Pre-service Mathematics Teachers' Multicultural Mathematics Competency: A Case of a University in Northern Thailand

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Abstract

This study aimed to explore pre-service mathematics teachers' perceptions of their strengths and deficiencies in dealing with students from diverse mathematics cultural backgrounds. The pre-service mathematics teachers in the final year at a university located in Northern Thailand were participants. The survey and focus group interview were manipulated to attain more profound confirmation about how the pre-service mathematics teachers performed in their diverse mathematics classrooms. The pre-service mathematics teachers' strengths and deficiencies were represented and divided into the affective, cognitive, and psychomotor domains. Their strengths included 1) consciousness about the multicultural processes, 2) acknowledgment of students' sources of resistance, and 3) possession of a feedback cycle for dealing with diverse mathematics classrooms. Nevertheless, it was found their deficiencies, including 1) unawareness of multicultural diversity through many perspectives, 2) limited knowledge to handle irrelevant students' culture, and 3) lack of skills to respond to a problem existing such as time limits.

The implication included that pre-service mathematics teachers should have the opportunity to 1) interact with other different cultural mathematics backgrounds, 2) study more content courses about multicultural mathematics, and 3) engage in various activities involving multiculturalism and be exposed to multicultural instruction courses.

Keywords: Multicultural, Pre-service teacher, Mathematics, Diversity, Culturally responsive

Introduction

The diversity among students in a classroom has been increasing due to the population diversity in the contemporary global society, calling multicultural education recognized as a support for cultivating students' intellectual capabilities from diverse cultural groups (Banks, 2016; Banks, 2009). Multicultural education has been addressed in the literature since the

1980s (Grant & Sleeter, 1985). It was stated that multicultural education depended on the context in which it was used, for whom it was multicultural, and whether it was the multicultural education of all the people in the world (Banks, 2019; Bennett, 2019).

Diversity and equity are repeatedly operated to explicate the characteristics of the multicultural education concept (Sleeter & Grant, 1987). Immense discussions are enthusiastically ongoing to respect students' cultural diversity with diverse backgrounds and affirm educational equity for all students (Banks, 2016). In the context of such changes in domestic and world society, there is an increasing awareness that school education should fulfill the responsibilities of cultivating students' capacity as social members who can embrace culturally diverse groups.

However, the 2008 Thailand Basic Education Core Curriculum aims to enhance all learners' capacity, who constitute the country's primary force, "to attain balanced development in all respects—physical strength, knowledge, and morality" (Ministry of Education, 2008, p.4). Thai students will "fully realize their commitment and responsibilities as Thai citizens and members of the world community" (Ministry of Education, 2008, p.4), stating the paradox in multicultural education perspective since assimilation as Thai citizens conflicts with diversity among members of the world community and does not respect students' identity, especially students from ethnic minority groups (Jun-on & Kim, 2019).

As a consequence of feeling mediocre or lower grades from the marginalization in formal education, students from minority groups, especially from ethnic groups being different from the central Thai ethnicity and low socioeconomic status, suppose that they ought to proceed with career choices to improve their social status (Arphattananon, 2012; Arphattananon, 2018; Jun-on & Kim, 2019; Nawarat, 2018). Prominently, mathematics is essential in advancing students and career choices and functions as a filter to form a social hierarchy. The field of mathematics has been criticized for its academic elitism (Sriraman & Steinthorsdottir, 2007; Sriraman & Steinthorsdottir, 2009), and it has also "historically served as the gatekeeper to numerous other areas of study" (Sriraman & Steinthorsdottir, 2009, p.325).

In many countries, particularly in Asia, entry to government-supported programs is highly competitive and requires students to score at the top, in which mathematics is a significant component. This situation is not so different in Thailand, as evidenced by the importance of standardized tests in higher education programs. Thus, from Thai students' view, advancing mathematics knowledge and skill can promote their socioeconomic status.

To improve students' mathematics knowledge and skill, it is meaningful to comprehend their suppositions and assumptions when interpreting real-world problems that frequently reflect their home community's practices. To recognize the cultural characteristics of mathematics developed and emerged from diverse cultural groups, multicultural mathematics education has been suggested to be implemented to identify diverse mathematical knowledge.

