

Creativity-Related Instructional Strategies in Secondary Mathematics Classrooms: A Case Study

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Abstract

The Philippine mathematics curriculum encouraged teachers to promote students' creativity in the classrooms to equip students with "21st century skills". However, mathematics instruction often emphasized traditional teaching methods that limit students' creative thinking. Additionally, fewer studies documented how creativity-related instructional strategies were enacted in a mathematics classroom, especially in the Philippine context. Therefore, this case study investigated the creativity-related instructional strategies employed by a teacher in teaching mathematics. The study was conducted in a laboratory school of a state university in Region X, Philippines. The class involved a teacher and 34 7th-grade students. Data collection was done through observations and interviews. Seven classes about division of polynomials were continuously observed. These were video recorded, transcribed verbatim, and segmented into classroom talk episodes. Qualitative content analysis, guided by a coding framework, was used to analyze the episodes. On the other hand, interviews with the teacher were audio-recorded, transcribed verbatim, and analyzed thematically to support the findings. The findings revealed that the teacher employed a range of creativity-related instructional strategies. These were categorized into four general themes: (1) allow collaborative making sense of mathematics, (2) elicit conjectures with respect, (3) stimulate divergent thinking, and (4) guide convergent thinking. Specific instructional strategies in each theme were also discussed. The findings suggested that the teacher created opportunities to support students' creative thinking in the mathematics classroom.

Keywords: creative thinking; instructional strategies; mathematics classrooms; secondary education; teaching mathematics

1. Introduction

Promoting creativity and creative thinking (CT) among learners has gained increasing attention among educational researchers. In the current times, CT skills are becoming more significant in the workplace as human resources should not only rely on routine skills to be competitive in this advancing world. According to the Organisation for Economic Co-operation and Development (OECD, 2024), CT is an important skill that an individual must possess, particularly school students. This call made the OECD Programme for International Student Assessment (PISA) incorporate CT as an innovative domain in its 2022 assessment in order to identify how schools support students' CT (OECD, 2023).

CT is defined as the cognitive ability that produces new, unique, or imaginative ideas (Hong, 2013; Ali et al., 2021). It is the cognitive processes involved in a creative act, and is identified as part of the broader multidimensional construct of creativity (Amabile & Pratt, 2016; Brandt, 2023). Compared with creativity, CT is a more observable and measurable construct within an educational setting. In the PISA 2022, CT was defined to reflect what students can reasonably demonstrate in the classrooms. It was defined as the students' ability to engage productively in ideation processes, particularly in the generation, evaluation, and improvement of ideas (OECD, 2023).

The MATATAG Curriculum, the Philippines basic education curriculum, states that the mathematics curriculum should also develop students' creativity as part of their "21st century skills" (Department of Education, 2023). The curriculum suggests that mathematics teachers should employ mathematical tasks that can stimulate students' cognitive processes as they try to understand and solve problems using a variety of approaches. The curriculum states that:

"Presented with non-routine problems, learners can identify new connections between concepts and ideas, examine them from various perspectives, consider alternative ideas or solutions, and demonstrate a willingness to try other methods or strategies in spite of previous unsuccessful attempts." (Department of Education, 2023, p. 7).

These tasks further support students' creativity by encouraging them to engage in CT and to develop creative dispositions in the mathematics classroom. This further highlights the teachers' role to promote students' CT in mathematics classrooms.

The creativity literature and the perspective of social constructivism also emphasize that classrooms, which are facilitated by a teacher, play a role in developing students' CT. According to OECD (2023), external factors such as school and classroom climate, cultural norms and expectations, and educational approaches can promote or hinder students' CT. Additionally, Vygotsky's (1978) concept of social constructivism acknowledges external factors such as cultural, historical, and social interaction, in the development of cognitive processes rather than attributing it solely to individual construction. These views highlight the vital role of classrooms in engaging students in thinking creatively, whether as an individual or as a product of a collective interaction with the teacher or with other students.

While the study primarily draws on perspectives of CT and classroom interaction, Shulman's (1987) concept of pedagogical content knowledge (PCK) served as a complementary lens for interpreting how teachers' instructional decisions supported opportunities for students' CT in mathematics classrooms. According to Ball et al. (2008), components of PCK in mathematics include Knowledge of Content and Students (KCS), Knowledge of Content and Teaching (KCT), and Specialized Content Knowledge (SCK), which can be reflected in how teachers respond to students' mathematical thinking, facilitate discourse, and guide conceptual understanding.

Mathematics teachers generally prefer traditional teaching methods such as lectures and rote memorization, which limit students' CT in the subject (Bicer, 2021; Pascua & Romero, 2020). However, several strategies noted in the literature to promote students'

CT in a mathematics classroom. According to the systematic review of Bicer (2021) on the research on students' mathematical creativity, the studies suggest that teachers should integrate discipline-specific instructional practices, such as problem-solving and problem-posing activities, and general instructional practices, such as allowing students to make mistakes and establishing a collaborative classroom environment. These practices help to increase students' creative potential in mathematics. On the other hand, the systematic review of Jasmin and Buan (2025) found that CT in mathematics can be promoted through a range of instructional interventions in teaching mathematics, such as the use of contextual learning, problem posing activities, inquiry-based learning, problem solving approach, cooperative learning, and interdisciplinary lessons.

The reviewed empirical studies mostly emphasized general instructional approaches in promoting students' CT in mathematics. Fewer studies have examined specific teacher actions that may support students' CT in the classroom, especially in its natural setting without any instructional intervention. To address this gap, a case study was conducted to explore the instructional strategies employed by a mathematics teacher during instruction that create opportunities for students to express CT. In the context of the study, instructional strategies referred to the specific, or concrete actions of the teacher enacted during the mathematics instruction. This study added to the body of knowledge by providing insights into how opportunities for CT can emerge in everyday classroom practice, and how these creativity-related instructional strategies were evident in the context of Philippine mathematics classrooms. Specifically, this study was guided by the main research question: "What creativity-related instructional strategies were used by a teacher in teaching mathematics?"

2. Methods

2.1. Research Design

This study employed a single case study research design, specifically an intrinsic case study, which describes the case in detail to provide an in-depth understanding of the creativity-related instructional strategies used by a teacher in teaching mathematics (Fraenkel et al., 2011; Creswell & Guetterman, 2019). The case of a regular mathematics classroom illustrated how a teacher used creativity-related instructional strategies in teaching mathematics.

