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## IN-SERVICE ELEMENTARY SCHOOL MATHEMATICS TEACHERS' EXPERIENCE ON CHANGING BELIEFS ABOUT TEACHING, LEARNING, AND THE NATURE OF MATHEMATICS

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### Abstract

This study aims to describe the experiences of primary school mathematics teachers in changing their beliefs about teaching, learning, and the nature of mathematics. The data were reduced and coded using qualitative methods to answer the research questions. Data were obtained through in-depth interviews with three primary school teachers who participated in the National Movement for the Eradication of Mathematics Blindness (Gernas Tastaka) Program in Muara Enim District, South Sumatra. The results showed that in teaching, previously, they thought that math teaching only delivered material from textbooks and practiced calculations. Now, they believe teaching should be contextualized, use the Concrete-Pictorial-Abstract approach, and utilize teaching aids. In learning, they initially believed that math is only about calculation. Now, they understand that math learning should be more meaningful and relevant to real life. Teachers previously believed that mathematics is the application of procedures and calculations. Now, they believe that mathematics includes the application of mathematical ideas in everyday life.

**Keywords:** belief change, teaching, learning, nature of mathematics

### Abstrak

Penelitian ini bertujuan mendeskripsikan pengalaman guru matematika sekolah dasar dalam mengubah keyakinan mereka tentang pengajaran, pembelajaran, dan hakikat matematika. Penelitian ini menggunakan metode kualitatif, data direduksi dan dikodekan untuk menjawab pertanyaan penelitian. Data diperoleh melalui wawancara mendalam dengan tiga guru sekolah dasar yang mengikuti Program Gerakan Nasional Pemberantasan Buta Matematika (Gernas Tastaka) di Kabupaten Muara Enim, Sumatera Selatan. Hasil penelitian menunjukkan dalam pengajaran, sebelumnya mereka menganggap pengajaran matematika hanya menyampaikan materi dari buku teks dan melatih perhitungan. Kini, mereka percaya pengajaran harus kontekstual, menggunakan pendekatan Konkret-Piktorial-Abstrak, dan memanfaatkan alat peraga. Dalam pembelajaran, mereka awalnya berkeyakinan bahwa matematika hanya tentang perhitungan. Sekarang, mereka memahami bahwa pembelajaran matematika harus lebih bermakna dan relevan dengan kehidupan nyata. Para guru sebelumnya percaya bahwa matematika adalah penerapan prosedur dan perhitungan. Kini, mereka meyakini bahwa matematika mencakup penerapan ide-ide matematis dalam kehidupan sehari-hari.

**Kata kunci:** perubahan keyakinan, pengajaran, pembelajaran, hakikat matematika

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## **INTRODUCTION**

The educator's belief is one factor that influences how they engage in mathematics instruction and comprehension in the classroom (Beswick, 2006). The beliefs of mathematics educators consist of three components: the essence of mathematics, the nature of mathematics instruction, and the process of learning mathematics (Belbase, 2024; Pajares, 1992; Skott, 2014). Mathematics education in schools always has a particular purpose and teachers are responsible to try to achieve that purpose. For example, based on the Merdeka Curriculum BSKAP Kemendikbudristek RI (2022) which is implemented in several schools in Indonesia, mathematics education in Indonesia aims to ensure that students develop mathematical understanding and procedural fluency, learn mathematical reasoning and proving skills, flourish their problem-solving skills, build the ability to communicate and represent mathematical ideas, create connections between mathematical concepts and other ideas, and have a positive disposition towards mathematics. Teachers' beliefs about mathematics, mathematics teaching, and learning mathematics would affect their practice towards specific mathematical aims, such as given in the Merdeka Curriculum. For example, teachers who believe that mathematics is about memorizing mathematical formulas would not aim to develop students' mathematical understanding. On the other hand, those who believe that mathematical understanding is important would aim to assure that their students understand basic mathematical concepts and can make relations between what is learned with various mathematical ideas.