This implies understanding the various community members and the ability to coexist, understand and cooperate with others in the present society, where diversity exists (Bishop, 1988). Besides, allowing students to interact with mathematical products from diverse groups

enriches mathematical literacy and enables them to coexist and communicate with diverse groups (D'Ambrosio, 1985; D'Ambrosio & Rosa,2017).

In this respect, restructuring students' diversity in school mathematics and providing equal educational opportunities is a fundamental academic challenge required to protect individual rights in a diverse society (Apple,1992). All mathematics teachers should have sufficient knowledge about the student's cultural background to provide educational equity involving studying the instructional goals or endpoints implicit in reform visions (Cobb & Hodge, 2002; Nasir & Cobb, 2002), meaning that multicultural mathematics competencies should be extended to all the professional elements that all mathematics teachers should have. Moreover, the standards for that level should be improved.

So, mathematics teachers need multicultural mathematics competency to link multicultural strategies with mathematics content and organize instruction to promote higher-level mathematical concepts for all students (Wiest, 2001). This competency has been believed to help students of all abilities understand mathematical concepts for their own sake (Zaslavsky, 1996). In this study, the theoretical literature analysis on multicultural teacher education and mathematics teacher education was realized, as well as an actual mathematics teacher education situation for equity and diversity in Thailand.

Aim

This study aimed to explore pre-service mathematics teachers' perceptions of their strengths and deficiencies in dealing with students from diverse mathematics cultural backgrounds, especially to what extent the pre-service mathematics teachers perceived themselves as competent to teach students in diverse mathematics classrooms.

Literature review

Multicultural mathematics education

Multicultural education advocates teaching to cultivate students' intellectual capabilities from various marginalized sociocultural groups (Sleeter, 2001). Banks (2016) defined multicultural education as a reform movement that promotes educational equity for all students and ends discrimination in a society where diversity exists, such as race, culture, language, gender, and religion. From Banks' point of view, multicultural education should be accomplished with the transformation of schools since it was believed that scientific literacy could link local sciences to modern sciences through daily life phenomena (El Islami & Nuangchalerm, 2020), which are precisely related to culture.

Since schools are a social system, multicultural education requires a wide range of changes across the various elements that make up schools. Multicultural mathematics education may be described as multicultural education practiced in the mathematics curriculum. This definition implies education that implements educational equity so that all students have majestic powers on the premise that the student and the mathematics subject are relative.

Two main ideas have been stated to grasp multicultural mathematics education concepts: diversity and equity. Diversity has been conceptualized relatively in terms of student participation within the broader society and characterized as encompassing a complex range of mathematics issues emerging when members of various local communities and broader groups into a more comprehensive society come together in the mathematics classroom setting.

Additionally, the proposed perspective on equity is not limited to only students' participation in out-of-school practices and their success in particular school mathematics courses and high-stakes tests. Instead, it also encompasses what is traditionally referred to as students' motivations to continue to study mathematics and their persistence (Cobb & Hodge, 2002).

In multicultural mathematics education, mathematics teachers should play the role of reforming the structure of inequity and pursuing justice more extensively by providing equitable teaching based on cultural pluralism. In particular, multicultural education aims at a broad goal ranging from the coexistence of diversity to realizing social equity and justice by realizing equal educational opportunities. The mathematics teacher competencies required for multicultural mathematics education are comprehensive.

Therefore, a discussion should be held on defining and categorizing prospective mathematics teachers' multicultural competencies as necessary for multicultural mathematics teacher education.

Multicultural mathematics competency

Discussions on multicultural approaches and teachers' multicultural competencies in mathematics education have been developed by the National Council of Teachers of Mathematics (NCTM) in the United States since 1989 through the literature on mathematics curriculum and math teacher expertise. It was recommended to provide a learning environment that respects students' unique mathematical backgrounds and provides high expectations and valuable learning opportunities to all students. Specifically, the preliminary guidelines for mathematics schools proposed by NCTM recommend that mathematics teachers plan and implement teaching activities that support students' cognitive diversity.

Therefore, as prospective mathematics teachers, pre-service mathematics teachers should be able to develop tasks with students' cognitive resources and connectivity and can communicate to guide the emergence of various ideas in classroom situations based on these tasks and facilitate negotiations between various mathematical concepts. To respond sensitively to the unique cognitive characteristics of students, teachers have been expected to have the ability to evaluate and analyze mathematics class situations and students.

