of teaching experience. Two of the participants had fewer than five years of teaching experience, while three have more than fifteen years of experience. Based on the interview conducted, all five teacher participants use Filipino as their first language and have capability in using English as it is a requirement for their undergraduate and graduate courses, hence, making them well-equipped of using both Filipino and English in teaching Mathematics.

As stated by one participant, "*Even from the start I am already using Filipino and English in teaching Math.*"

In teaching Mathematics, one participant indicated that they teach Mathematics the way they normally communicate with the students. "*I actually shift (*from one language to another, just like) *the way I talk to them. I teach Mathematics the way I normally communicate with them. So instead of saying credit I shift already as fast as I can in Filipino so they can understand the real meaning or real concept of negative and positive integers in real life situation and on that they really understand the lesson.*"

This was also the concept of other participants in teaching Mathematics. Whereas two teacher participants stated that since Grade 7 students still do not have strong grasp in the English language, the teachers need to teach the students using languages that they understand.

"*I am handling Grade 7 students so they often ask questions about the lesson. What I do is I shift from one language to another so I can explain Math terminologies and concepts in a more understandable way.*" one teacher indicated.

However, another respondent stated that she only uses certain Filipino words when teaching Mathematics. This include words that are not familiar to the students to enable them to make meaning to the discussion.

"I only translate *certain words ... for example when I explain the parts of the polygon, most of my students would not understand when I say the word "consecutive" ...so I need to say it in Tagalog first so they would understand what I am talking about.*"

However, during the class observations conducted by the researcher, it was revealed that all the teacher participants use Tagalong and English language sparingly in teaching Mathematics. Interviews on the students also revealed that teachers use both Filipino and English in all parts of the lesson when teaching Mathematics. Teachers skillfully navigated between and within modes, engaging in a dynamic and fluid languaging practice (Mackinney, 2022).They seamlessly integrated their existing linguistic resources into the teaching process, drawing on their language expertise to enhance classroom interactions and adapt to their students' needs. This approach allowed them to create a more inclusive and responsive learning environment, effectively bridging language gaps and facilitating deeper understanding of the material.

Teachers' perception on the effectiveness of their linguistic practices in teaching mathematics

All the teacher-participants agreed that teaching Mathematics using the combination of Filipino and English language is more effective since it enables students to express themselves freely. This results in a more active participation among students.

"*They are all active in participation. That's the effect of using Filipino and English in teaching Math, they understand the lesson more.*"

The use of translanguaging also helps Mathematics teachers to get the students attention. When the teacher uses translanguaging, it makes the lesson more relevant for the students which enables them to be more enthusiastic to listen and participate in the discussion.

One teacher answered, "*You have to use the language the students know to catch their interest. So you can hook them to listen to you. If they do not understand what you are saying, how would they be interested in listening to your discussion?*"

Building "homophily," or a sense of shared experience between teachers and students, is crucial in education. Research indicates that teachers' practices and interaction quality can significantly influence peer dynamics among students from diverse linguistic backgrounds. As discussed by Johnson et al. (2020), teacher-directed, classroom-level factors affect the formation of both same-language-status (bonding capital) and cross-language-status (bridging capital) friendships among students. This suggests that the language used in instruction can either facilitate or hinder the development of shared experiences between teachers and students. Employing a language familiar to learners enhances understanding and facilitates more effective communication (Shadiev, Chie, & Huang, 2020).

Ultimately, the use of translanguaging as discussed by the teachers improve students' Mathematics performance (Tai, 2022). When students understand the concept using the language they know, the students could easily grasp the lesson which also translates to their performance in class assessments.

As stated by one teacher participant, "*Using languages my students are familiar with, they can understand the lesson more, and this translates to higher score during evaluation because they can understand the concept, I teach better*."

"*When I teach using the languages they know, the lesson gets clearer for my students, and they get a higher score during quizzes*." another answered.

When math problems were discussed in a language students were familiar with, they demonstrated a significantly quicker response to math problems. This clearly shows that language is an inseparable part of mathematics (Wilkerson et al., 2022). Moreover, this phenomenon highlights the crucial role of linguistic familiarity in cognitive processing, particularly in problem-solving tasks. When mathematical concepts are communicated in a familiar language, individuals can focus more on the logical and numerical aspects of the problem rather than struggling to decode unfamiliar linguistic structures.

Moreover, the statement from one teacher "*Based on my experience, although the medium of instruction in Math is English, using Filipino and English, or the languages the students know can give a positive effect to students' Math learning, in building their confidence, and in helping them express their ideas properly*" clearly shows that the teachers strongly believe that the use of the language the students know should be promoted in Mathematics teaching and learning as this could really help in the overall development of students learning in the subject.

