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Investigating mathematical conversation in remote learning of mathematics during the covid-19 pandemic

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ABSTRACT

Remote learning that must be carried out by schools in Indonesia during the COVID-19 pandemic was a challenge for most teachers. This study aimed to investigate mathematical conversations maintained by the teachers in remote learning of mathematics during the COVID-19 pandemic. It was a descriptive qualitative study that was analyzed based on school time during the pandemic, online teaching platforms used, the way the teachers carry out remote learning of mathematics, and how the teachers and the students interact. The data were collected from three mathematics teachers and eight students in a public senior high school in Bekasi District, Indonesia. They were interviewed by phone, and then the results of the interview were complemented by several captures of the students' conversations when learning mathematics via WhatsApp. This study revealed that remote learning of mathematics was still dominated by a rigid or less interactive learning environment, which could be seen from how the teachers gave mathematics problems, questions, and instructions, as well as how they responded to student questioning

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INTRODUCTION

The implementation of teaching and learning in schools has changed in mid-March 2020 since Coronavirus Disease 2019 (COVID-19) has become a global pandemic. Many countries have applied a lockdown policy that impacts school closures and remote learning to prevent the spread of COVID-19, increasing over time. Schools in Indonesia also carry out this situation. The teachers and students are assigned to carry out online teaching and learning from home with an uncertain time limit (Kemendikbud, 2020). Although lockdown measures in Indonesia are being lifted in phases in the second week of June 2020, only schools located in COVID-19 low-risks areas or green zones can reopen in the 2020/2021 school year with strict requirements and health protocols (Kemendikbud, 2020). This condition is certainly a challenge as well as raises much concern for teachers, especially about how to convey materials, how to design effective, interesting, and meaningful teaching and learning, and how to ensure all students learn remotely (Mailizar et al., 2020; Purwanto et al., 2020; Rasmitadila et al., 2020; Syah, 2020). It is based on the fact of remote learning carried out during the previous two months.

Some studies have now discussed teaching and learning during the COVID-19 pandemic, mostly on how effective an online learning platform for students (Nurani et al., 2020; Nurhayati, 2020; Wicaksana et al., 2020). Mailizar et al. (2020) revealed the barriers to the use of e-learning for the

teacher, school, curriculum, and students in Indonesia. Some explained the effect of COVID-19 on the learning system (Rasmitadila et al., 2020; Sintema, 2020; Sullivan et al., 2020), but very few studies have discussed certain teaching and learning activities during this pandemic, especially mathematics teaching and learning (Mailizar et al., 2020). The implementation of mathematics teaching and learning in this pandemic is quite interesting to be highlighted because it is widely known as complex teaching and learning, which requires accuracy in terms of delivering materials and developing mathematical skills (Ball et al., 2005; Santagata & Yeh, 2014). One of the basic things that can be investigated is how the teachers engage the students in mathematical conversation.

Mathematics teaching and learning should focus on how the students get the purpose of what they are learning by getting information out of students' minds. It surely needs encouragement to make them think and express their understanding, which engages them in conversation. It is crucial because the conversation can basically develop their thoughts (Mercer, 1995; Temple & Doerr, 2012). Thought itself is classified as an internalized private conversation, while the rich, complex, and symbolic culture, such as mathematical texts and proofs, is an extended conversation (Zolkower et al., 2015). It indicates a connection between the nature of mathematics, the mind's use, and the expressions.

Conversations in mathematics teaching and learning can be classified into interactions, namely the immediate teacher-pupil interaction, learner-textually presented answer interactions, learner-computer presented answer interactions, and learner-peer interactions (Ernest, 2004). Ernest (2004) explains that the teachers try to engage the students in mathematical conversation to offer mathematical experiences and develop mathematical skills and competences, regardless of the form of interaction. The teachers have to ensure that the students gain mathematical knowledge and competencies and not some partial or distorted version. Conversational strategies and ways of structuring interaction can help the students to achieve social and cognitive goals, for instance, being able to listen and talk respectfully, to cooperate, to make mathematical conjectures and present evidence, as well as to understand mathematical concepts and procedures successfully (Chapin et al., 2003). The teachers can identify and correct students' understanding, improve their memory, develop mathematical skills, and train communication and social skills. Ernest (2004) also emphasizes that mathematics teaching and learning should ideally entail mutual respect and trust between teacher and learner; listening and showing an interest to learners in their views, conception, and sense-making; making teaching into real conversation, and treating the real topic of mutual interest and mutual benefit. It shows that the teachers have to create a learning environment that can integrate all of the goals through mathematical conversation, regardless of the learning situation.

Mathematical conversation can occur by posing mathematical problems and questions or giving instruction (Hundeland et al., 2020; Khairi et al., 2017; Sfard et al., 1998). When the students are given mathematical problems, it means that they are encouraged to think, to build mathematical understanding based on their prior knowledge, to show their mathematical ideas as well as the strategies, and to explain those to others to realize that mathematics is meaningful and useful (Karp, 2010; Sullivan et al., 2006; Temple & Doerr, 2012). This situation will encourage them to be more critical, more creative, and more generative. It can even motivate others to think. The problems given can surely be limited to certain questions to discuss or scaffold students' thinking pathways. The quality of questions can lead the students to precisely determine the knowledge they need to provide and connect (Park et al., 2020; Santagata & Yeh, 2014) so that through questions, the teachers can control what the students are saying and where their thought processing goes (Brodie, 2007; Harding et al., 2020). The other thing to engage them in mathematical conversation is by giving instruction. The instructions can guide or direct the students about what they should do and think, what they need, and where they should start (Jayanthi et al., 2008; Rasmitadila et al., 2020).

When the teachers develop mathematical understanding through conversation, emotional connection becomes a key element (Roth & Radford, 2011). Student emotions can be captured from their postures, gestures, and tone of voice (Roth & Radford, 2011), even their writings to express mathematical thinking (Baxter et al., 2005) can indicate their understanding, enthusiasm, as well as the sense of belonging. The engine for mathematical thinking and doing is self-efficacy (Andrà et al., 2020). Students who are recognized as good at something or have high self-confidence to speak and share tend to dominate the discussion or mathematical conversation, while low achievers remain passive (Baxter et al., 2001; Sullivan et al., 2020) because they feel that they have limited ideas due to insufficient prior knowledge. This condition will eventually affect student emotion.