In the discussions on multicultural mathematics teacher education, becoming a multicultural mathematics teacher means knowing the diversity of learner styles from cultural differences and a belief system necessary to ensure students' equity in a culturally diverse classroom. It has been mentioned that multicultural mathematics education should be a transformation process into a multicultural entity that can act based on such beliefs and

knowledge (Banks, 2016). This means that multicultural teacher competency is not merely developed by accumulating factual and technical knowledge about the classroom.

In other words, instructional skill is a whole-person existence, which is meant as a multicultural mathematics competency when contextualized in the continuation of the mathematics teacher's norms and values. This study defined multicultural mathematics teachers' competencies concerning the teacher's whole-person aspect and categorized it into a multicultural affective domain, a multicultural cognitive domain, and a multicultural psychomotor domain.

First, the multicultural mathematics teacher competency's defining area includes elements about the belief system and attitude toward multicultural diversity and mathematics background differences as the multicultural affective domain. For example, the intercultural ability to reflect on the teacher's and student's cultural attitude and to interact effectively with culturally diverse groups, interest in students, parents, and local communities, and culturally minority students, enthusiasm, and commitment to ensuring educational equity are included in the definition domain of multicultural mathematics teacher competency.

Mathematics teachers with multicultural consciousness and attitude can recognize various cultural perspectives and competencies in the classroom related to mathematics. Furthermore, students can be allowed to express their worldview clearly and to discover how to shape their own mathematical perspectives based on their experiences and culture. In other words, by recognizing that mathematics is a product that reflects cultural, sexual, racial, ethnic, and hierarchical backgrounds, a mathematics curriculum should allow students to immerse themselves in learning to form a unique self identity. They have a more receptive and positive attitude toward mathematics classrooms' value and the possibility that support successful academic achievement in mathematics through learning methods meaningful to them (Sleeter, 1997).

In the multicultural cognitive domain, the multicultural mathematics teacher competency includes knowledge about the culture, knowledge about folk mathematics, thinking style, and communication practice of mathematics classes that embrace cultural diversity suitable for such cultural background, teaching methods, evaluation methods, and methods of collecting and analyzing materials useful for class reflection. It also includes elements that correspond to the intellectual resources required of a mathematics teacher for a risk. Therefore, knowledge of students' cultural backgrounds related to mathematics and cognitive resources and competencies is a significant component of mathematics history competencies required in diverse mathematics classrooms (Greene-Clemons, 2016; Greer, 2009).

The multicultural psychomotor domain of the multicultural mathematics teacher competency includes explaining concrete lesson plans by synthesizing multicultural attitudes and consciousness and various mathematics teachers' knowledge and applying and practicing them in context. In other words, multicultural psychomotor competency can be the ability to realize affective and cognitive competencies in actual mathematics classroom situations.

Mathematics teachers should recognize students as having legitimate mathematical resources and competence in mathematics classes and avoid simple memorization or penalties.

Moreover, mathematics teachers should demonstrate writing mathematical writing, explanation, and justification, emphasizing the higher skills of comment, establish a human and equal relationship between mathematics teachers, communicate mathematical ideas, emphasize a sense of community, to harmonize and integrate individual learning and the learning experience of the entire class, and to facilitate student-led discourse and participation.

Mathematics, emphasizing cooperation rather than competition, is a teaching strategy contextualized to a specific mathematics classroom situation by comprehensively applying a mathematics teacher's knowledge, multicultural consciousness, and attitude to students' diverse mathematics backgrounds. In conclusion, a multicultural belief system and attitude, knowledge of various students' mathematics backgrounds, and the appropriate mathematics teaching, which is the ability to synthesize and apply knowledge to concrete and apply plans for practical mathematics instruction, are essential multicultural mathematics teacher competencies (Greer, 2009).

Research method

An explanatory sequential method design that combines elements of quantitative and qualitative research approaches to understand better the problem was implemented in this study (Creswell & Creswell, 2018). In the first quantitative phase of the study, survey data was collected from the final-year pre-service mathematics teachers at a university in Northern Thailand to review their perceptions of the strengths and deficiencies related to multicultural mathematics education.