2.2. Research Participants

The research was conducted in the laboratory school of a state university in Region X, Philippines. This particular secondary school uses a mathematical problem in teaching mathematics lessons. The research subjects were chosen using a typical sampling method, guided by the criterion of representativeness of the wider population, as recommended in case study research (Duff, 2018). Typical sampling is a form of purposeful sampling that selects participants because they are average or a typical case of a population (Fraenkel et al., 2011; Creswell & Guetterman, 2019). The researchers selected a single mathematics classroom that represented all the existing mathematics classrooms in the laboratory school. The class was also not subjected to any programs aimed at promoting creativity in the classroom.

The selected classroom was a 7th-grade mathematics class with 34 student participants having varied proficiency levels in mathematics. The teacher participants included a female mathematics cooperating teacher with 25 years of teaching experience, and a female pre-service teacher participating in an internship program at the laboratory school. Both prepared the lesson plan and worked together during instruction. Given their shared responsibility and shifting roles during instruction, it was difficult and less meaningful to attribute instructional strategies to a single teacher. Instead, the study

focused on instructional strategies as a collective teaching process, examining how they emerged in the classroom rather than evaluating individual teacher performance. In line with this, both of them were treated as a single teaching unit, and referred as the “teacher” in this study.

2.3. Research Procedure

The researchers obtained ethical clearance from the university before conducting the study. Before the classroom observations, permissions were obtained from the head of the laboratory school and from the participants. The participants were also informed about the research procedure, as well as the risks and benefits associated with their voluntary participation.

Data collection was conducted through classroom observations and interviews. The researchers conducted preliminary classroom observations a week prior to the main observations to become familiar with the classroom environment. The next two weeks were allotted for main classroom observations. Seven 60-minute classes were continuously observed over a two-week period. The lessons in all of the observed classes were about the division of a polynomial by a binomial. The entire duration of classes was video-recorded and supported by audio recordings. After the series of observations, the teacher participants were interviewed using a semi-structured questionnaire (see Appendix 1), and the entire interview was audio-recorded. The recordings were transcribed verbatim before the analysis.

2.4. Data Analysis

Qualitative content analysis was used to analyze the lesson transcripts. This analysis allowed quantification of the data to report the frequency of similar codes (Vaismoradi & Snelgrove, 2019). Before the analysis, the lesson transcripts were segmented into classroom talk episodes to allow the observed strategies to be meaningfully interpreted (Cobb & Yackel, 1996). This process resulted in 33 classroom talk episodes. The transcripts were coded using an established coding guide to ensure consistent identification and categorization of the teacher’s instructional strategies. The coding process focused on observable teacher-student interactions that highlight the teacher’s instructional strategies.

The coding guide for creativity-related instructional strategies used in this study was modified from the “teaching for creativity” codes of Schoevers et al. (2019) to analyze the episodes. The set of codes was already noted in the literature to have the potential to support students’ mathematical creativity. The modified codes focused on observable teacher moves and classroom interactions, which served as the basis for identifying creativity-related instructional strategies within mathematics instruction. The codes also reflect the teacher’s PCK in mathematics, such as facilitation of classroom discourse and responses to student thinking during the instruction (Ball et al., 2008).

To establish reliability, the first author and a second coder independently coded sample transcripts from the preliminary classroom observations. The reliability was determined with an inter-coder agreement, which was calculated by counting the total number of agreements divided by the total number of agreements and disagreements (DeCuir-Gunby et al., 2011). The first coding returned 51.35% inter-coder agreement. The inconsistencies were examined through discussion, which revealed overlapping meanings and ambiguities in several operational definitions. The codes were adjusted, and the operational definitions were clarified. The same transcripts were second coded using the adjusted coding guide. The second coding returned 81.81% inter-coder agreement, which is already a good reliability (Fraenkel et al., 2011), suggesting improved consistency and a more shared understanding of the coding scheme. Table 1 showed the coding guide for the instructional strategies used in teaching mathematics, which revealed eleven codes.

Using the coding guide, episodes were coded, and frequencies were tallied. Descriptions of the codes were then developed through an interpretive analysis of the classroom data.

On the other hand, thematic analysis was used to manually analyze the interview transcripts (Braun & Clark, 2006). A deductive approach was adopted, wherein the analysis was guided by pre-established codes. The analysis began with familiarization with the data through repeated reading of the interview transcript. Initial codes were then generated with reference to these predetermined constructs to capture salient and recurring ideas.

Furthermore, the teacher's instructional strategies were grouped into general themes to reduce fragmentation of the findings and highlight their shared pedagogical intent. Rather than merely aggregating similar behaviors, the themes further provide an analytically meaningful structure for understanding how creativity-related instructional strategies were enacted in the classroom.

Table 1. Coding guide for creativity-related instructional strategies

Code	Operational Definition
1. Let students collaborate	The teacher let the students collaborate by allowing them to work together in doing a task.
2. Encourage autonomy	The teacher encourages autonomy by allowing the students to use any methods or strategies in completing a task.
3. Encourage creative ideas	The teacher explicitly encourages students to think of unusual or non-standard ideas.
4. Ask activating questions	The teacher asks an activating question that helps the students to reflect on the task.
5. Ask students to connect ideas to prior knowledge	The teacher asks the students to connect ideas to mathematical concepts they have previously encountered or learned.
6. Ask students to connect ideas to real-world contexts	The teacher asks the students to connect ideas to real-world contexts or own life experiences.
7. Stimulate diverse viewpoints	The teacher stimulates diverse viewpoints by suggesting a different perspective about the task.
8. Let students share ideas freely	The teacher let the students share their ideas with the whole class without interruption.
9. Acknowledge ideas with respect	The teacher acknowledges students' ideas with respect by responding with a neutral language, or by repeating or elaborating a student's idea without immediate evaluation.
10. Ask more about students' idea	The teacher asks a follow-up question about a specific student's idea to learn more about them, to support the student's thinking, or to obtain clarification.
11. Let students react on each other's ideas	The teacher let the students react on the ideas of each other by encouraging them to respond, challenge, or add up to what another student has said. The teacher may ask a follow up question that is directed to the class instead of a specific student.