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The aspects above become the rationale of this study, which is implemented in mathematics teaching and learning during COVID-19 the pandemic. It underlies the fact that learning mathematics does not only play a role in cognitive aspects but also in social and affective aspects (Agus, 2019; Andrà et al., 2020; Chapin et al., 2003), which can emerge in conversations when expressing mathematics and mind. The mathematical conversation should appear in mathematics teaching and learning regardless of any conditions. It is the center of a cyclic process in constructing understanding based on mathematical knowledge and personal knowledge of mathematics (Santagata & Yeh, 2014). Mathematical conversations can affect the pathways of students' thinking (Forster & Taylor, 1999; Marlita et al., 2019), become the basis of developing rich mathematical argumentation and mathematical skills (Dovigo, 2016; Khairi et al., 2017), as well as evaluate didactical practices (Harding et al., 2020; Parks, 2008). Many studies explain it in the context of interaction. They investigated how interaction promotes mathematical understanding of students (Temple & Doerr, 2012; Uygun & Akyüz, 2019). Some revealed that interactions in classroom discussions or group work could be a great opportunity to construct understanding, the capabilities, and confidence because the students have opportunities to voice their thinking (Forster & Taylor, 1999). Andrà et al. (2020) further analyze interactions based on an interpretive lens about utterances, glances, postures, gestures, and intonations as the indicators of participation. The other studies also analyze the importance of mathematical conversation, which has many influences on the success of mathematics teaching and learning (Dovigo, 2016; Marlita et al., 2019; Temple & Doerr, 2012).

Based on the literature and the studies above, mathematics teaching and learning should facilitate the students to think and understand what they are learning and develop their mathematical skills. It leads to how mathematics teachers develop mathematical conversation in their teaching and learning regarding how meaningful the problems, questions, or instructions the teacher poses to make them think and express what they think or understand. Therefore, this study intends to investigate teacher awareness of the importance of mathematical conversation in remote mathematics learning during the COVID-19 pandemic. This study aims to describe the reality of mathematics teaching and learning and teachers' efforts in remotely teaching in terms of how they maintain a mathematical conversation in remote learning of mathematics during the pandemic.

METHOD

This study used a qualitative descriptive design. It was a method for exploring and understanding facts or phenomena (Creswell, 2016; Sugiyono, 2019) so that the findings could provide useful information or understanding within related contexts. In this study, this method was used to explain the condition of mathematics teaching and learning during the COVID-19 pandemic, which was observed based on the teacher's way of engaging the students in mathematical conversation. It could describe teacher awareness of the importance of facilitating mathematical conversations in mathematics teaching and learning, even though they had to develop a remote learning system.

The data was collected from three mathematics teachers (two teachers of eleventh graders and one teacher of tenth graders) and eight students in a public senior high school in Bekasi District, Indonesia. The teacher was initialized with T1, T2, and T3. They had a variety of background regarding years of teaching experience and familiarity with e-learning. These criteria were needed to be related to how they create a learning environment for high school students and creativity in utilizing technology to carry out remote learning. The selection of the students was based on the recommendation from their teacher. They were classified as students with high (A), moderate (B), and low (C) abilities in mathematics based on teacher assessments in the classroom before the COVID-19 pandemic. The students were initialized with their first name followed by the class and their ability, namely R11A, C11A, A10A, V11B, A11B, K11C, R11C, and R10C. This classification was needed to see the relationship among the abilities, their perceptions about teaching performance, and how they interact with each other.

An interview protocol was developed by researchers and initially comprised 10-12 semi-structured questions. Those questions were basically about the effect of COVID-19 on remote learning of mathematics, which could be an overview of educational practice implications. They had been validated by two mathematics lecturers as the experts in mathematics education and had eight questions in the final version for investigating the emergence of mathematical conversation. The aspects were the way the teachers carry out remote learning of mathematics and the interactions between teacher and students

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and/or among students. These aspects could show how the teacher maintained mathematical conversation in this situation and reflected the teacher's concern about mathematical conversation and their teaching practices in class. The questions were asked to students and their teachers with the same concept to mutually support the facts conveyed by students and teachers, for instance, "*How did teachers carry out mathematics learning during this pandemic*"; "*How did teachers interact during remote learning?*". Other questions were "*How did teachers know the level of student's understanding when remote learning?*" (for teachers) and "*Did you ask your teacher if there was something you did not understand? If so, how would your teacher respond it?*" (for students).

Interviews were conducted by phone because all citizens had to do self-isolation and work from home. These were recorded using voice recording from the other smartphone and took about 30 minutes each on average. The interviews were transcribed and reduced according to this paper's topic, which was about the mathematical conversation in remote learning of mathematics during the COVID-19 pandemic. The results of student interviews strengthened the results of the teacher interviews. Those interview data were then supported by several captures of the students' conversations when learning mathematics via WhatsApp and videos recordings from teachers when carrying out remote learning. When the interview was finished, the researcher asked permission from the teachers and students to prove what was conveyed by sending screenshots of their messages when interacting with teachers or students and videos about how the teacher explained the material.

The interview data transcript between teachers and students was then put together if the questions had the same sub-themes. A group of students was grouped based on their abilities so that researchers could find out students' answers according to their self-efficacy. A collection of sub-themes was analyzed in order to find the main themes as aspects of the investigation. Furthermore, they were analyzed through descriptive data analysis techniques among the students and their teachers and were focused on the mathematical conversation. The discussion began with school time during the pandemic, online teaching platforms used, the way the teachers carry out remote learning of mathematics, and the interactions between teacher and students and/or among students. During the data analysis processes, the researchers ensured this study's validity and reliability and involved two experts in discussing the results. The experts were lecturers who had experienced in mathematics education and qualitative research. The discussion was about the suitability between research findings and the aspects to identify mathematical conversation.

RESULTS AND DISCUSSION

The interviews initially asked about school time during the pandemic and online teaching platforms used. The information was needed to get a link between the media used and how the teacher implemented teaching and learning. The interview results showed that there were some technical changes in the implementation of teaching and learning. School decided that each lesson was only once a week, and each subject only lasted one and a half to two hours. This condition affected some changes in the teaching process. The teachers had to utilize e-learning platforms for the continuity and quality of teaching and learning during the COVID-19 pandemic.

As for mathematics teachers, they often used Google Classroom as an online learning platform during this pandemic. They used it for announcing, uploading videos of explanation, and assessing students' assignments. In fact, the teachers often gave the exercises to students due to the materials were already finished before the pandemic. As a video conferencing meeting, the teacher said that Zoom was only used once or twice during the past two months.

