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Assessing the educational needs of Philippines' indigenous Kalinga teachers and students in mathematics: Insights for researchers and policymakers

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ABSTRACT

Society 5.0 and the post-pandemic trends in mathematics education have presented significant challenges, especially to the teachers and students of indigenous communities. Because of the uniqueness of these groups, different studies present varied ways of addressing problems particular to a certain group. Through an Exploratory Sequential Research Design (ESRD), this study identified and analysed the challenges encountered by the Philippines' Indigenous Kalinga teachers and students in mathematics education with the goal of recommending evidence-based solutions to address emerging issues. The primary qualitative phase consisted of a presentation of the general landscape of teacher education and education in the community obtained from a systematic review of pertinent literature and records. Zooming in, a focused view of the Kalinga teachers and students was achieved through 2 focus group discussions integrated with a semi-structured interview. The secondary quantitative phase was subsequently conducted through the measurement of the teachers' TPACK skills and students' learning engagement. The results from both phases showed that the teachers are challenged to equip themselves with various technological resources, misalignment of instruction with the mandated framework, a mismatch between the teacher education program courses and the expected mathematical content knowledge for teachers, and a lack of pedagogical understanding regarding the interplay of culture and technology. For students, their emotional and social engagement is limited, affecting their overall engagement in learning mathematics. In the integration phase, practical solutions for how teachers can effectively integrate cultural elements into the design of technology-based instructional materials, such as authoring tools, are presented. By implementing these recommendations, we anticipate significant improvements in students' engagement in mathematics from the teachers' transformed pedagogical practices that conform to current trends.

Introduction

Central topics of educational research are the assessment of teachers' pedagogical needs, the learning prerequisites of students, and the availability of teaching and learning resources (Karampelas, 2021; Yig, 2022). For this reason, numerous studies have delved into these areas, proposing solutions to many educational challenges, which are focused primarily on formal education. These studies predominantly address issues such as student motivation and teacher instructional techniques within classroom settings. While these factors significantly contribute to advancing general education and enhancing teaching and learning processes, a crucial aspect warrants attention—namely, the inclusion of students and educators from Indigenous communities. In particular, assessing their needs, from where research could be conducted and solutions could be recommended, could promote their context of education and their community. This inclusive approach is essential for fostering equity and ensuring that educational opportunities are accessible to all (Alangui, 2017; Freire et al., 2020; Reyteran, 2021).

In the Philippines, education is for all students who are taught by licensed teachers regardless of their cultural background. Thus, Indigenous students are mainstream in a regular mathematics classroom, while Indigenous teachers deliver lessons using teaching strategies prescribed by the Department of Education (DepEd) for public schools (DepEd, 2021). This raises concerns about the contextualization of mathematics instructions and where students' learning is situated. On the basis of the guiding Framework for Philippine Mathematics Basic Education, mathematics should develop among Filipino students the ability to make mathematical connections with their environment and other aspects of their lives (Science Education Institute-Department of Science and Technology [SEI-DOST] & Philippine Council of Mathematics Teacher Education [MATHTED] Inc., 2011b). Cultural identity plays a crucial role in this process, and teaching strategies should be tailored to the context of IP learners to increase their ability to make connections. This is among the many challenges that both Kalinga students and teachers face in education that undoubtedly affect the performance of IP students in mathematics education (Hortelano & Lapinid, 2024). Thus far, little research has been conducted investigating these problems and additional challenges experienced by the community in education. In particular, as the landscape of education has drastically changed since the pandemic, further challenges are expected and should be investigated.

A needs analysis is one method that explores these problems and challenges, which is necessary to highlight what should be improved and addressed as pressing issues. According to McKillip (1987), this decision-making process is designed for human services and education and is applicable to diverse decision types, such as the allocation of funds and planning strategic techniques. Early studies on needs assessment in education highlighted the importance of language education in identifying the requirements of teachers and students for language learning (Kaya, 2021; Ulla & Winitkun, 2017). In mathematics education in particular, Asrowiah et al. (2021) applied needs analysis to explore the needs of teachers and students during the COVID-19 pandemic. Accordingly, needs analysis offers critical insights that can guide policymakers and educators in drafting educational policies and practices to better meet students' evolving needs. In the same context as the current study, we could provide a better understanding of the needs of IP students and teachers of Kalinga, which encompass several domains in mathematics education, such as depth of content knowledge, adequate and appropriate resources, and the nature of institutions serving their cultural context (Alangui, 2017; Gay, 2002; Koehler et al., 2013). On the basis of these findings, we aim to provide recommendations for educational policymakers and proposals for researchers to address these problems and meet the identified needs of the target community. This could pave the way for enhanced teacher education programs and a more supportive learning environment for IP students in the province.

Setting the pace for needs analysis: What is required for Philippine mathematics teachers and students?

In conducting a needs analysis, it is essential to understand the intricacies and the framework of such a research process. A framework of the needs analysis is presented in this section, which elucidates the systematic approach taken to evaluate the requirements of students and educators within the designated community vis-à-vis the cultural community.

A need emerges as a result of unmet expectations or problems. As per McKillip (1987), needs within the context of needs analysis represent "value judgments" stemming from a problem a specific group faces, which initiates acknowledging potential solutions among the members of the group. It is also linked to insufficient resources and available corrective measures to address this problem. It exhibits variations across different groups, circumstances, and communities, each adhering to distinct values. The purpose of conducting a needs analysis, sometimes referred to as a needs assessment, is to mitigate unforeseen expectations and facilitate decision-making for effective planning. This is particularly crucial in the field of education, where planning plays a vital role in program implementation, which encompasses aspects such as curriculum development, proposed teaching strategies, and teacher development programs (Freire et al., 2020).

Given the understanding of a need, it is also necessary to gather information on what is expected from mathematics teachers and students in the Philippines. As per the Framework for Philippine Mathematics Teacher Education (SEI-DOST & MATHTED, 2011a), mathematics teachers in the country are envisioned to be fully competent by displaying four components in their classroom practice: Mathematics Content Knowledge (MCK), which talks about the knowledge of teachers of mathematics lessons; Mathematical Pedagogical Knowledge (MPK), which is the knowledge of different classroom teaching strategies, including assessments and application of learning theories; General Pedagogical Knowledge and Management Skills (GPK & MS), which pertains to teachers' understanding of the student development, attitudes, and the general teaching strategies; and, Mathematical Disposition and Professional Development (MD & PD), which specifies the development of the affective domain among teachers. However, these components do not completely outline the technological competency of teachers in the post-pandemic era as they do not include the technological aspect of teaching but rather integrated within each component. For example, principle 8 of the Framework states, "Technology plays an important role in teaching and learning of mathematics. Mathematics teachers must learn to use and manage technological tools and resources as well" (p.7). With this, it is necessary to acknowledge teacher's knowledge and their use of technological resources, especially as the context of education is moving toward modernization, a key characteristic of Society 5.0. In addition, they are also expected to be at least 'Accomplished' teachers from the four levels: novice, emerging, accomplished, and expert. This implies that they should employ effective teaching strategies and be knowledgeable and flexible about content, pedagogy, and classroom management (SEI-DOST & MATHTED, 2011a). Through principles 7 and 9 in Table 1, the Framework also underscores that Filipino teachers should never stop learning. As mathematics is constantly evolving, they should adapt their teaching methods and continuously update their teaching approaches to reflect the latest developments in the field, such as various technological resources.