Students' linguistic demographics in mathematics

Classroom interaction

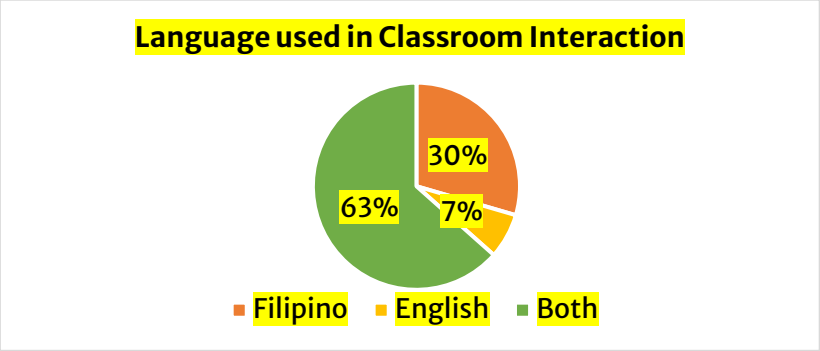

Figure 1. Linguistic demographics of students in mathematics in terms of classroom interaction

The linguistic demographics of seventh-grade students for mathematics classroom interaction are depicted in Figure 1, with an emphasis on the usage of either Filipino, English, or both languages. As shown, the largest segment of the figure indicates that a significant majority of students prefer using both Filipino and English during mathematics lessons. This bilingual approach reflects the students' comfort with translanguaging, where they can leverage their proficiency in both languages to better understand mathematical concepts and engage in classroom discussions.

To acquire a better understanding of how students interact in the mathematics classroom using Filipino and English, an FGD was conducted. As revealed by the students interviewed, two themes have emerged with regard how they interact with their teacher using Filipino and English.

Based on the students' interviewed, with regard their classroom interaction with their teacher, students feel that using both Filipino and English makes them more comfortable in the mathematics class. Since Mathematics is a difficult subject, using both Filipino and English in the discussion makes the students feel like they have the same wavelength as their teachers which makes the subject less intimidating. This gives the students the feeling that their teacher can relate to them.

As stated by one student "When my teacher uses pure English in teaching Math, I really feel nervous to answer her questions."

Another student similarly answered that "When my teacher uses Tagalog, I feel like we are on the same wavelength, and it removes the feeling that we are somehow beneath them. It gives us the feeling that we can treat them as a friend. When multiple languages are used, it feels less intimidating towards the teacher."

This clearly shows that the students feel more at ease when the teacher uses the language that they use in casual communication with others. According to Kioko (2015), when teaching starts in the languages the teachers' and learners know, the classroom experience was more natural and less stressful for all.

Meanwhile, with regard the students' interaction with their peers using both Filipino and English, students only stated that they feel comfortable in interacting with their classmates using both languages. As Filipinos, most students naturally speak in Filipino more often. Nonetheless, speaking in a combination of Filipino and English were more common in special sections. Students in higher sections communicates fluidly with their peers in both languages. However, students with lower academic performance only speaks in both Filipino and English when answering their teacher's questions but mainly use Filipino only when having conversation with their peers.

Solving mathematics problems

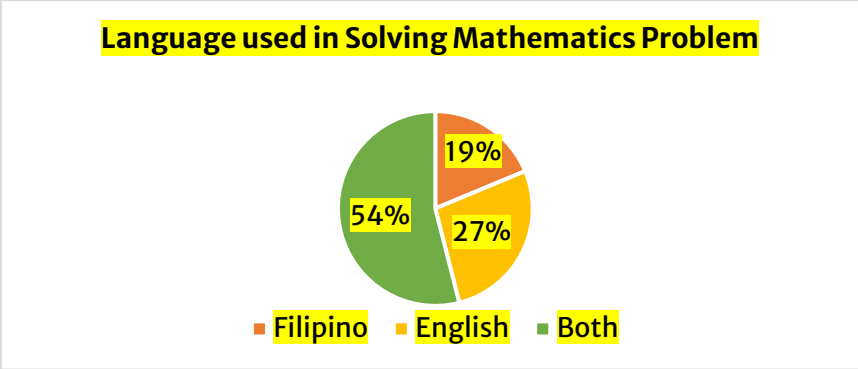

Figure 2. Linguistic demographics of students in mathematics in terms of solving mathematics problems

The students' linguistic demographics for solving mathematics problems are depicted in Figure 2, emphasizing the usage of English, Filipino, or a mix of the two languages. As depicted on the figure, the largest portion of the pie chart indicates that most students prefer to use both Filipino and English when solving mathematics problems. This bilingual approach highlights the importance of adopting translanguaging pedagogy to accommodate students' linguistic strengths and enhance their problem-solving abilities. By recognizing and leveraging the diverse language preferences in the classroom, educators can create a more inclusive and effective learning environment that supports all students in achieving mathematical proficiency (Faragher, Hill, Clarke, 2016).