> ***T2:*** *At that time, some topics had been taught, but the students still did not understand those topics, so I carried out teaching and learning using Zoom.*
> ***Interviewer:*** *How was the time management of teaching and learning on Zoom?*
> ***T2:*** *It cannot take more than 40 minutes when using Zoom. I used it just for explaining the topic and some examples, and then I gave some exercises to the students.*

The way the teachers carry out remote learning of mathematics

Zoom was used by the teachers when there was material that was still not understood by students so that they had difficulties in doing the exercises. It was used when their students really need some explanations. The teachers explained mathematics topics that the students had been taught before, and

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then they provided some examples which led to the types of problems given. This fact is also supported by students' statements that the teacher just recalled the previous material, gave some clues to solve the problems, and provided some examples related to the problems given.

> ***A11B:*** *My teacher was more dominant in giving exercises during this pandemic because the material had actually been completed before the pandemic. She invited us to an online discussion forum if there was something we wanted to ask. This condition happened when my teacher gave us the exercises, but we did not understand how to solve them. She finally invited us to learn together via Zoom. She explained to us how to solve some problems on the whiteboard.*
> ***Interviewer:*** *Did she immediately explain the solution or review the previous materials first?*
> ***A11B:*** *When explaining the solution of a problem, she reminded us about the material first, for example, "try to remember that this formula is used for finding this." Her teaching method is just the same as the way she usually teaches us in the class.*

Another way was the teacher firstly gave the material to students so that the students had an overview of the topic explained on Zoom meeting. When the Zoom meeting took place, the teacher explained the material which had been previously given, she explained it on whiteboard only for parts that the students did not understand.

> ***T3:*** *I usually shared the material I wanted to explain first (in PDF form). At the Zoom meeting, I asked the students to open the material I had provided. So, when I explained it, they knew what I was talking about. Then, I would explain on the whiteboard what the students did not understand.*

The teachers actually admit that they just used Zoom to explain the topics and the solutions of some examples due to the limited amount of time. Other than that, it had a barrier related to internet connection and quota, both teachers and students, so that the teachers tried to take another way. They finally gave the students a video (only 10-15 minutes) which contained a brief explanation about the mathematics topic and the examples. Figure 1 is a screen capture in one of the videos that the teacher gave to eleventh graders on the topic of synthetic division. Even though the teacher told them that it was a new topic, she did not explain it in detail, for example, why she put the number of two as the divisor at the left or why the quotient was written from the power of two. They just focus on describing the topic, giving some examples and solutions, without inviting them to think for a moment. The way she explained it was also less interactive because it was just explanatory.

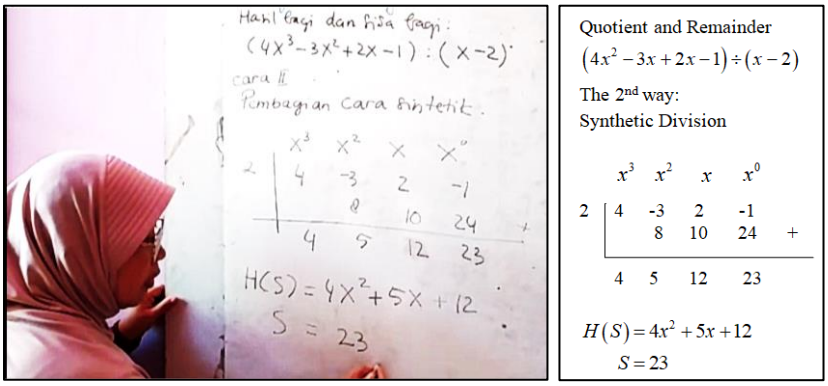

Figure 1. Video capture of explaining synthetic division

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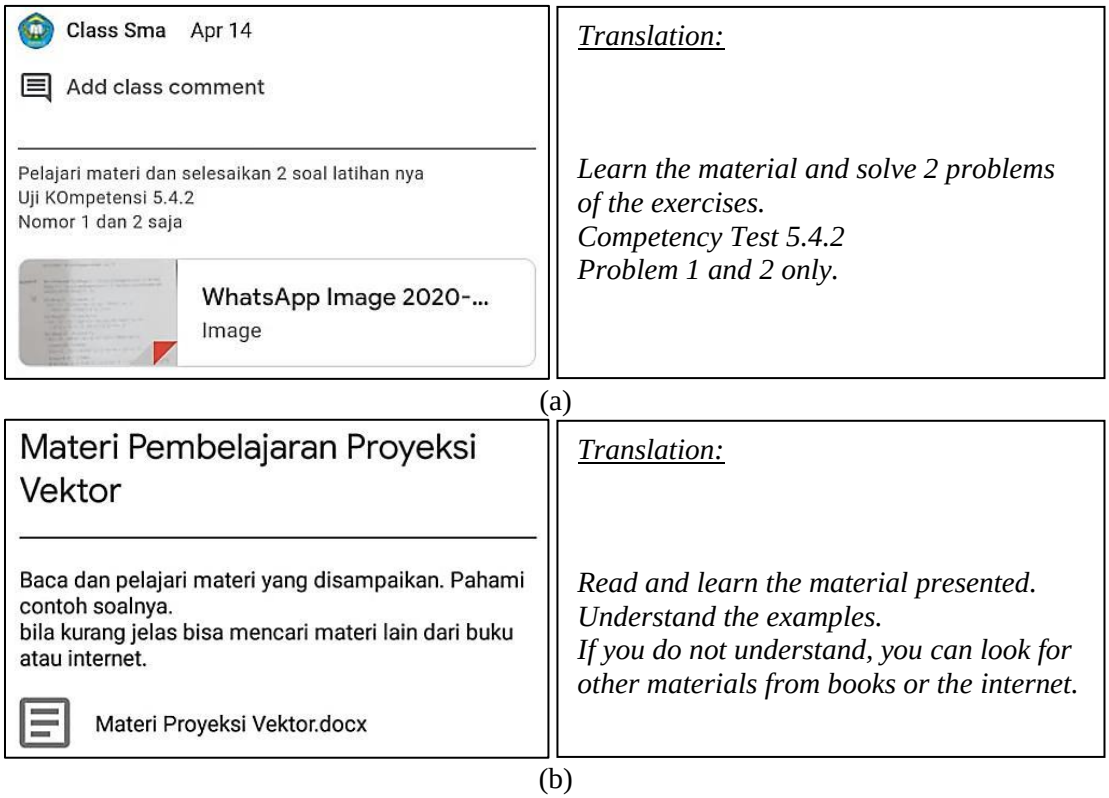

Figure 2. Screenshots of teacher instruction on Google Classroom: (a) the instruction from T1; (b) the instruction from T3

Another way the teachers did in delivering supporting material to do the exercises was they took a picture of the topic in the book and then shared it with students on Google Classroom (See Figure 2). It shows that the teacher asked the students to learn the material in that picture and to solve the problems. Another teacher gave additional instruction to look for other references from other books or on the internet if the material was still unclear. The teachers used this way when they felt that the topic was easy to learn, so that they just asked their students to learn it themselves.