Peer debriefing and member checking were conducted in the study to enhance its trustworthiness (Nowell et al., 2017). Peer debriefing happened through regular consultations with an experienced qualitative researcher and with the research team. The expert critically examined the alignment between the data and the analysis, questioned underlying assumptions, and provided alternative perspectives. On the other hand, member checking was conducted by presenting selected findings and interpretations to the participants. Their responses confirmed that the interpretations were consistent with their perspectives.

3. Results and Discussion

The study found that the teacher employed a range of creativity-related instructional strategies in teaching the division of a polynomial by a binomial. Table 2 presents the themes of the teacher's instructional strategies and their occurrence during the classroom observations. The analysis revealed that the most frequently used creativity-related instructional strategies were stimulating diverse viewpoints, asking activating questions, acknowledging ideas with respect, letting students react to each other's ideas, and asking more about students' ideas. The least frequently observed strategies were encouraging autonomy, and encouraging creative ideas. No episodes were coded under asking students to connect ideas to real-world contexts. Furthermore, the instructional strategies mainly revolved around the four themes: allow collaborative making sense of mathematics, elicit conjectures with respect, stimulate divergent thinking, and guide convergent thinking.

Table 2. Themes of the teacher's instructional strategies and their occurrence during the classroom observations

Themes	Codes	Sample Transcript	Occurrence in the Episodes (n=33)
Allow collaborative making sense of mathematics	Let students collaborate	Go to your groups and get your whiteboards.	5
	Let students react on each other's ideas	(S21 changes x^2-3x into $-x^2+3x$ when subtracting it from x^2-x) [Is it] right? If we subtract, will the subtrahend change sign?	19
	Elicit conjectures with respect	Okay, tell us here. Tell your classmates why did I appreciate your idea.	11
	Acknowledge ideas with respect	Oh, okay. Did you get her point? This is what they were saying (repeats S27's idea)	20
	Ask more about students' idea	(S27 claims that x divided by x is 1 which is also equal to x) x over x equals 1? Then?	14
	Stimulate divergent thinking	Encourage autonomy Try to solve this problem using any methods you have learned.	3
	Encourage creative ideas	Solve this one in the not usual way.	1
	Stimulate diverse viewpoints	Okay, I will pick one group for true and one group for false.	27
	Guide convergent thinking	Ask activating questions Notice all the methods. What happened?	23
	Ask students to connect ideas to prior knowledge	What was the rule of multiplication again?	11

Theme 1. Allow collaborative making sense of mathematics.

The first theme describes the instructional moves of the teacher that allow the students to make sense of mathematics, or, in the context of the study, to understand a mathematical idea using their existing mathematical knowledge in a collaborative environment. This theme includes the codes "let students collaborate", and "let students react to each other's ideas".

The following transcript was an excerpt from Day 1, where the teacher introduced the division of a polynomial by a binomial using the method of long division previously shown with large whole numbers. The teacher let the students work with their groupmates to divide x^2-x-6 by $x-3$. During problem solving, Group 7 had the following discussion.

Sample excerpt: teacher lets students collaborate

- S27: Let's try that (long division)
 S17: How about the distributive. Or what was written on the blackboard (long division)?
 T: (to all) Class, you cannot separate this $(x-3)$. The denominator is always considered as one. It is not possible that x is here then minus 3 here, no.
 S27: How can we make this a fraction?
 S23: How about that ...
 T: (to all) Use the same way. That principle (long division example in the board)
 S27: (writes the expression in a long division format)
 T: (arrives) That, start! This one first, x^2 divided by x , answer?
 Group: x
 T: What's next? Multiply (to first term), multiply (to second term) go

It can be noted from the transcript that the teacher guided the students during their collaborative problem solving. Moreover, the students proposed multiple ideas at the start, demonstrating their initiative in applying their prior knowledge to address the problem. These actions illustrate the theme because during the group activity, students tried to make sense of the problem using the concepts they learned from previous lessons.

In continuation of the previous transcript, the teacher invited Group 5 to share their work with the class during the whole class discussion. Figure 1 shows their whiteboard, which presents their solution.

Sample excerpt: teacher lets students react on each other's ideas

$$\begin{array}{r} x-3 \overline{) x^2-x-6} \\ \underline{x^2-3x} \\ 2x-6 \\ \underline{2x-6} \\ 0 \end{array}$$

Figure 1. Group 5's solution of $\frac{x^2-x-6}{x-3} = x+2$ in long division method

- S21: (explains their solution)
 The x^2 divided by x , is x
 x times $x-3$ is x^2-3x
 Then, I did minus x^2-x and x^2-3x
 So, x^2 minus x^2 is 0. Then, $-x$ minus $-3x$ is $+2x$.
 T: (intervenes in the middle of S21's explanation)
 [Is it] right? When we subtract, the subtrahend will change sign?
 (refers to x^2-x minus x^2-3x)
 S: Yes, Ma'am
 T: She said, x^2 minus x^2 becomes 0. $-x$ minus ..., this $(-3x)$ will become?
 S21: $+3x$
 T: Put a positive [sign] there
 S21: (writes + sign on their board)

The transcript showed that while S21 was explaining, the teacher interrupted with a question about changing the signs. This question highlighted an important step in performing long division with polynomials. Instead of asking the presenter back, she asked the class, who responded with an agreement to what the group did. These actions also

illustrate the theme because the teacher facilitated the class discussion, trying to make sense of the reason behind changing the signs of the polynomial during subtraction.

The first theme revealed that students' engagement in collaborative activities helped them make sense of mathematical ideas, which in turn fostered a sense of ownership in learning mathematics, enriching their learning experience (Leinwand et al., 2014). Sense-making activities in the mathematics classroom allow students to develop an understanding of an idea by connecting it to existing mathematical knowledge, bringing ideas they already know at some level (Van Velzen, 2016; Fitzgerald & Palincsar, 2019). In the observed classroom, students were not merely recalling procedures. Rather, they actively negotiated meanings, shared explanations, and connected prior knowledge with the mathematical ideas presented during instruction. This process was particularly evident during group activities where students exchanged and reflected on ideas with their peers. Consistent with Biccard (2018), sense-making in mathematics was strengthened through collaborative work, as students were given opportunities to discuss, justify, and refine mathematical ideas together. This theme may also reflect aspects of KCT, particularly in how the teacher facilitated collaborative mathematical discourse and structured opportunities for shared sense-making. Additionally, the teacher's responsiveness to students' developing ideas may also suggest aspects of KCS.