Several interventions have been made to encourage teachers to change either their knowledge, skills, beliefs, or dispositions related to mathematics, mathematics teaching, and mathematics learning. One of the interventions is in the form of teacher professional development (TPD) which might include teacher training, workshops, teacher learning groups, and much more. In Muara Enim, Sumatra Selatan an intervention to change elementary school teachers' beliefs about mathematics, mathematics teaching, and mathematics learning has been done by Gerakan Nasional Pemberantasan Buta Matematika (Gernas Tastaka).

Gernas Tasaka is an educational movement founded by several educators and education activists in Indonesia in 2018. This movement aimed to promote quality mathematics education in Indonesian elementary schools. The motto of Gernas Tastaka is "Bernalar, Konteksual, Sederhana, dan Mendasar". The motto means that quality mathematics education here refers to an educational process that enables the students to develop their mathematical reasoning skills, learn mathematics contextually, and focus on the essential mathematical skills and knowledge. To reach this aim, from 2018 until 2023, Gernas Tastaka worked together with more than 4000 elementary school teachers from various provinces around Indonesia. Gernas Tastaka provided the teachers with a 36-hour teacher training program about teaching and learning mathematics in elementary

school. In that teacher training program, elementary school teachers are exposed to the Concrete-Pictorial-Abstract (CPA) approach for learning mathematics (Main, 2021; Suo Hui et al., 2017), the standard process of mathematics which includes problem-solving, reasoning, and proof, representation, communication, and connection (NCTM, 2000). Besides that, through the training program, elementary school teachers also have the opportunity to relearn numbers, geometry, measurement, probability and statistics, and assessment in the mathematics classroom. All of those are in the context of teaching and learning mathematics in elementary schools.

In Muara Enim, Sumatra Selatan, Gernas Tastaka collaborated with PT Bukit Asam Tbk. (PTBA) to train 120 elementary school teachers in the Muara Enim area. The participants of the program were divided into four batches. The first batch and second batch joined the program in January until June 2022. The third and fourth batches joined the program from July until December 2022. The participants of each batch are 30 elementary school teachers. All participated in the 36-hour training program. The first and second batches did the training through the online mode, while the third and the fourth through the offline mode.

Besides participating in the training program, all participants were facilitated by pre-service teachers (university students from elementary school education and/or mathematics education) from Sriwijaya University, Palembang. These pre-service teachers lived in the area where the teachers teach for 3 until 4 months. While they were there, they observed the teachers teaching mathematics. Spent time learning together with the teachers to develop lesson plans for teaching mathematics. It is expected that the lesson plans iterate the Concrete-Pictorial-Abstract Approach and any of the Mathematics Standard Process (NCTM) 2000 either Problem Solving, Reasoning & Proof, Representation, Communication, or Connection. Two of Gernas Tastaka's Master Trainers then visit the teachers to discuss their lesson plans and provide feedback and insight for improvements. All participants were also facilitated to reflect on their changes in terms of mathematics teaching and learning. They were also encouraged to share their ideas and documentation about their teaching practices through a festival named "Festival Belajar". In this festival, the teachers created posters exhibiting their mathematics teaching practice. Some participants shared their reflections about their mathematics lessons through both online and offline discussions. Additionally, many of the teachers participated in writing a book to share their best practices in teaching mathematics.

The one-year program was designed to improve the quality of mathematics education in Muara Enim. In other words, the program was designed to create change in schools in Muara Enim, making mathematics education more meaningful to students. There are expectations that the elementary school teachers who joined the Gernas Tastaka Muara Enim Program teach mathematics using the CPA approach, integrates the NCTM 2000 Standard Process in their

teaching, ensure that students build their reasoning skills, communicate mathematical ideas clearly, learn through problem-solving and build problem-solving skills, use multiple representations to make meanings of mathematics, and connect mathematical concepts with other mathematical ideas or other contexts. Despite that, no research has been done on the Gernas Tastaka Program in Muara Enim. How did the program affect the teachers? Did any of their beliefs about changes in mathematics, mathematics teaching, or mathematics learning change? Was there a change in the teachers' practice in teaching mathematics? Therefore, there is a need to do research in the context of the Gernas Tastaka Program in Muara Enim.