> ***T1:*** *If there was material to be delivered, firstly, I just gave a short video. When the material was not too hard to learn, and it seemed that the students could learn it independently, I just asked them to read it. I took a picture of the material and uploaded it on Google Classroom (See Figure2a).*
> ***V11B:*** *When there was a Zoom meeting, my teacher just followed what was in the book. Due to her bad internet connection, she ended up explaining the material using a video (See Figure 1). She shared it on WhatsApp Group and asked us to watch it. She also often shared the materials by taking pictures of material in a book and sharing them on Google Classroom. Then, she gave us the exercises which had to be submitted on Google Classroom.*

Interactions during remote learning of mathematics

During Zoom meetings, the teachers just focused on explaining the topics with minimal interaction, or even no interaction at all. Questions were only raised by students when they did not understand what was being explained.

> ***Interviewer:*** *When using Zoom, WhatsApp, or Google Classroom, did you like to pose questions to students?*
> ***T3:*** *I did not pose questions when carrying out teaching and learning on Zoom. I just invited the students if they have something to ask. When using Zoom, I turned on the microphone just for me, while the students did not. I thought that if it was unmuted, it would be too noisy and not conducive. This condition was different from teaching and learning in the class that I could find out which students were willing to answer.*

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Interviewer: *How about using the Raise Hand feature (on Zoom)?*
T3: *Oh yeah, I did not think about it.*

This fact is also recognized by students that there were no conversations during teaching and learning. The students were only asked to pay attention to the explanation until the teacher had finished explaining. The following is a collection of student answers.

Interviewer: *When explaining the topic via Zoom, did your teacher pose any questions?*
R11A: *No, she did not. She just explained the material.*
V11B: *She just often said that if we have something to ask, please ask her on WhatsApp.*
C11A: *Sometimes. It usually started with questions that we asked when we still did not understand the teacher's explanation. So, she explained it again.*
A10A: *No, she did not. She just explained the material, and then she gave us the exercises. She just said that if we have something to ask, just ask her on WhatsApp.*

The teachers just ensured students' understanding based on student answers when the students submitted assignments. The teachers had already tried to change the numbers from the original questions so that the students could not search it on Google. The teachers then assessed the strategies which could show students' understanding. The teachers assumed that incomprehension would usually lead the students to ask the teachers or friends so that it would be a solution to that problem.

T1: *From the exercises, the students will definitely answer them, right? Based on the answer, I just conclude, "Oh, this means that the students can understand it." Even if there are questions that have not been understood, I usually always invite them to ask about them via WhatsApp.*
T2: *I gave them the exercises first. The students usually searched for the answers on Brainly. To avoid this, I changed the numbers in the problem. Sometimes, I put the answer as the information of a problem, while that information became the answer. Their understanding end could be seen from the process of solving it.*
T3: *That is actually an obstacle. The students did not even really admit their lack of understand when learning mathematics in the class. They always said that they understand when I ask whether they understand my explanation or not. I do not know what they think or understand. This condition also happened in this remote learning, but I tried to understand it because it was too hard to identify if it was not face-to-face mode. If the students really did not understand, they usually actively asked me via WhatsApp.*

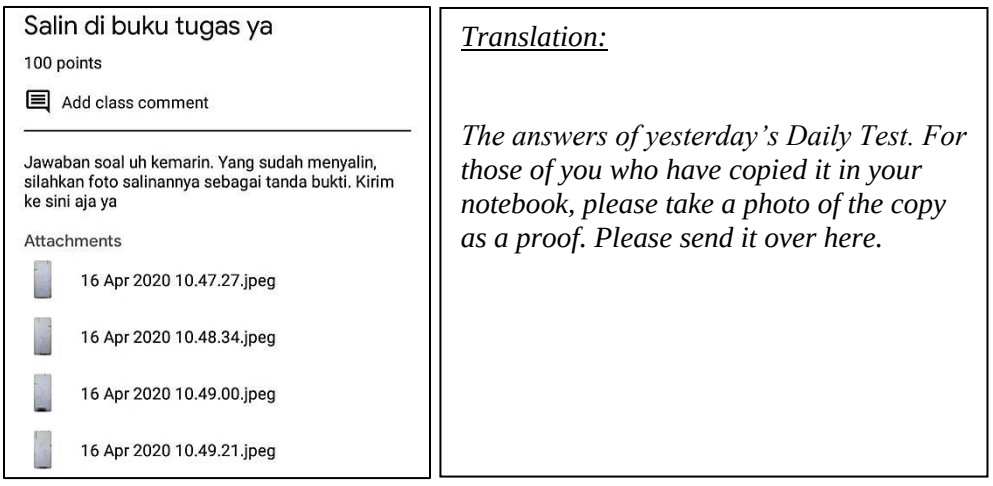

Figure 3. Screenshot of the teacher's way of improving students' understanding

When the students' works in mathematical problem solving had not reached a good level of understanding, one of the teachers' efforts was giving all solutions to students. The teacher asked the students to jot them down and prove it by sending the pictures of their notes, as shown in Figure 3. The teacher hoped that the students could understand it when jotting down and correct what they had done before. The following student statements also confirm this.