The Technological Pedagogical and Content Knowledge (TPACK) is a framework that describes the teachers' use of effective technology in teaching (Mishra & Koehler, 2006). However, this is not specified as one of the components of the Framework despite the emphasis that teachers should familiarize themselves with the different technological resources in teaching and how to integrate them appropriately. This affects the expectations made of Philippine mathematics teachers regarding the utilization of technological resources as an integral component of their teaching practices.

For students in a mathematics classroom, there is a strong demand that they should enjoy learning mathematics and consequently build mathematical connections in their environment (SEI-DOST & MATHTED, 2011a, 2011b). Both the Framework and the Mathematics Framework for Philippine Basic Education of 2011 emphasized these through the aforementioned principles. Specifically, principle 3 implies that Filipino students learn mathematics more effectively when they actively participate in the learning process. They should be involved in hands-on activities, problem-solving tasks, and discussions that allow them to explore mathematical concepts, ask questions, and apply their knowledge in meaningful ways. In addition, principle 5 advocates for an inclusive learning environment where all students are provided with the resources and support they need to succeed in mathematics, free from discrimination or bias.

Table 1 The 9 teaching principles outlined in the Framework for Philippine Mathematics Teacher Education

Principle 1	While the ability to explain and solve a problem is evidence of good understanding of some mathematical ideas, teaching mathematics requires much more than these
Principle 2	Mathematics must be real to students and therefore, mathematics teacher should be mindful of students' contexts when teaching mathematics
Principle 3	Mathematics is best learned when students are actively engaged
Principle 4	Mathematics can never be learned in an instant, but rather requires lots of work and the right attitude
Principle 5	All students regardless of sex, culture, socio-economic status, religion and educational backgrounds have the right to learn and be taught good and correct mathematics
Principle 6	Assessment mist be integral part of mathematics instruction
Principle 7	Mathematics as a field continues to develop and evolve. Therefore, the teaching of it must keep up with developments in the field
Principle 8	Technology plays an important role in teaching and learning of mathematics. Mathematics teachers must learn to use and manage technological tools and resources well
Principle 9	Mathematics teachers must never stop learning

These principles reflect how mathematics can shape Filipino students and contribute to the responsibility expected from Filipino teachers. In addition, it emphasizes learning engagement as an integral component of learning mathematics. Reschly and Christenson (2012) define engagement as "the glue, or mediator, that links important contexts to students and, in turn, to outcomes of interest" (p.3). Leis et al. (2015) characterize engagement in educational contexts through three distinct dimensions: social, emotional, and cognitive. Social engagement revolves around student interactions and communication, focusing on discussions about mathematics lessons and collaborative learning activities. Emotional engagement reflects the affective aspect of learning, measuring students' interest, enthusiasm, and enjoyment in engaging with the lesson content. Finally, cognitive engagement assesses students' effort and persistence when solving complex problems, indicating their commitment to deeply understanding the subject matter (Fredricks et al., 2004; Patrick et al., 2007).

Interplay of technology and culture and how it is beneficial for teachers and students belonging to the Indigenous communities

In the context of Indigenous communities, culture and technology can be seen as binary oppositions (Battiste et al., 2002). The former can be interpreted as primitive and backward to modern and scientific practices, and the latter entails modernity and dynamism brought by scientific advancement (Fuschi et al., 2008; Rosa & Orey, 2018). Despite various technological developments, culture continues to be relevant for the members of cultural communities, whereas technology continues to play a vital role in society as a whole. Education is one of the fields affected by both influences. Culture has always been influential in educational affairs and has shaped different aspects of education, such as values and ethics (Gay, 2002; D'Ambrosio, 1985). According to Rosa and Orey (2016), it is an important concept that humanizes the educational process, especially mathematics. Culture fosters healthy communication and respect for diversity in education. Technology, on the other hand, enhances productivity and streamlines workflow. For example, in education, teachers can compute grades faster using computing software and streamline feedback to various students through Learning Management Systems (LMS). In addition, the rise of e-learning and authoring tools to design teaching and learning resources is shaping the ways teachers and students learn in this era (Karoui et al., 2020). This has resulted in a shift in instructional materials and teaching strategies from traditional to the latest trends, strengthening the need for teachers to adapt to these changes. This could alter the importance of culture in education and become less relevant in an automated learning environment (Battiste et al., 2002). Thus, the need for research to focus on how culture can coalesce with technology should be emphasized.

Technology integration in education has its roots in training professionals in the transportation sector and language learning (Fuschi et al., 2008). According to Fuschi et al. (2008), the inherent ability of technology to store large amounts of information accounts for its benefits for teachers and students. It is also beneficial in the production of educational content and resources. With respect to culture, technology is a means to disseminate cultural elements, such as printout materials, and makes these elements accessible to different audiences. In mathematics education, there are yet to be more contributions to how the coalescence of culture and technology could enrich teachers' practice and students' learning (Sudirman et al., 2020).

Setiana (2019) and Sudirman et al. (2020) are two studies that explored the intersection of culture and educational technology, particularly within the domains of mathematics education through ethnomathematics. As society has progressed into the era of Society 5.0, which is characterized by rapid technological growth and the emergence of artificial intelligence (AI), preserving the humanization of mathematics becomes crucial. This entails nurturing culturally relevant pedagogies to ensure that students remain connected to their cultural heritage. Integrating ethnomathematics into education serves as a means of grounding students and teachers in their ancestral domains, which reinforces ethical and moral values amidst the technological advancements surrounding them (Setiana, 2019). Moreover, the integration of culture and technology can enhance students' motivation and comprehension in learning mathematical concepts (Sudirman et al., 2020).

While there are studies that address the expectations of Filipino students and explore the interaction between their culture and technology, there is none specific to the Indigenous communities. For example, there are no studies on Kalinga teachers and students regarding their TPACK skills and learning engagement needs, respectively. This study seeks to bridge that gap by identifying their specific needs, designing targeted interventions, and developing a proposal focused on their development. This approach aligns with the criteria outlined in the DOST-SEI and MATHTED (2011a) Frameworks, ensuring that the proposed interventions support the seamless integration of technology in education while preserving the cultural identity of the Kalinga community.