Change means there is a difference over time. The question then, is, what kind of change is expected to be experienced by the elementary school teachers joining the Gernas Tastaka program? As mentioned before, there is an expectation that teachers change their teaching practices when teaching mathematics to their students. However, mathematics teaching practices are influenced by changes in beliefs especially beliefs about the nature of mathematics, beliefs about teaching mathematics, and beliefs about learning mathematics (Ernest, 1989). Although the teachers in Muara Enim participated in the Gernas Tastaka Program, belief changes might be influenced by other factors. For example, they might have the opportunity to join other TPD programs, they might also read or watch materials related to mathematics and how it is learned and taught. They might also change their beliefs because of their interaction with students and other mathematics educators.

Several studies have been done on teachers' beliefs about mathematics, teaching, and learning mathematics. A case study about teachers' belief in the nature of mathematics by Beswick (2012). The participants are two secondary school mathematics teachers regarding their beliefs on the nature of mathematics both as a discipline and as a school subject. This research tries to explore each teacher's beliefs concerning the question "What mathematics is really all about?" (Beswick, 2012). One of the findings of this research is that there is evidence that teachers can hold different views about mathematics. For example, one of the participants, an expert mathematics teacher believes that "Mathematics is an organized and logical system of symbols and procedures that explain ideas present in the physical world" while also believing that it is also "a beautiful, creative and useful human endeavor that is both a way of knowing and a way of thinking". In relation to teaching mathematics, a study was done on 49 elementary school teachers from New South Wales about their beliefs about using concrete materials for teaching Numbers and Algebra. By conducting a survey and semi-structured interviews it was found out that the reasons that the teachers use concrete materials for teaching elementary schools are related to the beliefs that the tools improve students' understanding, engagement, thinking, memory, social interactions, learning style, and fluency, and automaticity (Quigley, 2021). In relation to learning mathematics,

a large-scale study was done on teachers' beliefs in the role of problem-solving in learning mathematics. One of the findings is that teachers reported that they believed that open-ended and unfamiliar problems were more relevant for more able students in higher grades while students in general need more practice related to basic skills and procedures.

It is true that a number of studies have been done about teachers' beliefs of the nature of mathematics, mathematics teaching, and mathematics learning. However, a study about teachers' changes in their beliefs about mathematics, mathematics teaching, and mathematics learning is still necessary, especially in the context of Muara Enim, Sumatra Selatan is still necessary and would be valuable. From the studies defined above, some focused on teachers' current beliefs, not on their changes in beliefs. Not all research about teachers' beliefs specifically is about elementary school teachers' beliefs. Also, not all research explains in detail the experiences of how teachers changed their beliefs. Teachers' experiences with changes in beliefs will always be affected by the sociocultural context in which they live. Therefore, despite there might have been studies about teachers' experiences with changes in their beliefs about mathematics, mathematics teaching, and mathematics learning, studying a specific context such as the context of Muara Enim and The Gernas Tastaka Program would still be valuable.

This research aims to describe the experiences of three elementary mathematics school teachers in changing beliefs about the nature of mathematics, mathematics teaching, and mathematics learning. All are teachers who have joined the Gernas Tastaka Program in Muara Enim. This research is based on the assumption that there is a possibility that the teachers have experienced changes in terms of their beliefs about the nature of mathematics, mathematics teaching, and mathematics learning. Also, these changes might or might not happen because of their experience in joining the Gernas Tastaka Program. This research sees that the participant's point of view of their experiencing changes in beliefs is valuable, and might even be more valuable than an outsider's point of view (i.e. trainer, researcher). By giving the participants an opportunity to share their experiences in changing beliefs, participants have a voice to express which change really matters to them and which key experiences affect those changes. The research question of this research is "How do elementary school teachers experience changes in beliefs about teaching, learning, and the nature of mathematics?"