The quantitative study aimed to investigate how participants perceived themselves concerning their knowledge of multicultural mathematics education. The results of this phase were obtained from the participants, so it is uncertain whether they accurately reflect their strengths and deficiencies. It was contingent upon their comprehension of multicultural mathematics education.

However, whether the participants had sufficient knowledge about multicultural mathematics education to identify their strengths and deficiencies was questionable. The qualitative study aimed to explore the pre-service mathematics teachers' strengths and deficiencies from their responses to the explanatory follow-up questions through a focus group interview with a collection of open-ended questions. The researchers evaluated the responses to determine the participants' genuine strengths and deficiencies. In other words, this phase of the study was carried out to ascertain whether their responses to the quantitative survey indicated that they thoroughly understood multicultural mathematics education.

The results of both methods corroborated the participants' strengths and deficiencies regarding multicultural mathematics education by elucidating what transpired when they were confronted with certain situations in a diverse classroom. For instance, participants who self-identified as competent in specific competencies were asked follow-up questions in a

controlled scenario to gain a deeper understanding of their strengths. Nonetheless, the expression might entail certain deficiencies, and this coexistence would be articulated.

Data collection

Sixty-six participants were asked to complete the survey at the end of the first semester during the year of their school practicum following signing the consent form. After quantitative data analysis, 12 participants were invited to the focus group interview. Individual determination was made by the systematic selective method. Based on the quantitative data results, the focus group participants were ranked using the normal distribution indicated by a bell curve. A random starting number was used to identify the participant in the lower half of the bell curve and the participant in the upper half. Additional participants were selected by identifying pre-service mathematics teachers in ranking order, so participants corresponding to each half of the bell curve were identified. Selected participants who were unable to participate in the focus group interview or who did not volunteer to participate were replaced by participants adjacent to that individual in the ranking order list.

During the first quantitative phase of the study, the research questions were used to guide this study's investigation. This survey was given to the participants within the last week of the first semester of their school practicum. The survey was administered electronically using an online survey tool. The terminology was used from the paper of Gutierrez (2002), that "reflects the three goals of equity discussed in the article: the achievement and participation in mainstream mathematics; the ability to create mathematics while being critical of knowledge and society; and the erasure of inequities throughout areas of the globe" (Gutierrez, 2002, pp. 176-178).

The survey questions were derived from a literature review in developing the quantitative instrument. After establishing the competencies of all domains based on the literature, the survey items were constructed based on the definitions of each domain, drawing the terminology from the terminology mentioned above. Then, two professors as mathematics teacher educators who are experts in the mathematics education field reviewed the survey as a critique. Moreover, a public-school teacher who is well experienced with students from diverse mathematics backgrounds was also located to discuss the survey. Accordingly, certain irrelevant or ambiguous items were eliminated, as determined by the experts.

Several qualitative open-ended questions were developed for the post-survey focus group during the first quantitative portion of the research. Pre-service mathematics teachers selected according to the above-described method were reached in person. They had an individual initial meeting with the researcher to be notified and address a focus group interview timetable. During the second phase of the qualitative research study, the focus group interview was organized to discuss the qualitative questions to understand pre-service mathematics teachers' experiences better and support the quantitative results. In the qualitative focus group interview, the researcher conducted a face-to-face interview. The interview involved unstructured and generally open-ended questions that were "few and intended to elicit views and opinions from the participants" (Creswell & Creswell, 2018, p. 211). According to the

literature review, the developed interview protocol was part of the multicultural mathematics teachers' competencies. The focus group interview was recorded and succeeding transcribed.

Data analysis

The descriptive statistic technique analyzed quantitative data to tabulate individual items' mean scores, standard deviations, and percentages. The focus group interview was recorded and later transcribed to find pre-service mathematics teachers' perceptions from the data together with the review of the literature. Broad themes were placed with keywords as codes for instances that demonstrated multicultural mathematics competencies in each domain using the analytic coding method. To ensure the trustworthiness of the findings, the data set was separately considered and cross-referred, thereby using triangulation to ensure the data interpretation. Three coders independently coded the data after several meetings, which were set to ensure a complete common understanding. After the first analysis phase, the coders shared codes and developed themes based on the multicultural mathematics competency domain. Post-coding discussion included explanations and a discrepancy review until all three coders reached a consensus. During and after the final analysis phase, an ongoing debate occurred to determine the themes most relevant to the pre-service mathematics teacher's multicultural mathematics competencies. Of the most relevant themes, the coders decided to present the ones that best capture and support the phenomenon. This iterative and collaborative process ensures the trustworthiness of the results as much as possible (Creswell & Poth, 2018; Krathwohl, 2009).