To achieve this goal, this study offers a needs analysis focusing on two aspects: teachers' TPACK and students' engagement in learning mathematics. Furthermore, the analysis encompasses several key objectives: (1) systematically reviewing previous studies and records that are relevant to the study's objectives to glean insights and build upon existing knowledge; (2) providing a detailed description of the selected cultural community, elaborating on its unique characteristics and educational context; (3) conducting interviews with teachers and students to gather firsthand perspectives and insights; (4) assessing the level of TPACK among Kalinga teachers to identify areas for improvement and support; and (5) evaluating students' engagement in learning mathematics within the cultural context of Kalinga and highlighting factors that contribute to or hinder their learning experiences. Through this needs analysis, we aim to propose evidence-based strategies and recommendations that address Kalinga teachers’ and students' specific needs and challenges.

Method

Research design

The needs analysis employed an Exploratory Sequential Research Design (ESRD). This research design starts with qualitative data collection and analysis, which is the primary phase, followed by quantitative data collection and analysis, the secondary phase (Cresswell & Plano Clark, 2011). The findings from both phases are then integrated or linked to provide comprehensive insights (Berman, 2017). In general, exploratory research is used to investigate research problems that have not been previously studied or problems that must be defined more precisely to gain a better understanding. Furthermore, it is utilized when identifying issues and may not end with conclusive remarks but rather uses the findings as leverage for future research projects (Cresswell & Plano Clark, 2018; Shukla, 2008). In this study, it has been established that no prior needs analysis has specifically addressed the context of Kalinga elementary teachers and students, which leaves additional issues yet to be explored. Thus, ESRD offers the essential design to gather both qualitative and quantitative data and their interaction to analyze problems and needs. Consequently, we offer insights to researchers and policymakers for future educational policies and research projects.

Data collection procedure

ESRD considers primary and secondary types of data (Shukla, 2008). Primary data are directly collected by researchers from participants, whereas secondary data refer to information that already exists, such as that found in previous literature. The following subsections describe the five-step process of needs analysis utilized in the study (McKillip, 1987). We also integrated in these steps the collection of both primary and secondary data.

Identifying users and uses

This was the first step of the analysis, wherein users were identified, as were the uses of the analysis. McKillip (1987) refers to users as those who make decisions based on the analysis report. Here, we aspire that our users include researchers, teacher educators, and policymakers from DepEd who work on studying and implementing teacher and student development programs.

Describing the target population and service environment

Teachers and students within cultural communities constitute the ideal demographic and research setting for the goal of the needs analysis. Thus, the study utilized purposive sampling to select teacher and student participants for the analysis.

The criteria for selecting teacher participants included being a mathematics teacher at the basic education level, belonging to the Kalinga community, and possessing at least one year of teaching experience within the province. This criterion aimed to ensure the teachers' familiarity with the educational context of the province. The student participants needed to be enrolled at the basic education level, be members of the Kalinga community and demonstrate the ability to comprehend the interview questions. Consequently, we were able to invite 14 teachers and 30 students. The teacher participants consisted of 1 male and 13 females, with 2 master teachers and 12 classroom mathematics teachers. We enlisted the expertise of the master teachers to gather supplementary insights crucial for our needs analysis. The student participants included 8 males and 22 females, with 14 coming from Grade 5 and 16 from Grade 6, ensuring their qualification of the criteria. Additionally, we invited one teacher educator from a university in Kalinga to determine the program for teacher education in the province.

Identifying needs

This step is divided into three parts: the primary qualitative phase, the secondary quantitative phase, and the integration phase (Berman, 2017), which are necessary for determining the problems in the research setting and describing potential solutions. In each phase, we utilized different research instruments to gather secondary and primary types of data.

For the primary qualitative phase, the following data collection is conducted: (i) a systematic review examining previous studies to assess the fulfillment of requirements for Philippine mathematics teachers, particularly those serving the IP community, and whether these requirements are being met. McKillip (1987) characterizes this as a discrepancy problem, which occurs when there is a disparity between the expected outcome and the actual occurrence. Recent research findings from the previous literature are also incorporated into the analysis; a semi-structured interview during the Focus Group Discussion (FGD) to determine teachers' challenges, including the use of varied technological resources in teaching mathematics. Teachers, researchers, and master teachers participated in this process. Two sessions of FGDs were conducted: the first focused on administering the interview protocols and questions, which lasted for almost two hours, whereas the second involved discussing and confirming the results, which lasted for exactly one hour. (iii) A semi-structured interview with a teacher educator to determine the program for elementary teacher education in the province and an analysis of a sample Transcript of Record from the said program.

The secondary quantitative phase is conducted through the following steps: (i) dissemination of the TPACK instrument adapted from Lorenzana and Roleda (2024). Specific words were changed to put the instrument in the context of mathematics education; (ii) Dissemination of the instrument measuring student engagement in mathematics learning that assesses emotional, social, and cognitive engagement, which was adapted from Leis et al. (2015). The items were translated into their mother tongue to ensure comprehension among IP students.

For the integration phase, the results from the qualitative data and quantitative data collection were discussed, primarily focusing on how the quantitative data can be used to explore the qualitative findings. Consequently, needs were identified, and potential solutions were proposed based on the results gathered from the instruments.

Assessing the importance of the needs

Once problems and needs and their corresponding solutions are identified, an assessment of needs follows, guided by several reflective inquiries: Which issues are of utmost significance to the target population? Which ones hold the highest relevance for education policymakers and future research? Are there conflicting factors that necessitate consideration and resolution? These inquiries were essential for accurately evaluating the proposal's relevance for all the users involved.

Communicating results

This marked the final stage of the needs analysis, wherein findings were disseminated and communicated to the participants and pertinent audiences. Additionally, these results may be shared with the academic community, serving as a foundation for further analysis within their respective contexts. Despite being the concluding step, the needs analysis process is iterative, involving reflections after each proposal implementation.

The scope of this study encompassed a single cycle, spanning from identifying needs to formulating a proposal and sharing it with teachers in the province of Kalinga, Philippines.

Data analysis

Data from the primary qualitative phase were analysed via narrative analysis (Figgou & Pavlopoulos, 2015). This combines the results from the secondary data (i.e., review of previous literature and Transcript of Records) and primary data (i.e., FGD and interviews) to construct an organized storyline. Before the narrative analysis, the results of the FGD were analysed via thematic analysis (Nowell et al., 2017), wherein the teachers' recorded responses were transcribed and coded. Themes were generated based on the similarities and relationships between codes. Then the results were then integrated into the broader analysis to enrich the narrative.