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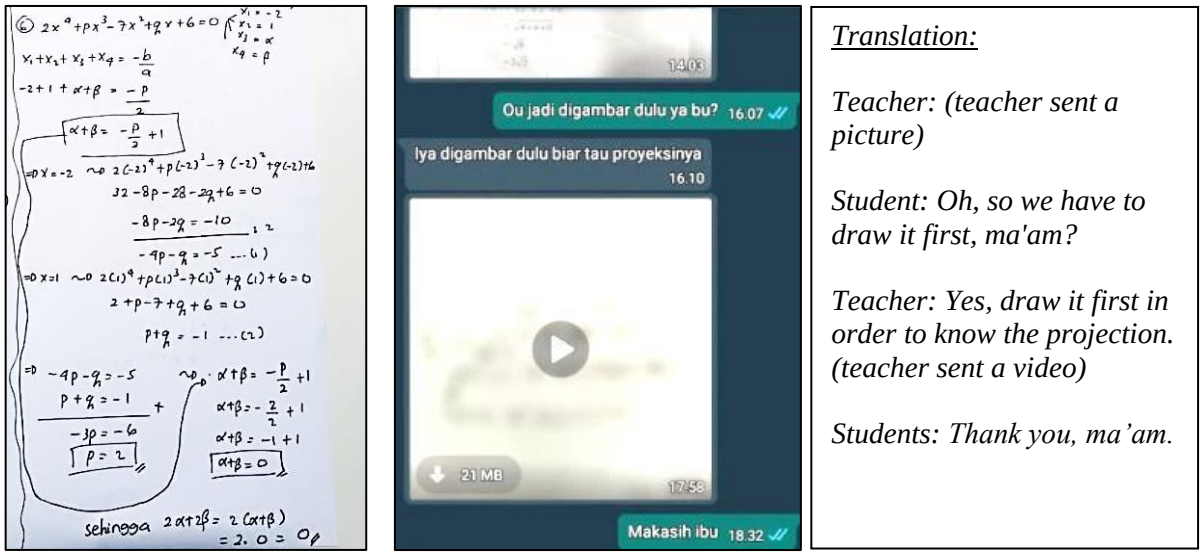
A11B: *She gave us the exercises. Next week or a few days later, she gave us the solutions. So, we could compare the answers that had been done and corrected the mistakes. When we collected the assignments, she never left any notes or gave any feedback. Hence, that was how she did it. Furthermore, we were asked to jot down the solutions she gave to understand it while we were doing it. After that, it had to be photographed and sent to her.*

The teachers believe that if the students cannot solve the problems, they will eventually ask their teacher or friends. Situations when the students interacted with the teacher show that the teacher responded enthusiastically. Some teachers responded by photographing the strategies of solving the problem which she had written on a paper (see Figure 4a), and another one gave additional explanation using video if a picture of how to solve the problem was still not understood (see Figure 4b). The interactions that occur were directly focused on explaining the solution to the problem that students did not understand. The teachers just wanted them to learn the strategies explained without encouraging them to think about it first or construct their understanding.

Interviewer: *During remote learning, did you often ask your teacher if something was not understood?*
C11A: *Yes, I did. Sometimes I asked her or my friends. I also usually searched on Google first.*
Interviewer: *When you asked your teacher, how did she respond to your question?*
C11A: *She wrote down the solution or method on a paper, and then she photographed it and shared it with me.*
A10A: *It is rare for me. I just asked her if there was something I really did not understand.*
Interviewer: *When you asked your teacher, how did she respond to your question?*
A10A: *I usually photographed the parts I did not understand first, and then she told me the strategies on her paper. If I still did not understand, I would ask her back, and she usually sent me a video to explain more about it.*
V11B: *Only once. I asked her outside of class hours.*
Interviewer: *When you asked your teacher, how did she respond to your question?*
V11B: *She typed the clues first. If I still did not understand, she photographed the steps toward solving the problem.*
R11C: *I never asked my teacher because I was afraid to disturb her.*
R10C: *Never. I usually tried to learn it from books first or asked my tutor.*



(a) (b)

Figure 4. Teachers' responses to student questioning: (a) handwriting of T2 in helping the student to solve a problem; (b) screenshot of the teacher-student conversation

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Translation:

Student: Ma'am, suppose like this, $f(x), g(x)$, is the index just multiplied or added? Problem 9, ma'am. Please help me, ma'am. I have a lot of tasks.

Teacher: The x is substituted by 2. Find $f(2)$ first. And then, find $g(2)$. After that, multiply them.

Student: Oh I see. Wait a minute. I'm going to calculate it.

Teacher: Okay.

Student: I find it. Is the answer still $h(x)$ or $h(2)$ already, ma'am?

Teacher: It is already $h(2)$.

Student: For Problem 7, the x is substituted by -2, right?

Teacher: Yes.

Student: Okay, ma'am. Problem 19, I used Horner's method twice, and then what should I do next, ma'am?

Teacher: Yeah, what's next?

Student: I forgot about the next step, about how to find m and n.

Teacher: Doing it one by one is fine. If it is a factor, then the remainder is 0. You can just substitute it.

Student: Here I used Horner's method as the first step,

Teacher: Yes.

Student: The remainder is $-n-m-6$, and then what should I do next?

Teacher: That means $-n-m-6=0$.

Student: After that? $-n-m=6$?

Teacher: Use Horner's method again now. And you will have two linear equations. Solve them using elimination method.

Student: Oh, the next step is solving them using elimination method. Alright.

Teacher: (Replying: Can I use Horner's method again in the first result, ma'am)

You can.

Teacher: (Replying: Oh, the next step is solving them using elimination method. Alright) Yes, it is.

Student: And then, where should I substitute it, ma'am?

Teacher: It is up to you. You can substitute it into the first or second equation.

Figure 5. Screenshots of teacher and student conversations via WhatsApp

When the students asked their teacher, the interactions seemed very limited. The response was also directly aimed at the solution of a problem. The teachers immediately told them about the steps or the answer, as shown in Figure 5. It shows that the teacher tells all about what the student needs without encouraging him to think about what he knows based on what he has learned. The teacher provided solutions rather than asking them to think or to express what they knew. Figure 6 also shows that the teacher helped the students to solve problems by providing the answers. The teacher thought that the students could learn or understand the problem afterward.

The emergence of mathematical conversation tends to be dominated by student-student interaction when solving problems, as shown in Figure 7. The students ensured their understanding by discussing with friends on WhatsApp group. They corrected each other's answers by investigating the truth of each process presented until they finally constructed their understanding based on the discussion.

Discussion

This study shows that the teachers still do not realize the importance of mathematical conversation, even though it is in the remote learning system. They do not seem to create an interactive learning environment during Zoom meetings. When the teachers provide some problems or explain the topic, they do not engage the students in mathematical conversation to discuss information or mathematical concepts. They just provide questions that are immediately answered, and then they explain the solution, without encouraging the students to think or inviting them to express what they have been thinking. This condition shows that teachers have not developed rich mathematical conversations in remote learning of mathematics. Lintuman and Wijaya (2020) also found that teachers often only focused on the material presented without allowing the students to express what they knew and understood. It can also reveal

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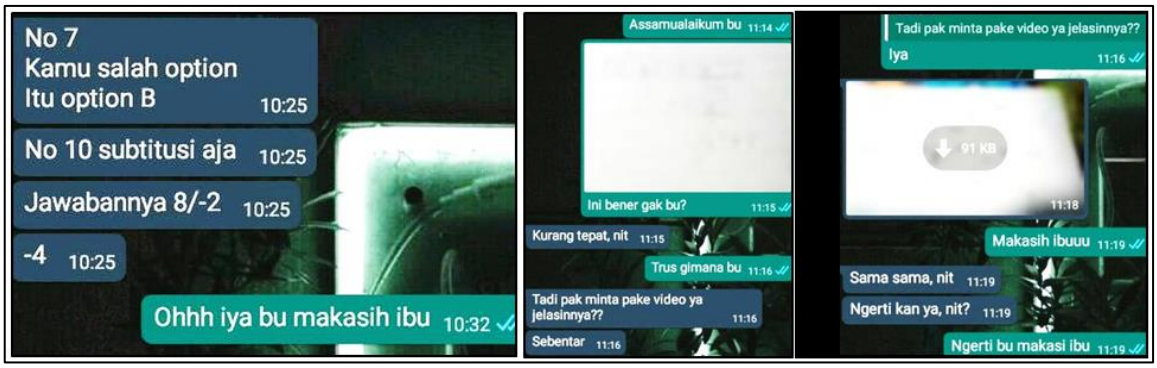


Translation:

Teacher: Problem 7, you got the wrong option. That's option B.