To gain a thorough grasp of the students' use of both Filipino and English in solving mathematics problems, FGD among selected students was executed. Based on the FGD, in solving Mathematics problems, it is a common practice for students to just show their solutions and not actually write any explanation for their answers. This limits the students in using their language capability. In mathematics class, writing was not a typical habit outside of finishing examinations and quizzes. The students who were questioned stated that their math teachers seldom ever include note-taking or correcting assignments into their students' everyday routines. As a result, students hardly ever wrote in mathematics.

Nonetheless, when a teacher asked the students to write a reflection about what they have learned in the class, the students clearly leveraged their full language capacity in explaining what they have learned in the lesson. This practice is shown in the students' actual answer sheet as shown below.

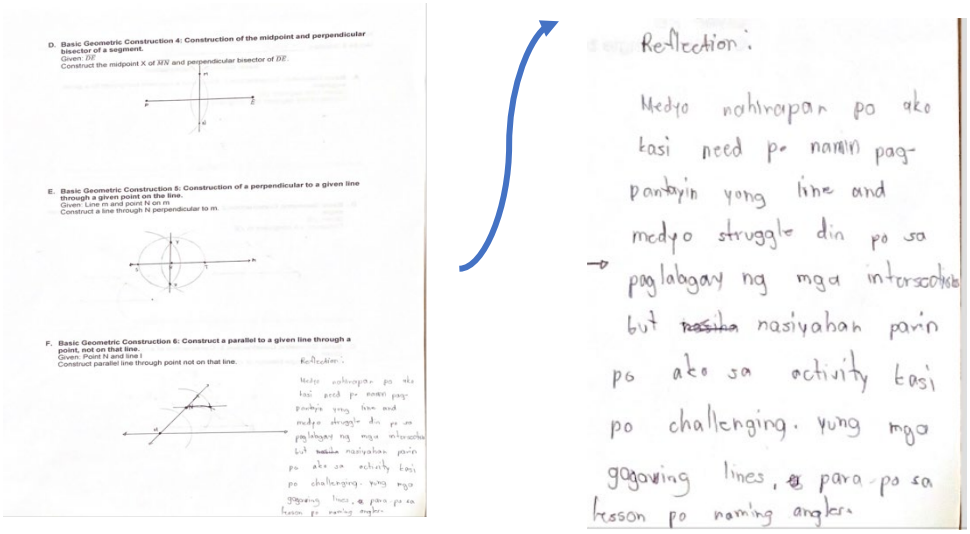

Figure 3. Student's output

Students' responses demonstrated the incorporation of vocabulary in answering their reflection. The students' answers reflected a combination of Filipino and English words. The English words used by the students as shown on their output are the mathematics terms which does not have equivalent term in Filipino. This revealed the impact of translanguaging in the mathematics setting.

Students' perception on the use of English as a medium of instruction in Mathematics

Table 1 displays the mean of the students' perception on the use of English as a medium of instruction in Mathematics.

Table 1. Mean and verbal interpretation of the students' perception on the use of English as a medium of instruction in Mathematics

Statements	SA	A	D	SD	Mean	Verbal Interpretation
1. English as a medium of instruction helped me increase my math proficiency.	76	327	40	11	3.03	Agree
2. English as a medium of instruction motivated me to learn Math more.	79	300	56	19	2.97	Agree
3. English as a medium of instruction made me more capable to participate in Math class.	69	286	78	21	2.89	Agree
4. English as a medium of instruction helped me understand Math easier.	81	317	42	14	3.02	Agree
5. I really like learning Math using English as the medium of instruction.	80	307	56	11	3.00	Agree
6. I can understand Math very well when teachers use English as a medium of Instruction.	54	270	99	31	2.76	Agree
7. I can easily absorb and process information in Math using English language.	58	261	103	32	2.76	Agree
8. I think it is important for my math teacher to speak English fluently.	63	218	106	67	2.61	Agree
9. I hesitate to ask for clarification when a math teacher use English as a medium of instruction.	66	216	107	65	2.62	Agree
10. Math should be taught in pure English as a medium of instruction.	31	214	115	94	2.18	Disagree
Overall Mean					2.78	Agree

As shown on the table, for the statement "English as a medium of instruction helped me increase my math proficiency", data gathered indicates students' agreement. Whereas, 327 students agree, 76 strongly agree, 40 disagree, and 11 strongly agree, receiving the highest mean rating of 3.03. Since English is commonly used in standardized tests and academic assessments, familiarity with it as a medium of instruction can help students perform better by minimizing language-related barriers (Civan, 2016). Furthermore, English proficiency is highly valued in higher education and professional fields (Aimen & Khadim, 2024). Acknowledging that strong English skills can enhance their academic and career prospects, students are encouraged to embrace English as the medium of instruction in mathematics.