Table 2 Sample coding from the thematic analysis

Theme	Description	Sample transcript translated in English (short labels)
No technological resources	Teachers do not use technological resources in their classroom mathematics	"I do not use computers in my math class" (No technological resources [TR])
Minimum technological resources	Teachers use a few technological resources in their classroom mathematics and use only basic functions	"I do not know how to use computer like making PowerPoint presentations" (No TR) "The school do not have enough resources" (Lack resources) "I am more comfortable using chalk and board" (Choice) "I use PowerPoint presentations sometimes, but I do not know other tools to use" (Minimal use) "I only use Microsoft Word and PowerPoint. I do not know how to use Excel" (Minimal use) "I know how to turn on a laptop. Type documents and print using a printer but I do not know how to make presentations in PowerPoint" (Minimal use)

In the secondary quantitative phase, the data from both the TPACK and engagement instruments were analyzed using descriptive statistics, particularly mean and standard deviation. The TPACK instrument employed a frequency scale as follows: 5 - Strongly Agree (SA), 4 - Agree (A), 3 - Neither Agree nor Disagree (N), 2 - Disagree (D), and 1 - Strongly Disagree (SD). The engagement instrument used a different frequency scale: 3 - 'I always do this,' 2 - 'Sometimes I do this,' and 1 - 'I never do this.

To ensure the trustworthiness of the data analysis, both data triangulation and member checks were employed. Triangulation is one of the key principles of conducting mixed methods research and serves as a test for the credibility of the data (Rubia-Avi, 2023). That is, the qualitative data should yield results that are consistent with the quantitative data. In addition, member checks were performed by presenting the results to the mathematics classroom teachers and master teachers for confirmation of the data collected during the initial FGD (Thomas, 2006). This process was carried out in the second FGD, where the topics included a discussion of the results from the first FGD and the results of students' learning engagement in mathematics. The results of the analysis from the Transcript of Record were also confirmed by the teacher educator.

Results

In this section, we present key findings derived from conducting ESRD. First, we present the results of the narrative analysis from previous research studies and the FGD, which elaborates on the background and challenges encountered by the teachers in their mathematics classroom. We subsequently present the results of descriptive statistical analyses concerning Kalinga teachers' TPACK and Kalinga students' engagement levels in learning mathematics. We further discuss the results by linking the results gathered from qualitative and quantitative data.

The context of Kalinga mathematics teachers and students

The Indigenous community of Kalinga is one of the various Indigenous communities in the Philippines situated in the northern parts of the country, particularly in the Cordillera Administrative Region (CAR). The Kalinga people are known for their valor and unique culture, from folklore music to traditional fashions. They boast a heritage untouched by foreign influence in their early history, which fosters a strong sense of community and cultural preservation. Given the rich history and cultural practices of the province that set them apart from other communities, these are not much observed or reflected in their educational context, specifically in mathematics education. This disconnection underscores a significant gap between the heritage of Kalinga and the educational framework within the locality (Hortelano & Lapinid, 2024).

In the province's capital, three local universities and colleges offer teacher education programs that cater to both elementary and secondary levels. Among these institutions, one of them predominates, and a significant proportion of aspiring educators graduate annually. Like other teacher education programs of other institutions across the country, pre-service teachers have a minimum of four years to finish— three years of academic and one year of in-campus and off-campus practice teaching. It is expected that at the end of the four-year program, each of them should be competent in delivering instructions that are responsive to the needs of their students and committed to the teaching profession, as stated in their college objectives and reiterated by the teacher educator. However, unlike their counterpart program (i.e., graduates of secondary teacher education), pre-service teachers at the elementary level specialize in general education. This implies that elementary pre-service teachers do not concentrate solely on one subject, such as mathematics or biology, but rather receive a broader education across all subject areas. In reviewing the course offerings through a sample Transcript of Record, 39 units were allocated for all the sciences— 18 units of which were only mathematics courses. This number is very low compared to the 57 units of mathematics courses for secondary pre-service teachers. This deficiency in content specialization impacts the preparedness of elementary pre-service teachers, particularly in their content knowledge and domain of mathematics instruction. They struggle to attain the requisite depth of expected content knowledge, as outlined in the frameworks by SEI-DOST & MATHTED (2011a). Consequently, this mismatch underscores the urgent need for reform in elementary teacher education programs to ensure that graduates are adequately equipped to meet the demands of a Philippine mathematics classroom.

Pre-service and in-service elementary mathematics teachers are expected to achieve proficiency in mathematics topics taught at Grade 10 or 11 levels, as outlined in the Most Essential Competencies (MELCs), particularly focusing on subjects such as probability and calculus (see Figure 1). This is problematic as the probability course is not included in the course offering for pre-service elementary teachers. There is, however, a calculus course, but it is merely an introductory subject, which does not suffice the intended mathematical competency level espoused in the Framework for elementary teachers. Consequently, the required topics for them to master are complex and advance to their current level. This specific finding from the analysis highlights a critical discrepancy that demands attention. Furthermore, findings from Hortelano and Lapinid's (2014) study indicate that elementary teachers in Kalinga exhibit deficiencies in MCK, attributed to insufficient teacher training programs essential for their ongoing professional development.

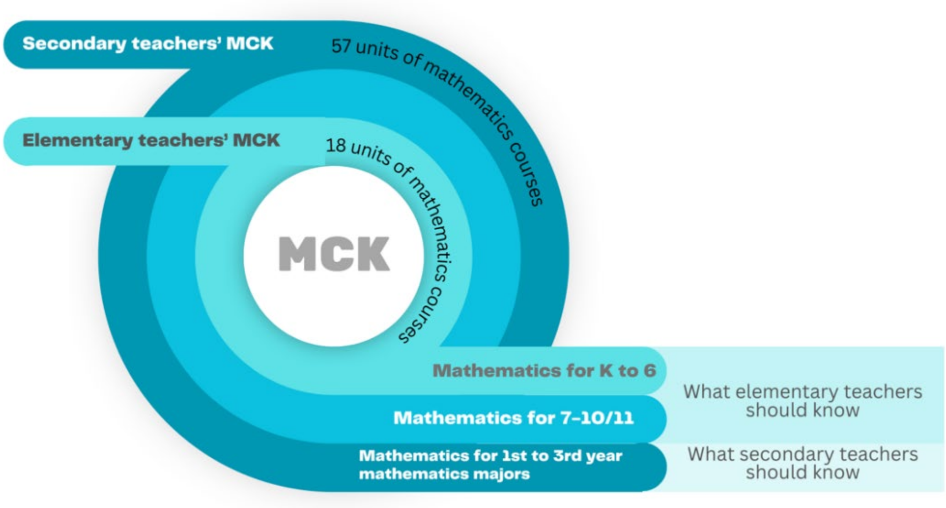

Figure 1 Expected MCK for elementary and secondary teachers and the proportion of mathematics units between elementary and secondary

In pedagogical courses, the institution provides elementary pre-service teachers with a comprehensive curriculum comprising 66 units of professional education courses. These courses are designed to equip them with the necessary skills to deliver effective instruction tailored to the needs of their students, with a significant emphasis on educational psychology. Within this curriculum, six units are dedicated to educational technology, aligning with contemporary teaching methodology trends and enhancing teachers' technological literacy. Consequently, it is anticipated that pre-service teachers should possess a minimum level of computer literacy (i.e., TPACK) to integrate technology effectively into their teaching practices, thereby preparing them to adapt to the demands of Society 5.0 and the Framework's principle 8 regarding technology use (SEI-DOST & MATHTED, 2011a).