Problem 10, just substitute it.

The answer is $\frac{8}{-2} = 4$.

Student: Oh yes, ma'am. Thank you, ma'am.

Student: (greeting)

(Sent a picture) Is this correct, ma'am?

Teacher: Not yet.

Student: And then, what should I do to solve it, ma'am?

Teacher: Your class asked me to send a video to explain it, right? Just a second.

Student: Yes, ma'am.

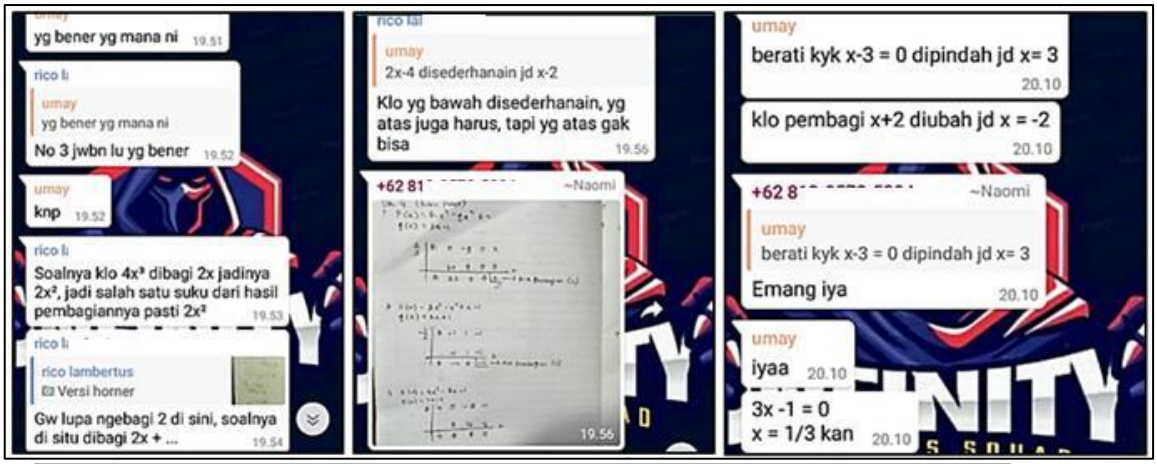
Teacher: (Sent a picture)

Student: Thank you, ma'am.

Teacher: You're welcome. Do you get it?

Student: Got it, ma'am. Thank you, ma'am.

Figure 6. Screenshots of student-teacher conversations via WhatsApp



Translation:

Umay : Which one is correct?

Rico : For Problem 3, your answer is correct.

Umay : Why?

Rico : Because if $4x^3$ is divided by $2x$, then the result is $2x^2$. Hence, one of the terms of the quotient is $2x^2$.

Rico (Using Horner's Method): I forgot to divide it by 2 here, because it is divided by $2x+\ldots$

Umay : $2x-4$ is simplified to be $x-2$

Rico : If the numerator is simplified, then the denominator is simplified too, but it cannot be.

Naomi : (sent a picture)

Umay : So, it is like $x-3=0$, and we find $x=3$. If the divisor is $x+2$, then we will find $x=-2$.

Naomi : *(Replying chat: So, it is like $x-3=0$, and we find $x=3$)* Is that so?

Umay : Yeah. $3x-1=0$, so $x=\frac{1}{3}$, right?

Figure 7. Screenshots of students' discussion via WhatsApp Group

the facts about the teacher's concern for student emotion. They do not make the students feel their teacher's presence, even if implemented in remotely teaching. Remote learning is an unprecedented experience for them, but it can show teachers' awareness of mathematical conversations' importance while carrying out mathematics teaching and learning. Questions basically can show how the students provide and connect their knowledge (Park et al., 2020; Santagata & Yeh, 2014). When the students express it, this can actually make the teacher know the level of students' understanding. The teachers

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can give instructions to scaffold students' thinking (Jayanthi et al., 2008; Rasmitadila et al., 2020) when students still do not understand the concept. Hence, the teachers know what they should do or improve their teaching and learning.

Regarding the explanation using video, the teachers also do not show an interactive situation. They just focus on describing the topic, giving some examples and the solutions, without inviting students to think for a moment first. The teachers should make teaching into a real conversation (Ernest, 2004) so that the students feel involved in the mathematical conversation when watching the videos. The teacher's instructions for making the students learn the material on their own might be the choice. The students are encouraged to discuss or interact with friends and lead them to the mathematical conversation, but it will depend on their self-efficacy. This engine of mathematical thinking and doing (Andrà et al., 2020) should be controlled by the teachers first to ensure the emergence of cooperation mode (Andrà et al., 2020) in online learning situations. Furthermore, the teachers need to create moments to validate students' understanding and check whether they have obtained correct and complete knowledge from their independent study. Hence, their mathematical conversations remain intertwined or appear. This study's findings can be caused by several factors, such as teachers not being used to remote learning, not mastering the use of e-learning or limited time. Mailizar et al. (2020) have revealed those factors as barriers for teachers when carrying out teaching and learning during the COVID-19 pandemic.

This study found that the teachers just ensured students' understanding based on the results of their assignments. Those results should be the kindly evaluation of didactical practices about what the students already know and understand, what parts need to be corrected and improved, and what the teachers should do in the next meeting. However, the teachers just trust that the students will improve their understanding themselves. The teachers believe that if the students cannot solve the problems, they will eventually ask their teacher or friends. The students with high and moderate abilities would not hesitate to ask their teacher, while the students who were less active or had low abilities just tried to ask their friends. It happens due to their self-efficacy (Andrà et al., 2020), which can differentiate them in thinking and doing.