However, despite the overall positive perception of English-medium instruction, a notable number of students (f=214) disagree with the idea that mathematics should be taught exclusively in English, followed by students who answered agree, strongly disagree, and strongly agree, with frequency of 115, 94, and 31 respectively. This disagreement highlights the students' desire to the inclusion of their native language (e.g., Filipino) alongside English (Melegrito, 2022). Integrating students' native languages alongside English in mathematics instruction can significantly enhance comprehension, particularly for those with limited English proficiency. Research indicates that English Language Learners (ELLs) often face challenges in mathematics due to language barriers, which can impede their understanding of complex concepts. By incorporating students' first languages into instruction, educators can make mathematical ideas more accessible, facilitating better learning outcomes. A meta-analysis by Sharma and Sharma (2023) highlights that effective teaching practices for ELLs in multilingual mathematics classrooms include the strategic use of students' native languages to support understanding and engagement. Additionally, Van Ryzin and Vincent (2017) found that the use of Native Language and Culture (NLC) in elementary and middle school instruction positively predicts mathematics achievement, underscoring the importance of culturally and linguistically responsive teaching methods. These findings suggest that incorporating native languages in mathematics education not only aids comprehension but also promotes equity and inclusivity in the classroom.

Nonetheless, the overall mean response of 2.78 verbally described as "agree" to the use of English as a medium of instruction in mathematics reflects a generally positive perception among students. While students recognize the benefits of English-medium instruction in enhancing their mathematical skills and proficiency, they also value the integration of their home languages into the learning process. This preference underscores the importance of translanguaging pedagogy, which leverages students' entire linguistic repertoire to create an inclusive and effective educational environment (Turner & Tour, 2024). Research indicates that incorporating students' native languages alongside English in mathematics

instruction can significantly improve comprehension and learning outcomes. For instance, Tai (2022) found that translanguaging practices in English-medium instruction science and mathematics classrooms facilitated better understanding among linguistically and culturally diverse students. Similarly, Thongwichit and Ulla (2024) highlighted that acknowledging students' first languages in English as a Foreign Language classroom fosters a more inclusive and effective learning environment. This preference for this instructional approach underscores the importance of translanguaging pedagogy, which leverages students' full linguistic repertoire to create an inclusive and effective educational environment.

Conclusions and recommendations

This study highlights several key insights in addressing the importance of language in mathematics teaching and learning. As revealed on the study, the teachers and students indicate a strong preference in leveraging both English and Filipino languages to optimize comprehension and engagement in mathematics classrooms. This preference underscores the potential benefits of translanguaging pedagogy, allowing students to utilize their entire linguistic repertoire, enhancing their comprehension of mathematical concepts. Thus, comprehensive research exploring its effectiveness, implementation, and impact on students and teachers is a must.

It was also uncovered that although the teachers recognize the benefits of translanguaging, it was found that teachers lack the idea with regard translanguaging pedagogy. This expresses the need for professional development to implement this pedagogy effectively. Thus, training in translanguaging strategies and techniques is essential for teachers to feel confident and competent in a bilingual or multilingual Mathematics teaching environment.

Moreover, the use of both languages in the classroom fosters a more inclusive environment, making students feel valued and understood. This inclusivity leads to higher levels of engagement, participation, and willingness to seek help, which are crucial for effective learning in mathematics. Thus, it is essential to develop a questionnaire which could capture students' perceptions and experiences with translanguaging. This will provide valuable data to inform instructional strategies, professional development, and resource allocation, ultimately leading to improved educational outcomes in mathematics.

Declarations

Informed consent

Informed consent for this study was obtained following ethical research standards to ensure that participants fully understood the nature and scope of their involvement. Before data collection, potential participants, including Grade 7 teachers and students from Talavera National High School, were provided with detailed information about the study. This information was delivered through a written consent form and an oral explanation to ensure clarity and address any questions. The consent form outlined the study's objectives, procedures, potential risks, and benefits. It also emphasized the voluntary nature of participation, assuring participants that they could withdraw at any point without any repercussions. For students, parental or guardian consent was also secured through a separate consent form, as they were minors. Teachers were approached individually, and their informed consent was obtained after addressing any concerns they had about their participation. The form also highlighted measures taken to protect participants' privacy and confidentiality, including the use of pseudonyms and secure storage of data. By signing the consent form, participants acknowledged their understanding of the study and agreed to take part in the research. This process ensured that all participants were informed and comfortable with their involvement in the study.

Availability of data and materials

The data and materials used in this study are not publicly available to protect the privacy and confidentiality of the participants. However, the datasets generated and analysed during the current study may be made available by the corresponding author upon reasonable request, subject to the approval of the ethics committee and in compliance with data protection regulations.

Competing interests

No potential conflict of interest was reported by the author(s).

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Authors' contributions

Princess A. Garcia: Conceptualization and writing, Lydia S. Roleda: Review and supervision.

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