Results

For the pre-service mathematics teachers' survey, the data was collected from the fifth-year students in mathematics education at the university in Northern Thailand, who finished their school practicum of the first semester in one academic year. The survey was sent to 66 pre-service mathematics teachers, who responded based on their perceptions; hence, the results revealed how they regarded themselves from their perspective. Data for each school was obtained from school system reports with their schools' size and the grade levels that participants taught. Of the 66 pre-service teachers, most are females constituting 71.21% compared to 28.79% males.

The data of pre-service mathematics teachers' perception regarding multicultural mathematics competency in teaching and learning in mathematics was collected using a 28-item scale with five-point scoring: 1 = indicating seriously flawed competence and 5 = indicating outstanding competence. The mean score was interpreted as how the pre-service mathematics teachers perceive their competency in each item as follows: outstanding (4.50 – 5.00), excellent (4.00 – 4.49), very good (3.50 – 3.99), acceptable, but low priority (3.00 – 3.49), needs revision (2.50 – 2.99), needs major revision (2.00 – 2.49), and seriously flawed (1.00 – 1.99).

The focus group interview result contained multiple vague between pre-service mathematics teachers' actual competency and how they perceived themselves according to the

survey findings, requiring more consideration of alternative questions. The added questions included simulated situations that might assign pre-service mathematics teachers to focus on a diverse classroom. The results from the response of 12 pre-service mathematics teachers (indicated by PMT1 – PMT12 in this study), together with the analysis of the survey result, were discussed. The survey data was analyzed as in Table 1.

Table 1 Means and standard deviations of multicultural competencies

Item	Question	Means	S.D.
3	Have an in-depth understanding and flexible subject-matter knowledge as a characteristic of equity teaching shared across students.	3.85	0.72
5	Have a moral commitment as a characteristic of equity teaching shared across students.	4.15	0.68
12	Recognize how students develop the moral commitment needed to enact practice that leads to equity goals discussed.	4.11	0.72
26	Regard the multicultural process that influences other mathematics teachers.	3.68	0.98
27	Regard the multicultural process that influences the mathematics that was created or used.	4.02	0.75
28	Regard the multicultural process that influences how people use mathematics in everyday life.	4.17	0.69
	Affective competencies	**4.00**	**0.76**
1	Know about teaching that leads students of all backgrounds to participate and achieve in mainstream mathematics.	4.09	0.67
2	Know what characteristics displayed in the practice of teachers who serve particular populations, especially students who traditionally have performed poorly in mathematics, are.	4.11	0.68
4	Know students' individuals as a characteristic of equity teaching shared across students.	4.18	0.72
6	Know the mathematical resources that teachers employ in their practice in the multicultural classroom.	4.06	0.73
7	Know the student resources that teachers employ in their multicultural classroom practice.	4.03	0.72
8	Know the contextual (local or workplace) resources that teachers can employ in their practice.	3.94	0.75
15	Know how the practice developed in places where it does not typically occur.	4.05	0.66
17	Know where lived experiences and identities fit different individuals.	4.11	0.72

Item	Question	Means	S.D.
18	Know what forms of resistance occur.	4.17	0.71
19	Know what the sources of resistance are.	4.20	0.72
	Cognitive competencies	**4.09**	**0.71**
9	Know how teachers develop the useable mathematical understanding needed to enact practice that leads to equity goals discussed.	4.11	0.72
10	Know how teachers develop the useable student understanding needed to enact practice that leads to equity goals discussed.	4.09	0.67
11	Know how teachers develop useable context understanding needed to enact practice that leads to equity goals discussed.	4.03	0.65
13	Involve in communities of practice where equity traditions are supported (e.g., membership with other teachers, membership in broader communities, partnerships with universities)	4.06	0.71
14	Have the ability to erase inequities in classrooms.	4.12	0.71
16	Understand how to translate and extend practices that occur with a particular set of students to operate with other kinds of students.	4.03	0.62
20	Ability to translate the knowledge, skills, and moral commitment you have.	4.14	0.77
21	Know when to put the knowledge, skills, and moral commitment you have to good use.	4.11	0.72
22	Know how to put the knowledge, skills, and moral commitment you have to good use.	4.11	0.68
23	Continue to assess how effective your strategies are.	3.91	0.71
24	Select the proper assessment process for different kinds of students.	4.03	0.72
25	Have a feedback cycle if it works after trying the process.	4.23	0.67
	Psychomotor competencies	**4.08**	**0.70**