Studying their experiences from their 'own point of view' is seen as important. An outsider can have assumptions about what experiences might affect each teacher's change in beliefs. However, this research is interested to understand the teachers' experience from their point of view. What kind of changes have they been experiencing concerning mathematics, teaching mathematics, and learning mathematics? Which of their experiences affect their changes in beliefs

about mathematics, teaching mathematics, and learning mathematics? Was it the Gernas Tastaka Program? Or was it something else?

## **METHOD**

This research is done using a qualitative approach which refers to “the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things” . Specifically, this is narrative research. Narrative research is the study of “how human beings experience the world, and narrative researchers collect these stories and write narratives of experience” (Gudmundsdottir, 2001). Through narrative research, the researcher can examine the relationship between human actions and their social contexts (Moen, 2006).

In-depth interviews are a qualitative interview technique that “involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation” (B. L. Berg, 2001; Carolyn Boyce, 2006). This type of interview is usually chosen when the researcher aims to explore a new issue in depth. Through an in-depth interview, the researcher has the opportunity to understand the context to enable them to offer a more complete picture to the readers, not only what happened but also why (Carolyn Boyce, 2006).

For this research, In-depth interviews were conducted with three participants (P1, P2, P3). All are public elementary school teachers, each teaching in different schools. All joined the Gernas Tastaka Program in Muara Enim. Joining the program meant that all joined a 36-hour training and other activities such as coaching, and joining the Festival Belajar. Data gathered during and after the participants join the program. It tooks around 6 months for gather the data through the in-depth interview. The data then transcribed verbatim to the document interview. The collected data then reduced to focus on the research question. The reduced data then display and analyze by the relevant code. Finally the analzed data used to deduct conclusion of the research.

Before presenting the findings of this research, it is important to highlight that the training program was grounded in the CPA approach, which served as the foundational framework for its implementation. The CPA approach represents a structured learning sequence that guides students in developing mathematical understanding. It begins with exploring concrete objects, progresses to representing these objects through pictorial illustrations, and culminates in the use of symbols to construct mathematical models and solve problems. By following this progression, the CPA approach enables students to transition seamlessly from tangible representations to abstract concepts, fostering a deeper comprehension of mathematics and encouraging the flexible application of symbols and abstract reasoning (Shuxratovna, 2024).

## RESULTS AND DISCUSSION

To understand the participants' changes in beliefs about the nature of mathematics, mathematics teaching, and mathematics learning, it is important to know briefly about each participant's background. The background of the participants is as can be seen on Table 1.

**Table 1. Participant's Background**

Participant Code	Background
P1	P1 is a first-grade teacher who joined the first batch of the Gernas Tastaka Program in Muara Enim. In 1985, P1 joined Sekolah Pendidikan Guru (SPG), a high school education program aimed to prepare elementary school teachers. She continued taking a 2-year diploma program, then continued taking a bachelor education program in elementary school education. P1 joined the 1st batch of the Gernas Tastaka Program (fully online training)
P2	P2 is a first-grade teacher. P2 graduated from Pendidikan Guru Sekolah Dasar (PGSD), a university program aimed to educate pre-service elementary school education teachers P2 joined the second batch of the Gernas Tastaka Program (fully online).
P3	P3 is a six-grade teacher who joined the fourth batch of the Gernas Tastaka Program in Muara Enim (both online and offline mode). In 2005, she joined a 2-year diploma program in elementary school education. In 2009, she continued her bachelor's degree in elementary school education at the same university that is an open university. She was also chosen to join the Guru Penggerak program provided by the government. She is currently taking her master's degree at Bengkulu University majoring in Educational Technology.

All of the participants experienced changes in terms of their beliefs, especially their beliefs about mathematics teaching and mathematics learning. However, beliefs about the nature of mathematics did not seem very evident. Given are the narration of the participants' changes in their beliefs about the nature of mathematics, teaching mathematics, and learning mathematics.

### *Changes in Beliefs about The Nature of Mathematics*

Mostly the participant of this research shifted beliefs about the nature of Mathematics. At first, the participant surely beliefs that Mathematics is about calculation. By joining the Gernastastaka, they started to shifted their beliefs about the deeper understanding about the nature of mathematics.