The interview transcripts also revealed that the teacher valued students' collaboration as part of mathematics learning. When students work together on a task, they will not feel helpless, which makes them more likely to share ideas as they complete the given task. This also provides an opportunity for them to apply their prior knowledge to solve the problem. The teacher shared that,

"...when you work alone, [and] you don't know how to do it you'll feel useless, you're helpless, you're afraid. And when you let them do collaborative activity, they will see themselves 'oh, I can really contribute'. ...".

"... There is a need for groupwork so that they [students] can share ideas."

These statements suggest that collaboration was not simply a classroom arrangement but an instructional strategy that encouraged students to express ideas, test their thinking, and participate in constructing mathematical understanding. During collaborative activities, students became less hesitant to share tentative ideas because the group setting reduced feelings of helplessness and increased their confidence to contribute. This environment enabled students to apply prior knowledge, compare different ways of thinking, and collectively make sense of mathematical concepts.

Together with mathematics learning, collaborative sense-making was also noted to provide an opportunity for students to express creativity in the classrooms. The literature emphasized the importance of collaboration in promoting creativity in classrooms (Davis et al., 2017; Gardiner, 2020). Similarly, Craft (2008) argued that creativity and the construction of meaning are closely intertwined because constructivist learning environments encourage the generation of original and useful ideas. Furthermore, other researchers believed that the development of students' mathematical creativity was related to those students who make meaning of the mathematics content for themselves and with others (Catarino et al., 2019).

Theme 2. Elicit conjectures with respect.

The second theme describes the instructional moves of the teacher that elicit students' conjectures, or, in the context of the study, mathematical ideas that are potentially true without the fear of being judged with the correctness of their ideas. This theme includes the codes "let students share ideas freely", "acknowledge ideas with respect", and "ask more about students' idea".

The following transcript was an excerpt from Day 4, where the teacher let the students answer the following problem: “ $\frac{x+25}{x+5} = 5$. Is this TRUE? If not, do something to make it TRUE.” Group 7 used an incorrect method for dividing polynomials, but the teacher still invited their group to share their answer with the class. Figure 2 shows the whiteboards for Group 7 (left) and Group 6 (right). Group 7 used an incorrect way for dividing polynomials, but the teacher still invited their group to share their answer with the class.

Sample excerpt: teacher lets students share ideas freely

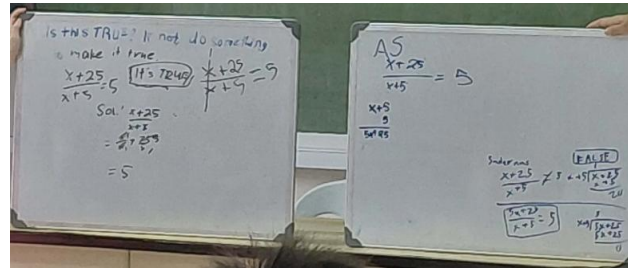


Figure 2. Whiteboards of Group 7 (left) and Group 6 (right) showing different answers.

T: This group is important. I may have appreciated it, but it's not correct.

T: Okay, tell us here. Tell your classmates why did I appreciate it. Okay go.

S27: (starts explaining their work for true)

So, what we did is we come up with a concept that we can cancel the operation of addition. So, what we did is we cancel the two x in here (points to x in both numerator and denominator) and left with 25 over 5 to get 5

However, I'll admit that our statement is false, said by Ma'am earlier, because x with a value is equal to 1.

So, technically, 1 equals x, x equals 1. Therefore, dividing x by x is 1 which is equal to x. Therefore, our statement should have been false. However, in our interpretation, x divided by x cancels out to nothing, which is why we got 5.

The transcript showed that Group 7, who showed an incorrect answer, was still invited to present their work to the class. The teacher gave them time to freely share their ideas without interruption. During their presentation, they tried to change their answers, but still showed an incorrect idea. This action illustrates the theme because the teacher allowed the students to articulate their ideas in the class, even if they were incorrect.

Continuing the previous transcript, S27 further explained their new idea. Figure 3 shows S27's writings on the board as she explains her idea to the class.

Sample excerpt: teacher asks more about students' idea

S: Ha?

S19: Ay, x over x is equal to 1?

T: x over x equals 1?

S27: Yes, Ma'am

T: Then?

S27: (further explains their reasoning while writing on the board)

Since x equals 1, and 1 equals x

We have 1 divided by 1 equals 1, and x divided by x equals x. Since, x equals 1

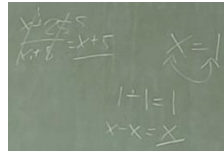


Figure 3. S27's writings on the board.

Therefore, to make the statement true, it should have been $x+5$

S: Ah

The transcript showed that the teacher tried to better understand the idea of Group 7 by asking follow-up questions to S27. These questions encouraged students to articulate the reasoning behind their ideas, making their conjectures more explicit. These exchanges further illustrate the theme as students were given the opportunity to develop and explain their ideas in a supportive, and non-threatening classroom discussion.

Continuing the previous transcript, S27 reiterated their idea.

Sample excerpt: teacher acknowledges ideas with respect

S27: So, the answer should be $x+5$.

And since in the given problem, the answer is only 5, our statement was supposed to be false.

T: To make it right, it should be $x+5$?

S27: Yes, Ma'am

T: Oh, okay. Did you get her point?

T: This is what they were saying. (repeats group 7's idea)

This is what they were thinking, isn't it?

The transcript showed that the teacher and the other students tried to understand the idea of Group 7. Although it was mathematically incorrect, the teacher did not label it as wrong. Instead, the teacher accepted their idea, and also made sure that other students understood their point. These actions further illustrate the theme because the teacher responded in a way that students' ideas were recognized and considered despite their inaccuracy.

The second theme revealed that conjecturing emerged as an important instructional strategy in teaching mathematics. It allowed students to openly express and examine their mathematical thinking. Conjectures are important in mathematics classrooms because they reveal students' differing conceptions, support reasoning, and foster learning (Lim et al., 2010). During the observed instruction, the teacher frequently elicited students' ideas through probing and follow-up questions that encouraged them to explain the reasoning behind their answers rather than simply state whether an answer was correct or incorrect. This reflects the teacher's processing skills in teaching mathematics, which involve using varied questions to uncover students' thinking and deepen their reasoning (Buan et al., 2021). Instead of immediately evaluating students' responses, the teacher often sustained discussions around students' ideas, allowing conjectures to remain open for examination and justification. This aligns with Leinwand et al. (2014), who emphasized that withholding immediate judgment enables students to test, defend, and refine their conjectures through classroom interaction. This theme may also reflect the aspects of KCS, particularly in recognizing how students develop mathematical reasoning. Moreover, guiding students to refine conjectures may also suggest elements of SCK.