Table 1 represents the means and standard deviation of the participant responses for the items regarding multicultural competencies in each domain, including affective, cognitive, and psychomotor domains, collected through the 28-item scales.

Multicultural mathematics affective competency

The data of the pre-service mathematics teachers' perception of their multicultural affective competency was collected through 6 items from the 28-item scale provided. The items of this domain consisted of only six items according to validation by the experts. This domain

was related to a belief system and attitude, which might not be concrete, so the experts tried to avoid confusing items. The result was indicated as the following.

It was noted that four of the six items were in the range of 4.00 to 4.49 mean score, and the remaining two were in the field of 3.50 to 3.99 mean score. It shows that pre-service mathematics teachers' perception of their multicultural mathematics affective competency is positive, with a 4.00 mean score and 0.76 standard deviations. Most pre-service mathematics teachers perceived themselves as excellently competent in diverse mathematics classrooms; of the 66 pre-service mathematics teachers formerly perceived themselves as the multicultural process that influences other mathematics teachers, with the lowest 3.68 to mean score and 0.98 standard deviations. Moreover, they perceived that the multicultural process influences how people use mathematics in everyday life, with the highest 4.17 mean score and 0.69 standard deviations. This finding indicates the participants' strengths that they had consciousness of the multicultural processes that influenced how students used mathematics in their daily lives.

However, the focus group interview showed that the participants continued to share their feeling of competence, which unintentionally focused on comparing the difference between pre-service mathematics teachers and students. They also concluded that many of their feelings about the students were based on social class issues which notedly were a type of diversity. Still, the pre-service mathematics teachers did not acknowledge other types of multicultural diversity. Although they questioned whether their assumptions about students' diversity were based on mathematics background or social class, they often gave examples of poverty. For instance, PMT3 talked about how students from middle-class or working-social class backgrounds have more exposure to mathematics literacy based on parental involvement, the educational background of the student's parents, and experiences. That comparison can be harmful because the students come from an environment where many live at or below the poverty level of Thai society.

Additionally, it was found that although the pre-service mathematics teachers might be aware of the students' diversity, they had difficulty moving away from making prejudice toward their students. As a result, they simplified by perceiving diversity at the mercy of assimilationist ideology. The following example expressed this perception by PMT7.

> *PMT7: "…I think it is complicated. Like every day when they go outside [school], I see their parents interact with them differently for each of them. … I know it is hard for students to have different ways to interact [at school and home] and behave with all expectations, but it is also difficult for a teacher who needs to achieve all responsibilities. It looks so easy to others [who are not teachers], saying teachers can reach students in various ways to respond to students differently according to their differences. Following one rule is necessary since if students cannot go on mainstream, they might face many difficulties in the future. For example, you know what would happen if a mathematics teacher could not speak Thai fluently? So, we have an incredible*

job of teaching them the classroom regulation and getting them to follow the rule, including the consensus of how to learn [mathematics] in the classroom."

The participant showed her belief and attitude that did not interact effectively with culturally different groups, reflecting the questionable intercultural ability. Thus, the pre-service mathematics teachers reflected the deficiency of empathizing with other types of diversity among Thai students, apart from social classes. For example, culture, gender, race, ethnicity, socioeconomic class, or language, so they rarely ensured educational equity by not recognizing mathematics as a product that reflected cultural, sexual, racial, ethnic, and hierarchical backgrounds.

In the conclusion of the affective domain's analysis, the participants showed the strength of consciousness about the multicultural processes affecting mathematics usage by students but illustrated unawareness of multicultural diversity through many perspectives, which was the deficiency of this domain.