P1 says that she is someone who enjoys mathematics since she was in elementary school. She continued enjoying mathematics in middle and high school. She views mathematics as very important. She makes analogies that mathematics is like lauk pauk, the type of food that usually provides protein and fat. Without eating lauk pauk, someone will lack nutrition. P1 did not explain much about her beliefs about mathematics teaching but she did explain that previously she believed mathematics is only about calculations. There is no evidence that her beliefs about the nature of mathematics have changed.

P2, initially seeing mathematics as solely about calculations and formulas, realized through teaching experiences that not all students share her enthusiasm. Joining Gernas Tastaka highlighted

the importance of emphasizing conceptual understanding over formulaic approaches. However, she still perceives mathematics as primarily about numbers and fixed knowledge, not necessarily fostering creative thinking.

P2 says that used to believe that mathematics is about calculation and formulas. This belief was built because of her experience learning mathematics, while P2 was still a student in school. Personally, she admits that she loved mathematics. However, from her teaching experiences, she noticed that not all of her students enjoyed mathematics as she does. Some of her students view mathematics as terrifying.

By joining Gernas Tastaka P2 noticed that teaching mathematics should emphasize the understanding of basic mathematical concepts, and not directly uses formula for calculations. However, it seems that P2 believes that there is a difference between the mathematics at low levels and at higher levels. She mentioned that at higher levels, mathematics is related to daily life. P2 says that in lower grades, mathematics is more about calculations. This is her current belief about the nature or mathematics but it seems that this belief is also her previous belief (there were no changes in this belief).

After joining Gernas Tastaka. P2 believes that mathematics is about numbers. P2 says: *“Teaching about mathematics is about teaching numbers... Before joining Gernas Tastaka, I believed that teaching mathematics is about calculation, doing multiplication, addition, and counting. Multiples must be memorized. Now, when talking about zero, what does it mean? We can use it [to understand] for positive and negative (fractions). Sometimes zero is the origin. We can use numbers for many things, add them, multiply them, and square them. By starting with numbers we can learn other things.”*

However, P2 seems to see mathematics as a fixed set of knowledge that needs to be learned. P2 does not see mathematics as a tool to develop creative thinking since she mentioned that it is okay for students not to be smart in mathematics as long as they have other creative skills. P2 also says that mathematics is related to numbers. This seems to be both her current and previous beliefs about mathematics (there were no changes in these beliefs).

P3, formerly focused on calculations and formulas, now recognizes mathematics as encompassing fundamental concepts. Believing in the broad conceptual nature of mathematics, she emphasizes understanding over rote calculation and sees its applications in daily life. P3 used to believe that mathematics is about doing calculations such as performing addition and using mathematical formulas. Now, P3 believes that mathematics relates to fundamental mathematical ideas. P3 mentioned that now she believes that mathematics is broad, and is about basic understandings. It should be conceptual. P3 explains by giving an example of learning cubes. P3 also says that mathematical calculations can also be used in daily life.

*“Besides calculating, when seeing a cube, students can discuss the ideas of a cube. What is it like? Are the rooms also in the shape of a cube? Or is it a rectangle?”*



### ***Changes in Beliefs About Mathematics Teaching***

P1 maintains her belief in the crucial role of mathematics teachers, guiding students through question-and-answer sessions and foundational concepts like addition and subtraction. She previously relied on textbooks for teaching but transitioned to using teaching aids after joining the 2013 curriculum workshop. Gernas Tastaka introduced her to new teaching methods, emphasizing tools found in the surroundings. P1 used to believe that the role of teachers in teaching mathematics is very important. She still has the same belief about the role of mathematics teachers. She mentioned that the role of a mathematics teacher is to lead question-and-answer sessions. Students are asked to come forward to solve mathematical problems on the board. She also mentioned that first-grade students needed to be guided to enable them to understand addition, subtraction, multiplication, and division. She says:

*“Students do not understand without guidance. They do not know the theories needed to answer questions. I need to guide them one by one like for addition and subtraction, especially because I am teaching the lower grades.”*