In terms of cultural factors in the elementary teacher education program, only three units account for indigenous knowledge, which is a special topic offered in the last year of the program. In addition, no courses allow them to prepare for Culturally Responsive Teaching (CRT), which is necessary for the context of Kalinga students. This deficiency results in a limited understanding among teachers of how to effectively incorporate cultural elements into their teaching methodologies, especially in mathematics, where the context of CRT is most studied (D’Ambrosio, 1985; Gay, 2002). As highlighted by Gay (2002), CRT represents a pedagogical framework known to enhance students' motivation and engagement, particularly in mathematics education. An effective strategy to achieve this is through the integration of ethnomathematics, a concept pioneered by Ubiratan D’Ambrosio in Brazil, which is explicitly conceptualized to address the educational needs of IP students and provides teachers with sustainable instructional resources to serve diverse cultural backgrounds better (D’Ambrosio, 1985). Despite the recognized benefits of integrating cultural perspectives into classroom instruction, elementary teachers in Kalinga continue to rely heavily on nationally disseminated textbooks and materials that often lack elements of CRT (Hortelano & Lapinid, 2024).

For students, the Framework underscores their active involvement and quality of mathematics learning regardless of their cultural background (SEI-DOST & MATHTED, 2011a, 2011b). They are expected that as they progress from Kindergarten to Grade 6 (i.e., the end of the elementary level in the Philippines), their MCK and comprehension of mathematics lessons should also progress. Like in other schools, the elementary students of Kalinga are taught using the K to 12 mathematics curriculum, from grades one to six, to be exact. As espoused on MELCs, they start learning whole numbers as they begin their first grade and experimental probability by the time they finish sixth grade. In each quarter of the school year, they are taught different mathematics: number and number sense for the first quarter, operations and algebra for the second quarter, geometry for the third quarter, and statistics and probability for the fourth quarter, with increased difficulty as they progress to the grade level. While this is a structured curriculum for the IP students of Kalinga that conforms to national standards, it still lacks the elements of CRT.

In the province of Ifugao, not far from Kalinga, the Gohang National High School is a unique institution dedicated to IP students and teachers. Diverging from the national K to 12 curriculum, the school's educational framework is woven with Ifugao culture, particularly centered around rice farming practices. Their four quarters are organized on the basis of the local farming season, locally termed *Ahitulu*, *Iwang*, *Lawang*, and *Tiyargo*, which is implemented to preserve the ancient tradition of rice terracing, a hallmark of Ifugao's cultural heritage (Alangui, 2017). This approach imparts academic knowledge and nurtures a deep connection to local customs and identity. This model serves as a compelling example for the education system in Kalinga, suggesting the importance of integrating indigenous cultural practices into the curriculum to preserve heritage and empower students to play an active role in preserving culture. Aside from MELCs and the two Frameworks, this allows teachers, students, and local DepEd authorities to abide by the National Indigenous Peoples Education Policy Framework, which highlights the rights of IPs toward quality learning and the utilization of the Indigenous Knowledge Systems and Practices (IKSP) (DepEd, 2011).

Kalinga teachers’ use of technological resources: no resources vs minimum resources

When asked about the challenges that teachers experience in their utilization of technological resources, two themes were formed: no resources at all and minimum integration of these resources. Most of the teachers indicated that they are not utilizing any technology in teaching mathematics because of insufficient technology literacy and knowledge of the various software available in teaching mathematics. These teachers are not trained to operate computers in their college days and are rarely required to attend training about computer literacy, as these are also limited.

For teachers who integrate minimum technological resources in their mathematics instruction, they mentioned their proficiency in designing and developing lessons via Microsoft PowerPoint. Additionally, they utilize this software to design assessment tasks for their students. Nevertheless, this raises a pertinent question: does possessing adept PowerPoint skills equate to possessing sufficient TPACK? According to Mishra and Koehler (2006), teachers should possess relevant knowledge of various educational technologies, ranging from low-tech tools such as paper and pencil to high-tech software applications. In this sense, having proficient skills in PowerPoint does not encompass the breadth of TPACK required for effective teaching. These limitations significantly influence teaching practices, particularly in mathematics instruction, and can shape how teachers motivate their students to learn. As articulated by Teacher 13:

"Lack of technological resources affects my performance as a teacher because some of my students today can easily understand the lesson using technology, so the teaching and learning process is well achieved if there is a computer or laptop."

Moreover, as the master teachers noted, the principal barriers hindering the development of computer literacy among the teachers are the absence of a reliable internet connection due to weak signals, insufficient funds to procure necessary resources, and a lack of proficiency in operating educational technologies. Furthermore, the geographical location of the elementary schools, which are predominantly situated in remote and mountainous areas of the province, exacerbates these challenges.

Measuring Kalinga elementary teachers' TPACK

In this subsection, we present the outcomes derived from evaluating the TPACK of the teacher participants. Table 3 offers a summary of the assessment results, explaining the current proficiency levels of the teachers in terms of integrating technology, content, and pedagogy altogether and exploring what was derived from the qualitative phase.

Table 3 Results of assessing Indigenous teachers' TPACK

Items	Mean (M)	Standard Deviation (SD)
I can design lessons that appropriately combine technology and teaching strategies on particular mathematics concepts.	3.21	0.58
I can teach lessons that appropriately integrate technologies and teaching strategies on particular mathematics concepts.	3.5	0.65
I can use technology to teach mathematics effectively using various teaching strategies.	3.29	0.47
I can select appropriate technologies that can simplify mathematics concepts to enhance how I teach and what the students learn.	3.01	0.47
I can design engaging learning activities that appropriately combine technologies and teaching strategies on particular mathematics concepts.	3.21	0.57
I can design individual or collaborative performance tasks that use technology to show, apply, and/or solve mathematics-related problems.	3	0.68
I can evaluate the student's performance and understanding of mathematics using appropriate technologies and assessment strategies.	3.36	0.63
Overall	3.23	0.59

Overall, the teachers responded within the "neither agree nor disagree" category (M= 3.23, SD= 0.59) on the five-point Likert scale vis-à-vis their TPACK in mathematics instruction. This response implies uncertainty regarding the items assessed in the instrument (Baka & Figgou, 2012). Consequently, teachers are uncertain regarding their capacity to effectively integrate technological resources across various facets of teaching mathematics, including designing teaching strategies, conducting specific mathematics lessons, implementing assessment strategies, and orchestrating learning activities. This confirmed what was predetermined during the FGD session in the primary qualitative phase with the teacher participants.