Multicultural mathematics cognitive competency

The data of the pre-service mathematics teachers' perception of their multicultural cognitive competency was collected through 10 items from the 28-item scale provided. According to Table 1, It was noted that nine items of the ten items were in the range of 4.00 to 4.49 mean score, and the remaining one item was in the field of 3.50 to 3.99 mean score. It shows that pre-service mathematics teachers' perception of their multicultural mathematics cognitive competency is positive, with a 4.09 mean score and 0.71 standard deviations. A majority of the pre-service mathematics teachers perceived themselves as being excellently competent in diverse mathematics classrooms. The 66 pre-service mathematics teachers perceived themselves as knowing the contextual (local or workplace) resources that teachers can employ in their practice with the lowest 3.94 mean score and the 0.75 standard deviations.

Moreover, they perceived themselves as knowing the sources of resistance, with the highest 4.17 mean score and the 0.69 standard deviations. This shows their strengths in the cognitive domain, that they acknowledged what the sources of resistance were. Thus, they would seek an understanding of students' cultural background, such as folk mathematics, thinking style, or communication practice, in order to alter those sources of resistance, thereby constructing mathematics classrooms where learning is practically effective.

According to the focus group, from the pre-service mathematics teachers' competency in the multicultural cognitive domain analysis, the participants discussed their knowledge about their student background. It was expressed that much of those pieces of knowledge were based on their own experiences. For example, PMT6 discussed how hard it was to understand a student from an ethnic minority group. She admitted that she had difficulty realizing how different her thinking style comparing to other students in her classroom. For example,

PMT6: "I think it's also crucial to do various subjects besides just doing mathematics and working with the different students. Because I worked with

tribal students in my class, I indeed found that the existing situation differs from our book in a class we have learned."

Indeed, the participants asserted that the students performed differently in mathematics classrooms with their different mathematics backgrounds, diverse by their family backgrounds and location areas. However, their knowledge about a different culture, thinking style, or communication practice in mathematics classrooms was not performed in the focus group discussion. As soon as the participants began discussing this topic, they could not think beyond their knowledge from their undergraduate teacher education programs. They only began to think about how to teach their students by following the standard textbook, designed from the mainstream culture perspective, which was the central Thai culture.

For this domain, their strengths included that they acknowledged forms of student resistance that occurred in diverse mathematics classrooms. Nevertheless, they reflected deficiency that they had limited knowledge to handle irrelevant students' culture.

Multicultural mathematics psychomotor competency

The data of the pre-service mathematics teachers' perception of their multicultural psychomotor competency was collected through 12 items from the 28-item scale provided. It was noted that 11 items of the 12 were in the range of 4.00 to 4.49 mean score, and the remaining one was in the field of 3.50 to 3.99 mean score. It shows that pre-service mathematics teachers' perception of their multicultural mathematics psychomotor competency is also positive, with a 4.08 mean score and 0.70 standard deviations. Thus, most pre-service mathematics teachers perceived themselves as excellently competent in the psychomotor domain. The 66 pre-service mathematics teachers perceived themselves as continuing to assess how effective their strategies are, with the lowest 3.91 mean score and the 0.71 standard deviations.

Moreover, they perceived themselves as having a feedback cycle if it worked after trying the process with the highest 4.23 mean score and the 0.67 standard deviations. So, their strength in this domain was that they had a feedback cycle if it works after trying the process of dealing with diverse mathematics classrooms. This reflected the ability to respond to students' diverse cultural backgrounds by applying their consciousness and knowledge.

For the multicultural psychomotor domain, the participants found it challenging to use their consciousness and knowledge linked to multicultural mathematics education to create lessons that could handle diverse cultural classrooms. Since the participants in the focus group claimed that their schools focused on standardized testing, they severely limited their creativity. Even the small-size school, the participants admitted that the pressures of the Ordinary National Education Test (O-NET) had changed their teaching styles. For example, PMT11 believed that she was always rushed and had no room for them once the creative lessons she used when teaching.

PMT3 also agreed that she rarely taught fun and creative lessons because she was forced to turn in the test preparation materials that her school required her students to complete. Also,

PMT3 estimated that about one-third of her students were at the appropriate grade level to complete the practice examination successfully. Throughout the interview, the pre-service mathematics teachers shared that they would be more open to designing multicultural-based lessons in their mathematics classrooms if they received more support from the schools. The pre-service mathematics teachers were currently isolated and pushed to spend too much of their teaching time on test preparation. Although they admitted that students respond best to creative and fun lessons, they just ended up with the answer that "we cannot do anything since we stayed as teachers in those schools only one year."