The interview transcripts also revealed that the teacher intentionally created a classroom atmosphere in which students felt safe to share ideas, even incorrect ones. The teacher recognized that students' incorrect answers were valuable because they provided insights into students' thinking and misconceptions, which could then serve as starting points for discussion and clarification. The teacher shared that,

“... like making them feel safe that it’s okay to be wrong. ... even if it [idea] is wrong, I can polish it. Then, I can gain some insights about the reason behind their answer. Then, I can clarify it.”.

“It [students’ error] is not to make them feel ashamed.”.

These responses reflected how the teacher viewed students’ conjectures, including incorrect ones, as meaningful contributions to the learning process rather than failures to be corrected immediately. In the observed classes, wrong answers became opportunities for students to justify their thinking, compare ideas, and collectively examine mathematical relationships. Such interactions encouraged students to participate more actively in classroom discussions because they knew that their ideas would be heard and explored respectfully. This supports the findings of Schleppenbach et al. (2007), who argued that students are more willing to share ideas when they feel safe to talk in the classroom, even when discussing incorrect answers. Similarly, Francome and Hewitt (2020) emphasized that students’ mistakes can serve as productive opportunities for advancing mathematical discussions and learning.

Instructional strategies that elicit conjectures with respect were not only important for conceptual understanding, but also provided opportunity for students to express their CT in the mathematics classroom. The process of conjecturing encouraged students to think broadly and flexibly about mathematical ideas and relationships, allowing them to explore possibilities and alternative explanations rather than rely solely on fixed procedures (Simsek, 2020). In this study, the teacher’s openness toward students’ ideas created opportunities for students to test initial ideas, refine their reasoning, and engage in mathematical risk-taking. This kind of supportive classroom environment is important in promoting creativity because students become more willing to express unconventional or incomplete ideas without fear of embarrassment or judgment. Consistent with the literature on mathematical creativity, classrooms that encourage students to freely express ideas, learn from mistakes, and take intellectual risks are more likely to support the development of students’ CT (Sriraman, 2005; Nadjafikhah et al., 2012; Basic et al., 2022; Johansen et al., 2022; Veith & Bitzenbauer, 2022).

Theme 3. Stimulate divergent thinking.

The third theme describes the instructional moves of the teacher that can stimulate students’ divergent thinking, or, in the context of the study, the students’ ability to generate diverse ideas and creative ideas in the classroom. This theme includes the codes “encourage autonomy”, “encourage creative ideas”, and “stimulate diverse viewpoints”.

The following transcript was an excerpt from Day 7, where the teacher let the students solve $\frac{60}{12}$ using methods other than long division.

Sample excerpt: teacher encourages creative ideas and autonomy in solving the problem

T: We have here (writes on the board) $\frac{60}{12}$. How do we usually solve this one?

S: Long division

T: Okay, using long division

T: Now, I want you to go in your groups. Solve this one in the not usual way.

S: In the not usual way?

T: You will not use the long division, but instead use the other methods to divide 60 by 12

S5: Can we use factoring, Ma’am?

T: Yes, you can. Any method

The transcript showed that the teacher explicitly prompted the students to solve the problem using uncommon methods. The teacher also acknowledged the use of any methods they can think of, emphasizing their autonomy in problem solving. These actions illustrate the theme because the teacher prompted the students to generate any ideas they could use to solve the problem, even encouraging unconventional ideas.

Continuing the previous transcript, the teacher acknowledged different ways to divide 60 by 12 without using the long division method. Students have shared the use of drawing sticks or boxes, repeated subtraction or addition, and factoring methods. The teacher further emphasized the discussion on the use of factoring. Figure 4 shows a sample of students' boards showing different methods to solve 60 divided by 12.

Sample excerpt: teacher stimulates diverse viewpoints

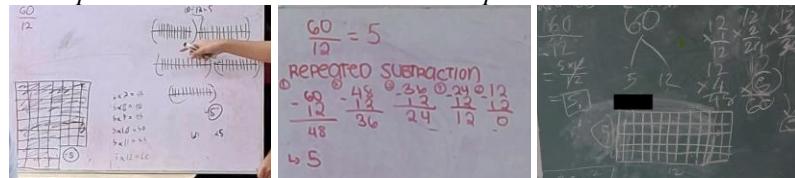


Figure 4. Sample of students' boards showing different methods to solve 60 divided by 12.

- T: Using the repeated subtraction, is the expression (points to $\frac{12 \times 5}{12}$) equal to this? (writes on the board $= \frac{12+12+12+12+12}{12}$)
- S: Yes
- T: Yes? So, how many 12s are there?
- S: 5
- T: Is the expression equal to this? (writes on the board $= \frac{12(1+1+1+1+1)}{12}$)
- S: Yes?
- T: Why did it turn out to be 1? Why did the 12 become 1?
- S: factor out

The transcript showed that the teacher represented $\frac{60}{12}$ in different forms using the students' work in repeated subtraction. The teacher led the students to realize that those representations led to the factored form of the problem. This action also illustrates the theme because the teacher intended for the students to analyze different viewpoints, which further presented diverse ideas in the class.

The third theme revealed that divergent thinking is an important cognitive activity in the mathematics classroom. It encouraged students to explore and generate multiple approaches to mathematical problems. In mathematics, divergent thinking is commonly associated with generating multiple solutions or approaches to solve a problem (Hadar & Tirosh, 2019). However, divergent thinking also reflects students' broader ideation processes in the classroom, particularly in their ability to generate diverse and creative ideas during instruction (OECD, 2023). In the observed classes, the teacher consistently encouraged students to think beyond routine procedures by inviting them to share alternative methods, explain uncommon ideas, and explore approaches that were not explicitly taught in class. Rather than directing students toward a single expected solution, the teacher created opportunities for students to freely present different mathematical strategies and reasoning. This instructional practice allowed students to engage more actively in exploring mathematical possibilities and relationships. This theme may also reflect aspects of KCT, particularly through the teacher's use of instructional strategies that encouraged multiple solution pathways and flexible mathematical thinking.