Measuring Kalinga students' engagement in learning mathematics

Table 4 Results of assessing students' engagement in learning mathematics

Items	M	(SD)
Emotional engagement		
Math class is fun	2.53	0.51
I feel bored when learning math	1.37	0.49
I enjoy thinking about math	2.5	0.51
Math class is interesting	2.6	0.62
I like solving problems in my math class	3.47	5.42
Overall	2.49	2.52
Social engagement		
I talk about math to other kids in class	1.77	0.82
I help other kids with math when they don't know what to do	2.23	0.63
I share my ideas and materials with other kids in math class	2.23	0.63
Me and my classmates help each other during math class	2.3	0.75
Overall	2.13	0.73
Cognitive engagement		
I work as hard as I could in learning math	2.8	0.41
It is important that I understand the math really well	2.57	0.73
I try to learn as much as I could in math class	2.6	0.62
I do a lot of thinking during my math class	2.33	0.71
Overall	2.58	0.64
Overall Engagement	2.41	1.66

Table 4 displays the frequency of engagement among Kalinga students across the three dimensions. The emotional engagement items were reported as occurring 'sometimes' (M=2.49, SD=2.52), whereas the social engagement items also fell within this frequency (M=2.13, SD=0.73). On the other hand, the cognitive engagement items consistently received higher ratings, indicating that they were 'always' practiced (M=2.58, SD=0.64). Overall, students' engagement in learning mathematics was found to be varied (M= 2.41, SD= 1.66), which implies that while students may demonstrate periods of active participation and interest in mathematical learning, there are also instances where their engagement decreases. Understanding the nature of such engagement is essential for designing interventions and instructional strategies that promote sustained and consistent engagement in mathematics among elementary students. It is necessary to maintain the balance between the three dimensions to ensure the quality of learning mathematics (Leis et al., 2015).

After these findings were presented to elementary teachers, they acknowledged that students' observed level of engagement reflects their teaching practices. Teachers expressed a commitment to prioritizing the development of emotional and social engagement among students, recognizing the potential benefits of integrating cultural elements or technology into their instructional approaches to enhance these dimensions of engagement. This is evident through the statement of Teacher 1:

"It is my first time to determine the engagement of my students, and to know that it is not always fun for them makes me reflect on my teaching practices... Maybe by integrating culture or technology in teaching mathematics, I can somehow boost their engagement."

Discussion

In this section, we explore how the integration of qualitative and quantitative data has enriched our analysis of the identified problems for needs assessment. By linking numerical data to qualitative findings, we provide a discussion of the issues and offer key insights and recommendations.

Identification of challenges and recommendations

1. *The elementary teachers exhibit a deficiency in MCK*. Addressing this knowledge gap does not necessarily entail revising the curriculum of local institutions in the province offering teacher education programs for elementary education. Instead, we propose initiating the enhancement process with in-service teachers by providing targeted training sessions focused on MCK. These sessions should specifically address challenging aspects of mathematics lessons, aiding teachers in understanding and mastering them effectively. The absence of such training opportunities within the province underscores the urgency of this initiative. One viable approach is inviting mathematics experts, researchers, or secondary teachers with strong content expertise to facilitate these training sessions. Furthermore, leveraging this opportunity to propose accredited training programs to the Professional Regulation Commission (PRC) for teachers could enable them to accumulate additional Continuing Professional Development (CPD) units essential for career advancement.

In addition, we suggest updating the Framework for Philippine Mathematics Teacher Education, such as incorporating TPACK as a distinct component and aligning it with the course offerings of pre-service elementary teacher education programs.

2. *Elementary teachers demonstrate a deficiency in pedagogical strategies for promoting CRT*. In response, it is imperative for researchers and policymakers to coordinate training initiatives aimed at equipping teachers with the necessary skills to conduct CRT effectively. These training sessions should be designed to address the unique context of the Kalinga culture and endemic practices prevalent in the province. By doing so, teachers can enhance their instructional practices and contribute to preserving and promoting cultural traditions within the educational framework.

The province's annual celebration of the IP month in October serves as an avenue to honor cultural practices. However, while this highlights cultural appreciation, it falls short of adequately equipping mathematics teachers with the knowledge and skills needed to integrate cultural elements into their teaching practices effectively. To address this gap, it is essential to engage the expertise of cultural specialists, such as those affiliated with the provincial tourism office and regional museums. By collaborating with mathematics experts and educators, these specialists can facilitate training sessions designed to bridge the gap between Kalinga's cultural practices and the teaching of mathematics. By fostering this collaborative approach, teachers can gain insights and strategies for incorporating cultural relevance into their mathematics instruction, which enriches the learning experience for students while preserving and promoting local traditions. For suggested training for both content and pedagogical knowledge, teachers could adhere to the principles of continuous learning from the Framework (SEI-DOST & MATHTED, 2011a).

3. *Elementary teachers' TPACK is currently insufficient.* To address this gap effectively, it is important to introduce teachers to new technological resources suitable for teaching mathematics and provide comprehensive training on their proper utilization. This training should encompass the development of software instructional materials beyond traditional tools such as PowerPoint, including platforms such as GeoGebra, Quizizz, and authoring tools for creating engaging and interactive activities.

Authoring tools, which represent a current trend in educational technology development, offer a user-friendly alternative to programming software, which allows teachers to integrate multimedia elements such as sounds, pictures, and text to craft meaningful learning materials for students (Karoui et al., 2020). However, realizing these enhancements requires adequate resources, particularly financial support. Therefore, concerned authorities should allocate increased funding to address these pressing needs. Furthermore, municipal administrators should actively seek investment opportunities to establish cellular sites in remote areas to ensure reliable connectivity for teachers and students alike. Moreover, it is essential to provide teachers with ongoing seminars and professional development opportunities to keep them informed about emerging educational trends, including those aligned with Society 5.0. These seminars should include in-depth discussions on TPACK to enable them to understand its components and cultivate this knowledge effectively for their professional growth. By prioritizing these initiatives and investing in teachers' skills and resources, educational institutions can foster a more technologically adept and pedagogically effective teaching workforce to increase the quality of education provided to students. It could also assist the teachers in abiding by the Framework's principle of adapting their teaching methods to the current trends in mathematics instruction (SEI-DOST & MATHTED, 2011a).