When the students asked questions or confirmed their answers, the teacher did not scaffold students' thinking pathways. They did not provide opportunities for students to explain or correct their understanding. These facts show that the conversation does not facilitate the students to express what they understand or encourage them to think. The teachers directly convey the solution and do not investigate their understanding. It indicates that the teachers have not engaged them in mathematical conversation. This conversation can indicate students' thinking, show how their prior knowledge construct their understanding, as well as explain what they can finally understand (Karp, 2010; Sullivan et al., 2006; Temple & Doerr, 2012), but the teachers have not been motivated to engage the students in a mathematical conversation that can improve students' mathematical knowledge and competences.

The emergence of mathematical conversation tends to be dominated by interaction among students. One way to have the students genuinely engaged in mathematical conversation is by having them talk to each other (Mambwe, 2020). The assignment can be used to start a conversation (Brodie, 2007) and enable students to demonstrate and reveal mathematical capabilities (Hundeland et al., 2020). The students explained their thinking to the others, developed their understanding, respected each other's ideas, and found out the truth together. This situation also shows that there are students who can help other students to think and understand. It proves that mathematical conversation can affect the pathways of students' thinking (Forster & Taylor, 1999; Marlita et al., 2019) and help them to achieve the goals that the teachers expect (Chapin et al., 2003). It also shows that mathematical conversation can affect students' success in learning mathematics. Hence, the teachers should create an online class that supports students' mindsets to believe that they are capable of doing mathematics by engaging them in mathematical conversation. This situation will lead them to believe that they belong in that classroom and convince them that there is a purpose for what they are doing or learning.

Based on research findings, this study contributes to the literature regarding the design of remote learning of mathematics and the importance of engaging the students in mathematical conversation in every situation of mathematics teaching and learning. It highlights the reality of mathematics teaching and learning that reflects mathematics teachers' awareness and concern about mathematical conversation in their class. Furthermore, those facts can give an overview of implications for educational practice, especially for mathematics education.

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Although this study shows that mathematics teachers still do not realize the importance of mathematical conversation in their teaching and learning, the investigation has a limited scope. This study only involved a few teachers and students in describing the reality of mathematics teaching and learning during the pandemic due to the constraints of collecting data by phone. As a result, it had limited information or had not presented varied ones. This study also did not carry out a detailed preliminary analysis. The investigation was only through discussions with teachers about the challenges and obstacles faced in remote learning during the pandemic. It can be an opportunity for further research to complement the preliminary analysis, such as the students' pretest and post-test scores, to show the effect of changes in the learning system.

CONCLUSION

The mathematical conversation does not seem to play a role in mathematics teaching and learning as much as it ideally should. The teachers have not realized the importance of mathematical conversation, which can be seen from how they carry out teaching and learning and how they interact with students. Remote learning of mathematics was still dominated by a rigid or less interactive learning environment. The students were also not given the opportunity or encouragement to express their understanding of topics. It causes the teacher did not clearly know what the students had already known and understood. Based on the conclusions, the researchers suggest that even though there are many obstacles in implementing remote learning during the COVID-19 pandemic, the teachers should keep the learning going as well as foster engagement and online conversation, especially mathematical conversation. It is necessary because it can affect students' success in learning mathematics and develop their mathematical skills, as well as can be used as teacher evaluation in designing mathematics teaching and learning which facilitate mathematical conversation in any conditions. This suggestion is surely expected to be implemented in other subjects so that teachers realize that teaching and learning is a combination of cognitive, social, and affective aspects.

REFERENCES

Agus, I. (2019). Efektivitas guided discovery menggunakan pendekatan kontekstual ditinjau dari kemampuan berpikir kritis, prestasi, dan self-efficacy [The effectiveness of guided discovery using the contextual approach in terms of critical thinking ability, achievement, and self-efficacy]. *Jurnal Riset Pendidikan Matematika, 6*(2) 120–132. https://doi.org/10.21831/jrpm.v6i2.14517

Andrà, C., Brunetto, D., Parolini, N., & Verani, M. (2020). Four fundamental modes of participation in mathematics group activities. *International Journal of Science and Mathematics Education, 18*(1), 123–143. https://doi.org/10.1007/s10763-018-09940-5

Ball, D. L., Hill, H. C., & Bass, H. (2005). Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *American Educator, 29*(1), 14–46. https://deepblue.lib.umich.edu/bitstream/handle/2027.42/65072/Ball_F05.pdf

Baxter, J. A., Woodward, J., & Olson, D. (2001). Effects of reform-based mathematics instruction on low achievers in five third-grade classrooms. *Elementary School Journal, 101*(5), 529–547. https://doi.org/10.1086/499686

Baxter, J. A., Woodward, J., & Olson, D. (2005). Writing in mathematics: An alternative form of communication for academically low-achieving students. *Learning Disabilities Research and Practice, 20*(2), 119–135. https://doi.org/10.1111/j.1540-5826.2005.00127.x

Brodie, K. (2007). Teaching with conversations: Beginnings and endings. *For the Learning of Mathematics, 27*(1), 17–23. http://www.jstor.org/stable/40248555

Chapin, S. H., O'Connor, C. & Anderson, N. C. (2003). *Classroom discussions: Using math talk to help students learn, Grades 1-6*. Math Solutions Publications.

Creswell, J. W. (2016). *Research design: Penelitian kualitatif, kuantitatif, dan mixed, cetakan V* (R. K. Pancasari & A. Fawaid, Trans.). Pustaka Pelajar. (Original work published 2014).

Dovigo, F. (2016). Argumentation in preschool: A common ground for collaborative learning in early childhood. *European Early Childhood Education Research Journal, 24*(6), 818–840. https://doi.org/10.1080/1350293X.2016.1239327

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Ernest, P. (2004) Postmodernity and social research in mathematics education. In P. Valero & R. Zevenbergen (Eds.), *Researching the socio-political dimensions of mathematics education: Mathematics education library* (Vol, 35, pp. 65–84). Springer. https://doi.org/10.1007/1-4020-7914-1_7

Forster, P., & Taylor, P. (1999). Learning mathematics through conversation and utilizing technology. https://files.eric.ed.gov/fulltext/ED454037.pdf

Harding, J., Hbaci, I., Hamilton, B., & Loyd, S. (2020). Transcribing: A tool for mathematics pre-service teachers to reflect on their own teaching. *Journal of Education, 00*(0) 1–11. https://doi.org/10.1177/0022057420914904

Hundeland, P. S., Carlsen, M., & Erfjord, I. (2020). Qualities of mathematical discourses in kindergartens. *ZDM – Mathematics Education, 52*(4), 691–702. https://doi.org/10.1007/s11858-020-01146-w

Jayanthi, M., Gersten, R., & Baker, S. (2008). *Mathematics instruction for students with learning disabilities or difficulty learning mathematics: A guide for teachers*. RMC Research Corporation, Center on Instruction.