The interview transcripts also revealed that the teacher values students' generation of diverse ideas in the classroom by giving the students opportunities to propose any solutions to a particular problem and by listening to their ideas. The teacher expressed that,

"What I saw with my students was that, ... the opportunity that we can give them to provide, ... several solutions."

"... if we listen to their answers, whether the activity you posted was easy or difficult, if you will not listen, you can never catch their ideas".

The teacher also emphasized openness toward unfamiliar or unconventional methods, and deliberately prompted students to move beyond routine strategies. She explained that,

"Although I did not teach it (particular method), if you think it will work, this will really work, class'."

"... I have to say that 'think of other ways than the usual'. Because that will prompt them [students] to explore not only the methods they already knew."

These statements suggest that the teacher viewed students' diverse ideas as an important resource for learning mathematics. During classroom discussions, students were not restricted to reproducing procedures demonstrated by the teacher. Instead, they were encouraged to construct and test their own approaches. The teacher's willingness to acknowledge methods that had not been previously taught further reinforced a classroom culture in which students felt unconventional ideas were valued. Moreover, by encouraging students to "think of other ways," the teacher created opportunities for students to move beyond routine thinking and engage in flexible exploration of mathematical ideas. Such practices stimulated students to think more flexibly and broadened the range of mathematical strategies explored during instruction. This reflects the idea of Tan and Sriraman (2017) that divergence of ideas is essential in the creative process of knowledge construction.

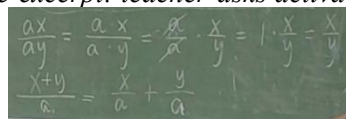
Stimulating divergent thinking was also noted in the literature as a way to create opportunities for students to express CT in mathematics. Divergent thinking has long been recognized as a central component of creativity research. Much of the literature on creativity is grounded in the divergent thinking indicators identified by Guilford (1950) and Torrance (1974), namely fluency, flexibility, originality, and elaboration. In mathematics education, these indicators are likewise reflected in studies on mathematical creativity, particularly in problem solving and problem posing activities (Silver, 1994; Silver, 1997; Siswono, 2010).

Theme 4. Guide convergent thinking.

The fourth theme describes the instructional moves of the teacher that guide students' convergent thinking, or, in the context of the study, their ability to evaluate ideas to construct new mathematical understanding. This theme includes the codes "ask activating questions", and "ask students to connect ideas to prior knowledge".

Going back to the observed class on Day 4, Group 7 showed that $\frac{x+25}{x+5} = \frac{x}{x} + \frac{25}{5}$. The following transcript showed that during the whole class discussion, the teacher tried to address the students' misconceptions by facilitating the recall of some algebraic properties. The teacher wrote on the board as students answered. Figure 5 shows the algebraic properties recalled during the discussion.

Sample excerpt: teacher asks activating questions



$$\frac{ax}{ay} = \frac{a \cdot x}{a \cdot y} = \frac{\cancel{a} \cdot x}{\cancel{a} \cdot y} = 1 \cdot \frac{x}{y} = \frac{x}{y}$$

$$\frac{x+y}{a} = \frac{x}{a} + \frac{y}{a}$$

Figure 5. Algebraic properties recalled during the discussion.

- T: Why is this allowed? Why is it equal? ($\frac{x+y}{a} = \frac{x}{a} + \frac{y}{a}$)
- T: It's just like (writes on the board as students answer)
 [Board: $\frac{1}{2} + \frac{3}{2} = \frac{1+3}{2} = \frac{4}{2} = 2$]
- T: (goes back to her question)
 This (points to $\frac{x+y}{a} = \frac{x}{a} + \frac{y}{a}$)? Because they have similar what?
- S: Denominator
- T: Denominator. But class, how about (writes on the board $\frac{a}{x+y}$)?
- T: Can we separate? (writes on the board $\frac{a}{x+y} = \frac{a}{x} + \frac{a}{y}$)
- T: Do they have the same denominator?
- S: No

The transcript showed that the teacher did not directly impose those properties on the students. Instead, she used several questions to help students reflect on those properties, and how they will be applied to the problem. This action illustrates the theme because the teacher is leading the students towards a shared understanding through questioning.

In continuation of the previous transcript, the teacher utilized students' prior knowledge to support their current understanding.

Sample excerpt: teacher asks students to connect ideas to prior knowledge

- T: What was that rule in multiplication? (together with students)
 numerator times numerator all over denominator times denominator
- S: numerator times numerator all over denominator times denominator
- T: How about this one, how to simplify?
 (writes on the board $\frac{2}{3} + \frac{5}{2} = \frac{2+5}{3+2}$) Is it like this?
- S: No
- T: No, right? What to do?
- S: LCD
- T: Find the LCD

The transcript showed that the teacher used students' prior knowledge of multiplication of fractions, the addition of dissimilar fractions, and the use of the least common denominator (LCD) to guide them in solving the given problem correctly. This action also illustrates the theme because the teacher intentionally used students' prior knowledge to reach a sound conclusion about simplifying the expression in the problem.

The fourth theme revealed that convergent thinking is also an important cognitive activity in the mathematics classroom. In contrast to divergent thinking, which emphasizes the generation of varied ideas, convergent thinking focuses on examining, connecting, and refining those ideas to develop a shared mathematical understanding (Lee, 2017). Convergent thinking involves students' ability to evaluate ideas and identify ways to improve them (OECD, 2023). Researchers also described convergent thinking as reflecting students' fact retrieval and automatization processes, where they connect previously known strategies and reasoning to identify more effective mathematical ideas (Tabach & Levenson, 2018). While it is commonly associated with arriving at a single best solution (Cromptley, 2006), convergent thinking goes beyond simply obtaining the correct answer. It involved students in comparing methods, reflecting on their reasoning, and identifying relationships among mathematical ideas in order to construct deeper understanding (Hadar & Tirosh, 2019). This theme may also reflect aspects of SCK, particularly in supporting mathematically sound reasoning during classroom discussion.

The interview transcripts further revealed that the teacher intentionally guided students' diverse ideas toward a collective mathematical understanding by emphasizing

connections between concepts and encouraging reflective thinking. The teacher shared that,

“... my only purpose is that the students will not compartmentalize in a way that after a lesson about a certain topic, they can already forget [what they learned].”

This suggests that the teacher aimed to help students connect mathematical ideas across lessons rather than treat concepts as isolated procedures. The teacher also highlighted the importance of reflective questioning during classroom discussions. She explained that,

“... it is very important to ask why or how questions. ... they can think again about what they did. Not only them, but their classmates will also realize what other possible ways can be done (in solving the problem).”