4. *Kalinga students' learning engagement levels were varied.* To enhance social engagement, teachers should adopt pedagogical strategies that encourage students to interact and discuss concepts with their peers. As implied by Leis et al. (2015), group activities and paired tasks can facilitate collaborative learning experiences, prompting students to actively participate and share their thoughts, even on challenging topics. In addition to social engagement, emotional engagement is essential for sustaining students' interest and motivation throughout mathematics lessons. Teachers should design interactive activities that target students' emotional investment in the learning process. This can be accomplished by providing positive reinforcements, such as praise and rewards. By catering to students' emotions, educators can bolster their comprehension and cognitive engagement, thereby fostering a more conducive learning environment. Furthermore, emotional engagement can positively influence social interaction among students, which fosters collaboration and healthy communication. As stated by the master teacher:

"Students' emotional factor is everything nowadays compared to 10 or 20 years ago during our time as students. Today, there is now an emphasis on their psychological well-being and emotional state that teachers should always keep in mind."

Maximizing the interplay between Kalinga culture and technology in teaching mathematics

Given the cultural significance of the Kalinga community and the growing need for technological integration in education, it is essential to include a discussion on how Kalinga culture can coexist with educational technologies.

Recognizing that elementary teachers may not possess programming skills to design technology-based educational resources, administrators can consider hiring programming experts to develop software or educational games customized to the needs of teachers and students. These resources can incorporate cultural elements to emphasize mathematics concepts, drawing inspiration from research in ethnomathematics as exemplified by works such as that of Hortelano and Lapinid (2024), who developed an ethnomathematical teaching resource rooted in Kalinga culture, albeit a nontechnological resource.

For technology-based examples, researchers such as Sudirman et al. (2020) and Setiana (2019) have explored how ethnomathematics can be leveraged to foster technological resources such as augmented reality. By embedding cultural elements into educational technology, teachers can humanize mathematics learning and promote the integration of technology and culture to reconcile what may seem to be opposing notions (Rosa & Orey, 2016). More importantly, they can store significant quantities of files in a single pocket without concern for physical space limitations in their classrooms. By embracing this approach, educators can create a learning environment that respects and celebrates the rich cultural heritage of the Kalinga community. This integration fosters a holistic approach to education that acknowledges the importance of cultural identity and technological advancement in the pursuit of knowledge.

Conclusion

This study highlighted the necessity of comprehensively addressing the distinct educational requirements of Kalinga elementary teachers and students in teaching and learning mathematics. Critical areas that mandate attention and intervention have been explored and identified through the needs analysis within the broader design of ESRD, encompassing a systematic review, assessing teachers' TPACK and students' engagement, and the interplay of technology and culture. These findings offer essential insights into developing practical solutions to the identified problems, aligning with the Frameworks outlined by SEI-DOST and MATHTED Incorporated, and keeping up with the demands of Society 5.0 for teachers. Specifically, this allows Kalinga teachers to respond to their responsibility of integrating technological aspects in teaching, which could aid in making students actively engaged and be at least accomplished teachers based on teacher growth and development levels.

Furthermore, this study holds significance beyond mere pedagogical developments. It underscores the commitment to preserving the cultural heritage of the Kalinga community amid the evolving educational landscape shaped by technology and the post-pandemic era, specifically the interaction between teachers and students. We advocate that researchers, teacher educators, and educational policymakers closely examine the identified needs outlined in this study and take proactive measures to address them, particularly focusing on the most pressing concerns in IP education.

In this study, we propose bold recommendations and practical solutions aimed at improving the teaching practices and learning experiences of Kalinga teachers and students. These initiatives are intended to be implemented and sustained over time to effect meaningful change and for researchers to use the assessed needs as leverage for future research. While the study is grounded in the context of Kalinga, it serves as a valuable model for other provinces serving IP communities. It provides a blueprint for adapting similar research approaches to analyze the distinct needs of teachers and students in diverse cultural settings. Doing so could highlight cultural communities worthy of being recognized through research, thereby contributing to their development.

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References

Alangui, W.V. (2017). Ethnomathematics and culturally relevant mathematics education in the Philippines. In M. Rosa, L. Shirley, M. Gavarrete, & W. Alangui (Eds.), *Ethnomathematics and its diverse approaches for mathematics education* (pp. 183-208). ICME-13 Monographs. Springer. https://doi.org/10.1007/978-3-319-59220-6_8

Asrowiah, O., Sujadi, I., & Slamet, I. (2021). Needs analysis of mathematics modules as learning materials in distance learning during covid-19 pandemic. *Proceedings of the International Conference of Mathematics and Mathematics Education (I-CMME 2021).* https://doi.org/10.2991/assehr.k.211122.030

Baka, A. & Figgou, L. (2012). ‘Neither agree, nor disagree’: a critical analysis of the middle answer category in voting advice applications. *International Journal of Electronic Governance, 5*(3), 244-263. https://doi.org/10.1504/IJEG.2012.051306

Battiste, M., Bell, L., & Findlay, L. M. (2002). Decolonizing education in Canadian universities: An interdisciplinary, international, indigenous research project. *Canadian Journal of Native Education, 26*(2), 82-95. Retrieved from https://www.proquest.com/scholarly-journals/decolonizing-education-canadian-universities/docview/230305394/se-2

Berman, E. (2017). An Exploratory sequential mixed method approach to understanding researchers’ data management practice at UVM: integrated findings to develop research data services. *Journal of eScience Librarianship, 6*(1). https://doi.org/10.7191/jeslib.2017.1104

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed.). SAGE Publications. https://books.google.com.ph/books/about/Designing_and_Conducting_Mixed_Methods_R.html?id=YcdlPWPJRBcC&redir_esc=y

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE. http://bayanbox.ir/view/236051966444369258/9781483344379-Designing-and-Conducting-Mixed-Methods-Research-3e.pdf

D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the Learning of Mathematics, 5*(1), 44–48. https://www.jstor.org/stable/40247876

Department of Education. (2021). *DepEd marks 1st decade of Indigenous Peoples Education Program (IPEd) with 2.5M learners served.* Department of Education Philippines. https://www.deped.gov.ph/2021/10/08/deped-marks-1st-decade-of-indigenous-peoples-education-program-iped-with-2-5m-learners-served/

Department of Education. (2011). *Department Order No. 62: Adopting the National Indigenous Peoples (IP) Education Policy Framework.* Department of Education Philippines. https://www.deped.gov.ph/wp-content/uploads/2011/08/DO-No.-62-s.-2011.pdf

Figgou, L. & Pavlopoulos, V. (2015). Social Psychology: Research Methods. *International Encyclopedia of the Social & Behavioral Sciences* (2nd ed.). 544-552. https://doi.org/10.1016/B978-0-08-097086-8.24028-2.