Before she used to believe that teaching mathematics should be based on mathematics textbooks. Textbooks differ depending on the type of curriculum used. For example, in the 2006 curriculum mathematics was taught using a separate mathematics textbook. In the 2013 curriculum, the textbook used in schools is the thematic textbook. Each book has a predetermined theme such as “Diriku”, “Keluargaku”, etc. In the textbook, mathematics is provided in some parts of the textbook and usually is related to the given theme. P1 seems to not question any given textbook used for teaching mathematics. This means, P1 uses any textbook as given by the curriculum and teaches according to it. P1 admits that when using the 2006 curriculum she used to teach mathematics by providing pictures and writing abstract mathematical ideas on the board.

However, she had the opportunity to join the 2013 curriculum workshop. There she learned that teachers should use teaching aids (*alat peraga*) for teaching mathematics. She also learned that teaching mathematics should be integrated with the given theme. Since she believed that using teaching aids is important for teaching mathematics, she started implementing the use of teaching aids while teaching mathematics. She did this while still explaining mathematical concepts, using pictures, and also sometimes songs to teach mathematics. After joining the Gernas Tastaka Program P1 learned about the concrete, pictorial, and abstract (CPA) approach. For her, the most remembered experience from Gernas Tastaka is how Gernas Tastaka introduced her to new ways of teaching mathematics, such as singing, and using teaching properties.

She learned how to teach calculation through singing and creating tools to teach mathematics. During the program, she also worked on the tasks given by Gernas Tastaka. She said that Gernas Tastaka has provided the tool kit which makes it easier to follow the process Gernas Tastaka made P1 realize that teachers can actually find teaching tools from their surroundings.

For example, she teaches 1st-grade students how to calculate by using mini balls that have different colors.

*“Now I use tools. Students, what is the color of these balls? Red. How many? What color ball is this? Blue. How many? Come on, if this one is added, how much will it be?”*

P2, previously focused on covering curriculum targets within set timeframes, shifted to a more varied and creative approach to teaching mathematics after joining Gernas Tastaka. She now incorporates diverse teaching tools, like buttons and playdough, to make mathematics engaging and tangible for students. When teaching mathematics, P2 believes that targets are important and these targets should be designed to be covered in a certain amount of time. P2 says:

*“We need to see the curriculum. From there we decide what to teach. Tomorrow, this is what we teach. We need to cover the target designed from the beginning until the end of the semester. We have to cover all the materials Do not let us miss any materials because, at the end of the semester, there is the final semester evaluation. If not all materials are covered that it will bring disadvantages for the students”*

Before P2 believes that teaching should be done by relating mathematics with daily life contexts. However, this can be done by giving examples or choosing mathematical problems:

*“When teaching addition, I said Wati has 2 candies. Then, her mother bought her three more candies. How many candies does Wati have now?... The students then can count using their hands.”*

When teaching children to do arithmetic operations using larger numbers, P2 believes that students should be taught how to count on:

*“If we want to teach students 25 plus 3, we tell them to remember the bigger number which is 25. Then they use their fingers to count on, 26, 27, 28. They remember this better rather than writing the numbers... By doing this they don't take too long to count.”*

After joining Gernas Tastaka P2 believed that teaching mathematics is interesting and there are many methods to teach mathematics. The tools to teach can be anything around us starting from fingers, buttons, playdough, and much more.

*“We can make two-dimensional shapes using sticks, we can group birds... we learned that there are many media that can be used to teach. Before, sticks were used to count but they can also be used to learn two-dimensional figures.”*

P3, who once relied on textbooks and formulas, now prioritizes conceptual understanding through hands-on activities and real-world examples. After Gernas Tastaka, she advocates for creative teaching methods and emphasizes the importance of students grasping fundamental concepts, such as the area of a circle, before moving to abstract ideas. Before, P3 believed that teaching students is by giving them mathematical formulas. Then, the teacher should explain the material to the student. For example, when learning about rectangles, it is the role of the teacher to explain the definition, give the formula or its area. When teaching P3 would draw a rectangle and explain about it. P3 learned about the CPA through Gernas Tastaka. She believes that students enjoy using that approach and using CPA makes them confident because it helps them understand mathematical concepts. P3 says:

*“Students like it when they can see the real object, such as cubes. They then know what a cube is. They know the cube sides and they relate it with the picture of cubes. The cubes are just like the pictures. They open the cubes and can calculate the sides of the cubes. They feel confident when they understand the concept.”*

P3 also says:

*“Before I used to teach by developing a lesson plan. The lesson plan is based in the textbook. We do not explore new ideas and teach what is in the textbook. In Gernas Tastaka, I learned to develop my own lesson plan, although it might be inspired by the book. In the book, the mathematics concepts are explained straightforwardly. Word problems are taken from the book too. Now, students can learn about circles by cutting. They create sectors of a circle by cutting the circle. They get to see what a segment of a circle is like. In the textbook, students are given the definition of the circle they show the formula straight away. However, students do not have the opportunity to hold the sectors and segments of a circle. Through hands-on activities, they know which is a secant line, and they notice that sectors have interior angles. Then, they learn the after they learn the concrete. I used to teach straight-to-abstract ideas.*

Since joining Gernas Tastaka, P3 believes that conceptual understanding is important. For example, when teaching about circles it is important to focus on the fundamental ideas of circles. Students can be asked to make circles using paper. Then, they can cut the circles in a way that it can be approximately like a rectangle. By doing that, students learn the basic concept of where the formula of the area of a circle comes from. P3 admits, after joining Gernas Tastaka, she believed that she mathematics teaching should be done more creatively. P3 said:

*“We are trained to be more creative in teaching mathematics, that’s what I think. Then, we can use children’s toys to be a media. At that time, we learned to make a learning fun, that is what makes me confident to learn. No need to focus.”*

### ***Changes Beliefs About Mathematics Learning***

P1 initially believed that students required guidance from teachers for learning mathematics and relied heavily on textbooks for instruction. However, after implementing the CPA approach, she realized the limitations of textbooks in visualizing mathematical concepts. She now advocates for a more contextual approach, incorporating real objects into mathematics instruction. P1 believed that students need teachers to guide them in learning mathematics. She did not mention any ideas where students can explore mathematical concepts by themselves. Seeing the significant engagement from her students after the use of the CPA approach, it changes her beliefs about learning mathematics. She used to believe that students learn mathematics from textbooks. After the application of the CPA approach, she found her students believe that textbooks are not enough to visualize things.

Learning mathematics requires other things than textbooks such as a contextual approach and bringing real objects to the class. P2's beliefs about learning mathematics were influenced by her experience as a pre-service teacher, realizing the importance of making learning enjoyable and recognizing individual student needs. She acknowledges that not all students excel in mathematics but emphasizes the importance of creative learning methods using everyday materials. Her beliefs shifted after implementing Gernas Tastaka's teachings, seeing increased student engagement and enjoyment in mathematics learning. Since P2 started to be a teacher she has realized that learning

should not only be based on books and can be done anywhere. This includes learning mathematics. Her beliefs about learning seemed to be influenced by her experience as a pre-service teacher when she was studying at Elementary School Education in University.

She realized that learning, anything, should not feel like pressure. She mentioned that she realized that when she was a student in school there was a lot of school work to be done until there was limited time to play. That experience made her feel that learning is like a burden. She also said that she noticed that each student has different needs. A student might not feel like learning but that must not mean that the student is lazy. There is a possibility that the student has other problems that affect their learning. P2 seems to believe that not all students are strong in mathematics. Some students are stronger in subjects that need memorization. P2 said:

*“Not all students have to be knowledgeable and skillful in mathematics, not all should be knowledgeable. As long as they have other creative skills, they would still be spirited. That’s a challenge for teachers. A teacher wants all of their students to be smart but that is not always the case.”*

P2 believed that students will learn mathematics joyfully when mathematics is learned using materials or things around them. This belief occurs because she has implemented what has been learned in Gernas Tastaka. P2 says:

*“I have implemented what I learned at Gernas Tastaka. For example, from Gernas Tastaka I learned that fractions can be taught using bread that is divided into several parts. Students can learn two-dimensional shapes from three-dimensional shapes such as shapes on a house. They learn three-dimensional shapes using balls. Learning like this ensures students enjoy their learning and they do not become bored with mathematics. In many cases, students are not enthusiastic about learning mathematics.”*

P3's beliefs about learning mathematics were transformed by the shift towards student-centered learning in the 2013 curriculum. She now advocates for hands-on activities and student exploration in mathematics instruction, believing that this approach enhances student engagement and understanding. After joining Gernas Tastaka, she emphasizes the importance of the CPA approach in teaching mathematics, noting increased student confidence and enjoyment in learning.

One of the changes in P3's belief about learning mathematics happened because she learned about the 2013 curriculum. In that curriculum, students learn best by doing observations, asking questions, and having discussions. Now, the Merdeka Curriculum makes her believe that learning should be student-centered. The students should have more freedom in deciding the direction of learning. However, this applies not only to mathematics learning but learning in general. Based on P3's experiences in teaching students basic mathematics concepts would make students enjoy mathematics more. P3 realized this after implementing what she learned in Gernas Tastaka. P3 noticed that her students enjoy learning mathematics more.

P3 says: “Before my students used to like sports more but now they like mathematics more. This happens because students learn the basic mathematics concepts.” P3 now believes that most

of her students have the potential to learn mathematics. This is based on her experience in teaching after implementing what has been learned in Gernas Tastaka.

*“Before only one or two of my students liked learning mathematics. Now, after I joined Gernas Tastaka most of my students do not feel that mathematics is terrifying. Now they are more active in learning and can see the concrete, pictorial, and abstract form.”*

P3 now believes that is important for students to have the opportunity to touch objects and manipulate them in order to learn mathematics. P3 says:

*“Before, mathematics is not learned through hands-on activities. Sometimes we show them teaching aids, like prisms. However, students cannot touch them. Now, they can bring an object such as a box, like a milk box from home. They cut the box. Then they explore the rectangles, they explore the concept of length.”*

After joining Gernas Tastaka, P3 believes that teaching mathematics should use the CPA Approach.

## **CONCLUSION**

It is evident that teachers have experienced changes in terms of their beliefs about teaching mathematics and learning mathematics. One of the highlight features is that all participants now believe in the importance of the CPA Approach, while before they used to believe that teaching and learning mathematics is about covering the materials in the mathematics textbook or curriculum. There is evidence that Gernas Tastaka made the participants believe that teaching aids are important in teaching mathematics. They also mentioned the importance of relating mathematics with everyday objects and contexts. None of the participants mentioned a change in belief about the purpose of teaching and learning mathematics to ensure students build more reasoning skills. However, it can be seen that without realizing it a participant did practice teaching the students reasoning skills (by proving the area of a circle). This, however, is based on the belief that conceptual understanding is important. It should be noticed that conceptual understanding relates to making connections between various mathematical ideas. And this needs reasoning skills.

Furthermore, although the participant (P3) did not explicitly mention that she currently believes that teaching mathematics is about reasoning skills, she explicitly mention the importance of teaching conceptually. Gernas Tastaka seemed to be a key experience for all three participants in changing their beliefs about teaching and learning mathematics. Other teacher professional development programs have affected the teachers' beliefs in teaching and learning in general, which relates to teaching and learning mathematics, but not specifically.

However, it can also be seen that there is no significant change in the beliefs about the nature of mathematics. The three participants still seem to see mathematics as a set of given knowledge that is related to calculations, numbers, and mathematical concepts. Future research can be done to improve this study. For example, the construct of the interview questions could be chosen more

carefully. More details can be explored in how the teachers changed their beliefs. For example, did their university experience as a pre-service student affect any of their changes in beliefs of teaching? Careful examination should also be done to ensure the difference in changes in beliefs and changes in teaching practice.

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