These responses illustrate that the teacher used questioning not merely to check answers, but to encourage students to revisit, examine, and refine their thinking. During the observed lessons, students were prompted to explain why a method worked, compare different approaches presented by classmates, and identify connections between strategies and mathematical concepts. Through these discussions, students were guided to consolidate diverse ideas into meaningful mathematical understanding. Rather than ending at the idea-generation stage, the instruction encouraged students to critically evaluate and connect ideas, thereby making mathematical concepts more coherent and transferable.

The findings suggest that guiding convergent thinking played an important role in the knowledge construction of mathematical ideas. This was also noted in the literature to provide opportunities for students to express CT in mathematics. Tan and Sriraman (2017) emphasized that convergent thinking is essential in the creative process because it helps learners organize and refine ideas into meaningful knowledge. Although convergent thinking is sometimes associated with narrow or routine thinking (Tabach & Levenson, 2018), this study's findings suggest that it operated differently in the observed classroom. Students were not simply directed toward one correct answer. Instead, they were encouraged to critically examine the strengths, limitations, and connections among various ideas generated during discussion. This supports the argument of Amabile and Pratt (2016) that evaluation of ideas is itself part of the creative process. Similarly, Lee (2017) explained that divergent thinking without convergent exploration may yield novel ideas that are mathematically meaningless. In the observed classroom, the teacher's instructional strategies helped students move from generating ideas to evaluating and refining them, enabling students to build a mathematically sound understanding. Thus, instructional strategies that activate convergent thinking also created opportunities for creative expression by encouraging students to reflect on, improve, and meaningfully connect mathematical ideas during classroom interaction.

4. Conclusion

The study revealed that over the two weeks of continuous classroom observations, creativity-related instructional strategies were observed while the teacher delivered the mathematics instruction. The teacher may not intend to promote students' CT, but these strategies emerged to meaningfully support students' learning of mathematical ideas and concepts. Since these strategies were noted in the literature as supporting mathematical creativity, this highlights that the teacher created opportunities for students' CT in the classroom. The presence of multiple creativity-related instructional strategies in the observed regular classroom indicates that creativity can be supported in a regular mathematics instruction without the need for specialized programs.

The four themes of instructional strategies identified in this study further imply that strategies that promote interaction, openness to students' thinking, exploration of multiple approaches, and reflective evaluation can create meaningful opportunities to learn mathematics, and for students to express CT in mathematics classrooms. Specifically,

allowing collaborative making sense of mathematics reflects how teachers facilitate mathematical discourse and shared understanding among students, while eliciting conjectures with respect highlights teachers' responsiveness to students' developing ideas and reasoning. Moreover, stimulating divergent thinking demonstrates instructional practices that encourage flexible and multiple mathematical approaches, whereas guiding convergent thinking emphasizes teachers' role in supporting students in evaluating, justifying, and refining mathematical ideas. These instructional practices may also reflect aspects of mathematics PCK, particularly in facilitating discourse, responding to students' thinking, and guiding mathematically meaningful reasoning during classroom interaction.

This study contributed to the body of knowledge by identifying specific instructional moves that mathematics teachers can adapt to support students' CT in a daily classroom practice. They are also encouraged to connect procedural topics to real-world contexts to further support students' learning and CT in mathematics. However, the study acknowledges that the findings are limited to a single mathematics classroom, and therefore, cannot be generalized to all mathematics classrooms. Future studies are encouraged to examine how these strategies were evident in other mathematics classrooms, in other mathematics content, and at other grade levels, particularly in the context of Philippine education.

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5. References

- Ali, D., Zubaidah Amir, M. Z., & Vebrianto, R. (2021). Literature Review: Mathematical Creative Thinking Ability, and Students' Self Regulated Learning to Use an Open Ended Approach. *Malikussaleh Journal of Mathematics Learning*, 4(1), 52-61.
- Amabile, T. M., & Pratt, M. G. (2016). The dynamic componential model of creativity and innovation in organizations: Making progress, making meaning. *Research in organizational behavior*, 36, 157-183.
- Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special. *Journal of teacher education*, 59(5), 389-407.
- Basic, A., Arsic, B., Gajic, A., Parezanovic, R. Z., Macesic, D., & Petrovic, T. L. (2022). Creativity in teaching mathematics. *Human Research in Rehabilitation*, 12(2), 127-137.
- Biccard, P. (2018). Mathematical sense-making through learner choice. *Pythagoras*, 39(1), 1-9.
- Bicer, A. (2021). A systematic literature review: Discipline-specific and general instructional practices fostering the mathematical creativity of students. *International Journal of Education in Mathematics, Science, and Technology (IJEMST)*, 9(2), 252-281. <https://doi.org/10.46328/ijemst.1254>
- Brandt, W. C. (2023). Measuring student success skills: A review of the literature on creative thinking. *National Center for the Improvement of Educational Assessment*. <https://www.nciea.org/library/measuringstudent-success-skills-a-review-of-the-literature-on-creative-thinking>.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Buan, A. T., Medina, J. B., & Liwanag, G. P. (2021, March). Capacity building in teaching mathematics through problem solving. In *Journal of Physics: Conference Series* (Vol. 1835, No. 1, p. 012090). IOP Publishing.
- Catarino, P., Vasco, P., Lopes, J., Silva, H., & Morais, E. (2019). Cooperative learning on promoting creative thinking and mathematical creativity in higher education. *REICE. Revista Iberoamericana Sobre Calidad, Eficacia y Cambio En Educacion*, 17(3), 5-22.

- Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational Psychologist*, 31(3–4), 175–190. <https://doi.org/10.1080/00461520.1996.9653265>
- Craft, A. (2008). Studying collaborative creativity: Implications for education. *Thinking skills and creativity*, 3(3), 241–245.
- Creswell, J. W., & Guetterman, T. C. (2019). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (6th ed.). Pearson.
- Cropley, A. (2006). Creativity: A social approach. *Roeper review*, 28(3), 125–130.
- Davis, N., Hsiao, C. P., Singh, K. Y., Lin, B., & Magerko, B. (2017, June). Creative sense-making: Quantifying interaction dynamics in co-creation. In *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition* (pp. 356–366).
- DeCuir-Gunby, J. T., Marshall, P. L., & McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field methods*, 23(2), 136–155.
- Department of Education. (2023). *MATATAG curriculum: Mathematics curriculum guide (Grades 1, 4, and 7)*. Department of Education.
- Duff, P. (2018). *Case study research in applied linguistics*. Routledge.
- Fitzgerald, M. S., & Palincsar, A. S. (2019). Teaching practices that support student sensemaking across grades and disciplines: A conceptual review. *Review of Research in Education*, 43(1), 227–248.
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2011). *How to design and evaluate research in education (8th Edition)*. New York: McGraw-Hill.
- Francome, T., & Hewitt, D. (2020). “My math lessons are all about learning from your mistakes”: how mixed-attainment mathematics grouping affects the way students experience mathematics. *Educational Review*, 72(4), 475–494.
- Guilford, J. (1950). *Creativity*. *American Psychologist*. 5 (9), 444–454. <https://doi.org/10.1037/h0063487>.
- Hadar, L. L., & Tirosh, M. (2019). Creative thinking in mathematics curriculum: An analytic framework. *Thinking Skills and Creativity*, 33, 100585.
- Hong, E. (2013). Creative thinking abilities: Measures for various domains. In *Teaching and measuring cognitive readiness* (pp. 201–222). Springer US.
- Jasmin, D. R., & Buan, A. (2025). A Systematic Review on Instructional Strategies Promoting K-12 Students’ Creative Thinking in Mathematics. *Journal of Innovation, Advancement, and Methodology in STEM education*, 2(3), 176–190.
- Johansen, A., Mogstad, E., Gajic, B., & Bungum, B. (2022). Incorporating creativity in science and mathematics teaching: Teachers’ views on opportunities and challenges. *Nordic Studies in Science Education*, 18(1), 98–111.
- Lee, K. H., Moon, S. J., & Noh, J. W. (2022). Integration of mathematical creativity into everyday classes through dynamics between divergent and convergent thinking. *ZDM Mathematics Education*, 54(1), 179–192.
- Leinwand, S., Brahier, D. J., Huinker, D., Berry, R. Q., Dillon, F. L., Larson, M. R., ... & Smith, M. S. (2014). *Principles to actions: Ensuring mathematical success for all*. NCTM, National Council of Teachers of Mathematics.
- Nadjafikhah, M., Yaftian, N., & Bakhshalizadeh, S. (2012). Mathematical creativity: some definitions and characteristics. *Procedia-Social and Behavioral Sciences*, 31, 285–291.
- 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), 1609406917733847.
- OECD (2023). *PISA 2022 Assessment and Analytical Framework*. PISA. OECD Publishing. Paris. <https://doi.org/10.1787/dfe0bf9c-en>.
- OECD (2024). *PISA 2022 Results (Volume III): Creative Minds, Creative Schools*. PISA. OECD Publishing. Paris. <https://doi.org/10.1787/765ee8c2-en>.
- Pascua, F., & Romero, D. (2020). Teaching styles and student engagement in the Philippines: An analysis of secondary education. *Philippine Journal of Education Research*, 30(1), 88–104.

- Schleppenbach, M., Flevares, L. M., Sims, L. M., & Perry, M. (2007). Teachers' responses to student mistakes in Chinese and US mathematics classrooms. *The elementary school journal*, 108(2), 131-147.
- Schoevers, E. M., Leseman, P. P., Slot, E. M., Bakker, A., Keijzer, R., & Kroesbergen, E. H. (2019). Promoting pupils' creative thinking in primary school mathematics: A case study. *Thinking skills and creativity*, 31, 323-334.
- Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard educational review*, 57(1), 1-23.
- Silver, E. A. (1994). On mathematical problem posing. *For the learning of mathematics*, 14(1), 19-28.
- Silver, E. A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *ZDM Mathematics Education*, 29(3), 75-80.
- Simsek, Z. Z. (2020). Constructing-evaluating-refining mathematical conjectures and proofs. *International Journal for Mathematics Teaching and Learning*, 21(2), 197-215.
- Siswono, T. Y. E. (2010). Leveling students' creative thinking in solving and posing mathematical problem. *Journal on Mathematics Education*, 1(1), 17-40.
- Sriraman, B. (2005). Are giftedness and creativity synonyms in mathematics?. *Journal of Secondary Gifted Education*, 17(1), 20-36.
- Tabach, M., & Levenson, E. (2018). Solving a task with infinitely many solutions: Convergent and divergent thinking in mathematical creativity. In *Broadening the scope of research on mathematical problem solving: A focus on technology, creativity and affect* (pp. 219-242). Cham: Springer International Publishing.
- Tan, A. G., & Sriraman, B. (2017). Convergence in creativity development for mathematical capacity. In R. Leikin & B. Sriraman (Eds.), *Creativity and giftedness: interdisciplinary perspectives from mathematics and beyond* (pp. 117-134). Switzerland: Springer International Publishing.
- Torrance, E. P. (1974). *The Torrance Tests of Creative Thinking—Norms Technical Manual Research Edition—Verbal Tests, Forms A and B—Figural Tests, Forms A and B*. Personnel Press.
- Unal, H., & Demir, İ. (2009). Divergent thinking and mathematics achievement in Turkey: Findings from the programme for international student achievement (PISA-2003). *Procedia-Social and Behavioral Sciences*, 1(1), 1767-1770.
- Vaismoradi, M., & Snelgrove, S. (2019). Theme in qualitative content analysis and thematic analysis. In *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research* (Vol. 20, No. 3). DEU.
- van Velzen, J. H. (2016). Evaluating the suitability of mathematical thinking problems for senior high-school students by including mathematical sense making and global planning. *The curriculum journal*, 27(3), 313-329.
- Veith, J. M., & Bitzenbauer, P. (2022). What group theory can do for you: From magmas to abstract thinking in school mathematics. *Mathematics*, 10(5), 703. <https://doi.org/10.3390/math10050703>
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (Vol. 86). Harvard university press.

Appendix 1

Teacher semi-structured individual interview Questions:

1. How do you know if students are thinking creatively in your class?
2. What are your ways to help students exchange ideas during mathematical discussions?
3. What are your ways to guide students to think diverse or uncommon ideas during class discussions or in solving a problem?
4. What are your ways to make students evaluate or improve their own idea or the idea of their classmates?
5. What kinds of support, resources, or professional development programs do you think could help you better promote students' CT in mathematics classroom?