Fredricks, J. A., Blumenfeld, P.C., & Paris, A. H. (2004). School engagement: potential of concept, state of the evidence. *Review of Educational Research, 74*(1), 59-109. https://doi.org/10.3102/00346543074001059

Freire, P., Ramos, M., Patton, L., Sleezer, C., Russ-Eft, D., & Gupta, K. (2020). Diverse students' needs assessment case study. In D. Russ-Eft & C. Sleezer (Eds.), *Case Studies in Needs Assessment* (pp. 189-196). SAGE Publications, Inc. https://doi.org/10.4135/9781544342351

Fuschi, D. L., Ong, B., & Crombie, D. (2008). How Technology Can Support Culture and Learning. In K. Ng & P. Nesi (Eds.), *Interactive Multimedia Music Technologies*, 195-230. https://doi.org/10.4018/978-1-59904-150-6.ch010

Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education, 53*(2), 106-116. https://doi.org/10.1177/0022487102053002003

Hortelano, J. C., & Lapinid, M. R. (2024). Recontextualizing Kalinga's batek and laga into an ethnomathematical teaching resource: An application of the second generation of didactical engineering. *Journal on Mathematics Education, 15*(2), 385-402. https://doi.org/10.22342/jme.v15i2.pp385-402

Karampelas, K. (2021). Trends on Science Education Research Topics in Education Journals. *European Journal of Science and Mathematics Education, 9*(1), 1-12. https://doi.org/10.30935/scimath/9556

Karoui, A., Marfisi-Schottman, I., & George, S. (2020). JEM Inventor: a mobile learning game authoring tool based on a nested design approach. *Interactive Learning Environments, 30*(10), 1851-1878. https://doi.org/10.1080/10494820.2020.1753214

Kaya, S. (2021). From needs analysis to development of vocational English language curriculum: a practical guide for practitioners. *Journal of Pedagogical Research, 5*(1),154-171. https://doi.org/10.33902/JPR.2021167471

Koehler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2013). The Technological Pedagogical Content Knowledge Framework. In J. Spector, M. Merrill, J. Elen, & M. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology* (pp. 101-111). Springer, New York, NY. https://doi.org/10.1007/978-1-4614-3185-5_9

Leis, M., Schmidt, K. M., & Rimm-Kaufman, S. E. (2015). Using the Partial Credit Model to Evaluate the Student Engagement in Mathematics Scale. *Journal of Applied Measurement*, *16*(3), 251–267. https://pubmed.ncbi.nlm.nih.gov/26753221/

Lorenzana, A., & Roleda, L. (2024). Development and validation of technological pedagogical and content knowledge— action research in teaching science instrument. *International Journal of Learning and Teaching, 10*(1), 118-125. https://doi.org/10.18178/ijlt.10.1

McKillip, J. (1987). *Need analysis*. SAGE Publications, Inc. https://doi.org/10.4135/9781412985260

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6), 1017-1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Morales, M. P. E., Anito, J. C., Jr., Avilla, R. A., Sarmiento, C. P., Palisoc, C. P., Elipane, L. E., Ayuste, T. O. D., Butron, B. R., Palomar, B. C., Casilla, N. A., Bornales, J. B., Prudente, M. S., Nepomuceno, C. T., Viray, K. R., Villanueva, R. M. R., Padama, A. A. B., Alcantara, E. C., Mercado, F. M., Sagun, R. D., Bernarte, R. P., & Pagkatipunan, P. M. N. (2019). *TPACK in Philippine STEAM education*. Manila, Philippines: Philippine Normal University. https://pnu-onlinecommons.org/omp/index.php/chedpnutpack/catalog/book/753

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods, 16*(1). https://doi.org/10.1177/1609406917733847

Patrick, H., Ryan, A.M., & Kaplan, A. (2007). Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement. *Journal of Educational Psychology, 99*(1), 83-98. https://doi.org/10.1037/0022-0663.99.1.83

Reschly, A. L., & Christenson, S. L. (2012). Jingle, jangle, and conceptual haziness: Evolution and future directions of the engagement construct. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of Research on Student Engagement* (pp. 3-19). New York, NY: Springer. https://doi.org/10.1007/978-1-4614-2018-7_1

Reyteran, R. (2021). Teaching in IP schools: an analysis of teachers' as input to pre-service teacher education. *International Journal of Language and Literary Studies, 3*(4). https://doi.org/10.36892/ijlls.v3i4.758

Rosa, M., & Orey, D. C. (2016). Humanizing mathematics through ethnomodelling. *Journal of Humanistic Mathematics, 6*(2). https://doi.org/10.5642/jhummath.201602.03

Rosa, M., & Orey, D. C. (2018). The Anthropological Dimension on Ethnomodelling Research Based on Ethnomathematics and Modelling. *Open Access Journal of Archeology & Anthropology, 1*(1). https://doi.org/10.33552/OAJAA.2018.01.000503

Rubia-Avi, B. (2023). The research of educational innovation: Perspective and strategies. *Education Sciences, 13*(1), 26. https://doi.org/10.3390/educsci13010026

SEI-DOST & MATHTED. (2011a). *Framework for Philippine mathematics teacher education*. Manila: SEI-DOST & MATHTED. https://www.sei.dost.gov.ph/images/downloads/publ/sei_mathteach.pdf

SEI-DOST & MATHTED. (2011b). *Mathematics framework for Philippine basic education*. Manila: SEI-DOST & MATHTED. https://www.sei.dost.gov.ph/images/downloads/publ/sei_mathbasic.pdf

Setiana, D. S. (2019). The role of ethnomathematics in welcoming the Society 5.0. *Advances in Social Sciences, Education and Humanities Research*. https://doi.org/10.2991/assehr.k.200827.130

Shukla, P. (2008). Exploratory research design. In *Essentials of Marketing Research* (Chapter 2). Bookboon. http://bookboon.com/en/marketing-research-an-introduction-ebook

Sudirman, S., Yaniawati, R. P., Melawaty, M., & Indrawa, R. (2020). Integrating ethnomathematics into augmented reality technology: exploration, design, and implementation in geometry learning. *Journal of Physics: Conference Series*. https://doi.org/10.1088/1742-6596/1521/3/032006

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*(2), 237-246. https://doi.org/10.1177/1098214005283748

Ulla, M. B., & Winitkun, D. (2017). Thai learners' linguistic needs and language skills: Implications for curriculum development. *International Journal of Instruction, 10*(4), 203-220. https://doi.org/10.12973/iji.2017.10412a

Yig, K. G. (2022). Research trends in mathematics education: a quantitative content analysis of major journals 2017-2021. *Journal of Pedagogical Research, 6*(3), 137-153. https://doi.org/10.33902/JPR.202215529