Thus, according to the focus group interview analysis, the pre-service mathematics teachers did not reflect the ability to realize affective and cognitive competencies in their classroom situations. Because of the time limitation, they shared that they did not implement their mathematics classrooms by synthesizing and applying knowledge of various students' mathematics backgrounds. This demonstrated that they were deficient in actualizing affective and cognitive competencies and the ability to implement attitude and knowledge to successfully respond to various scenarios in diverse mathematics classrooms, which was the time-limited circumstance in this result.

In the psychomotor domain, the pre-service mathematics teachers' strengths were that they responded to students' different cultural backgrounds and had a feedback cycle to notice if their responses were effective. So that they might acquire additional knowledge and respond successfully to diverse mathematics classrooms in the following lesson; however, they showed a deficiency in skills to respond to a problem existing in a diverse mathematics classroom.

Conclusion and discussion

In conclusion, as the following, most pre-service mathematics teachers were strong and deficient in multicultural mathematics competency in all domains. Their strengths included 1) consciousness about the multicultural processes, 2) acknowledgment of students' sources of resistance in diverse mathematics classrooms, and 3) possession of a feedback cycle for dealing with diverse mathematics classrooms. Nevertheless, it was found their deficiencies, including 1) unawareness of multicultural diversity through many perspectives, 2) limited knowledge to handle irrelevant students' culture, and 3) lack of skills to respond to a problem existing in a diverse mathematics classroom, such as time limits. The discussion of those deficiencies was expressed as follows.

For further discussion of deficiencies, the participants reflected that those mentioned deficiencies gave low awareness about the diversity among students from different mathematics cultural backgrounds for three reasons.

Firstly, the pre-service mathematics teachers gave low awareness about the diversity among students from different perspectives since they emphasized the consciousness of mainstream mathematics, which is central Thai culture by assimilating diverse cultural mathematics backgrounds to manifest the national identity, being relevant to some research about multicultural education in Thailand (Arphattananon, 2018; Prapinwong, 2018; Sitthitikul

& Prapinwong, 2020). Consequently, they did not cultivate the belief system and attitude toward multicultural diversity from many perspectives except the social class.

Secondly, the pre-service mathematics teachers reflected that they did not gain adequate knowledge to become multicultural mathematics teachers who knew the diversity of learner styles from cultural differences. They seemed to show their unawareness of bias and prejudice in both implicit and explicit forms. Following Sunthonkanokpong and Murphy (2019), when there exists a discrepancy between teachers' initial education and the need for actual classrooms, the teachers may not be qualified and show inadequacy in particular areas, including multicultural education, from this study. It was also found that the pre-service mathematics teachers focused on the lack of support they experienced from the teacher education curriculum in the university and the lack of educational training related to building skills for teaching multiculturally (Lazarevic, 2020).

Finally, due to time limitations, the national standardized test limited their creativity in developing a transformation process into a multicultural entity. The psychomotor domain may be challenging to distinguish from the cognitive domain. This domain included ability and skills from integrating affective and cognitive competencies to confront many specific classroom situations affected by students' diverse cultural backgrounds. In the psychomotor domain, pre-service mathematics teachers need to perform so that they can design appropriate multicultural lessons despite any difficulty. However, from the result of this study, pre-service mathematics teachers had no skill to handle the difficulty of time constraints to implement different multicultural lessons, for instance.

Additionally, the findings added implications to multicultural mathematics education for pre-service mathematics teacher education in Thailand:

1. Pre-service mathematics teachers should have the opportunity to interact with other different cultural mathematics backgrounds and be introduced to diversity from many perspectives. They might be aware of the importance of having a diverse student population in order to contribute effectively to the mathematics learning process (Greene-Clemons, 2016).

2. Mathematics education programs for prospective mathematics teachers should add more subjects related to multicultural education for practicing pre-service mathematics teachers to deal with students from different cultural backgrounds.

3. Pre-service mathematics teachers should have the incentive to engage in various activities involving multiculturalism and be exposed to multicultural instruction courses. They would be able to demonstrate a more concise level of competence when integrating affective and cognitive competencies to handle diverse situations in mathematics classrooms.

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