Karp, A. (2010). Analyzing and attempting to overcome prospective teachers' difficulties during problem-solving instruction. *Journal of Mathematics Teacher Education, 13*(2), 121–139. https://doi.org/10.1007/s10857-009-9127-y

Kemendikbud. (2020). *Panduan penyelenggaraan pembelajaran pada tahun ajaran 2020/2021 dan tahun akademik 2020/2021 di masa pandemi coronavirus disease 2019 (COVID-19) [Guidelines for organizing learning in the 2020/2021 academic year and 2020/2021 academic year during the 2019 coronavirus disease pandemic (COVID-19)]*. Author.

Khairi, H., Yunarti, T., & Widyastuti. (2017). Deskripsi percakapan matematis pada pembelajaran Socrates saintifik dalam memfasilitasi kemampuan komunikasi matematis [Mathematical conversation descriptions on socratic scientific learning in facilitating mathematical communication skills]. *Jurnal Pendidikan Matematika Unila, 5*(1), 1–13. http://jurnal.fkip.unila.ac.id/index.php/MTK/article/view/11902/8502

Lintuman, A., & Wijaya, A. (2020). Keefektifan model pembelajaran berbasis inkuiri ditinjau dari prestasi belajar dan kepercayaan diri dalam belajar matematika siswa SMP [The effectiveness of the inquiry-based learning model in term learning achievement and self-confidence in learning mathematics of junior high school students]. *Jurnal Riset Pendidikan Matematika, 7*(1), 13–23. https://doi.org/10.21831/jrpm.v7i1.17878

Mailizar, M., Almanthari, A., Maulina, S., & Bruce, S. (2020). Secondary school mathematics teachers' views on e-learning implementation barriers during the COVID-19 pandemic: The case of Indonesia. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(7), 1–9. https://doi.org/10.29333/EJMSTE/8240

Mambwe, B. (2020). Teachers' language practices in the teaching of mathematics in a grade four multilingual classroom in Zambia. *Studies in Educational Management, 5*(5), 30–42. https://doi.org/10.32038/sem.2020.05.03

Marlita, D., Yunarti, T., & Widyastuti. (2019). Deskripsi percakapan kritis matematis siswa dalam pembelajaran socrates saintifik [Description of students' mathematical critical conversations in socrates scientific learning]. *Journal of Mathematics Education, 1*(2), 70–80. http://jurnal.fkip.unila.ac.id/index.php/limacon/article/view/19854/14108

Mercer, N. (1995). *The guided construction of knowledge: Talk amongst teachers and learners.* Multilingual Matters.

Nurani, N. I., Uswatun, D. A., & Maula, L. H. (2020). Analisis Proses pembelajaran matematika berbasis daring menggunakan aplikasi google classroom pada masa pandemi covid-19 [Analysis of the online-based mathematics learning process using the google classroom application during the Covid-19 pandemic]. *Jurnal PGSD, 6*(1), 50–56. https://doi.org/10.32534/jps.v6i1.1151

Nurhayati, E. (2020). Meningkatkan keaktifan siswa dalam pembelajaran daring melalui media game edukasi quiziz pada masa pencegahan penyebaran covid-19 [Increase students' activity in online learning through quiziz educational game media during the period of preventing the spread of

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

covid-19]. *Jurnal Paedagogy: Jurnal Penelitian dan Pengembangan Pendidikan, 7*(2), 145–150. https://doi.org/10.33394/jp.v7i3.2645

Park, M., Yi, M., Flores, R., & Nguyen, B. (2020). Informal formative assessment conversations in mathematics: Focusing on preservice teachers' initiation, response and follow-up sequences in the classroom. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(10), 1–13. https://doi.org/10.29333/EJMSTE/8436

Parks, A. N. (2008). Messy learning: Preservice teachers' lesson-study conversations about mathematics and students. *Teaching and Teacher Education, 24*(5), 1200–1216. https://doi.org/10.1016/j.tate.2007.04.003

Purwanto, A., Asbari, M., Fahlevi, M., Mufid, A., Agistiawati, E., Cahyono, Y., & Suryani, P. (2020). Impact of work from home (WFH) on Indonesian teachers performance during the covid-19 pandemic: An exploratory study. *International Journal of Advanced Science and Technology, 29*(5), 6235–6244. http://sersc.org/journals/index.php/IJAST/article/view/15627

Rasmitadila, R., Aliyyah, R. R., Rachmadtullah, R., Samsudin, A., Syaodih, E., Nurtanto, M., & Tambunan, A. R. S. (2020). the perceptions of primary school teachers of online learning during the covid-19 pandemic period: A case study in Indonesia. *Journal of Ethnic and Cultural Studies, 7*(2), 90–109. https://doi.org/10.29333/ejecs/388

Roth, W. M., & Radford, L. (2011). *A cultural-historical perspective on mathematics teaching and learning*. Sense Publishers.

Santagata, R., & Yeh, C. (2014). Learning to teach mathematics and to analyze teaching effectiveness: Evidence from a video- and practice-based approach. *Journal of Mathematics Teacher Education, 17*(6), 491–514. https://doi.org/10.1007/s10857-013-9263-2

Sfard, A., Nesher, P., Streefland, L., Cobb, P., & Mason, J. (1998). Learning mathematics through conversation: Is it as good as they say? *For the Learning of Mathematics, 18*(1), 41–51. https://www.jstor.org/stable/40248260

Sintema, E. J. (2020). Effect of covid-19 on the performance of grade 12 students: Implications for STEM education. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(7), 1–6. https://doi.org/10.29333/EJMSTE/7893

Sugiyono, S. (2019). *Metode penelitian pendidikan (kuantitatif, kualitatif, kombinasi, R&D dan penelitian Pendidikan) [Educational research methods (quantitative, qualitative, mixed, R&D and Educational research)]*. Alfabeta.

Sullivan, P. A., Mousley, J., & Zevenbergen, R. L. (2006). Developing guidelines for teachers helping students experiencing difficulty in learning mathematics. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *Identities, cultures and learning spaces: Proceedings of the 29th Annual Conference of the Mathematics Education Research Group of Australasia* (Vol. 2, pp. 496-503). https://merga.net.au/Public/Publications/Annual_Conference_Proceedings/2006_MERGA_CP.aspx

Sullivan, P., Bobis, J., Downton, A., Feng, M., Hughes, S., Livy, S., McCormick, M., & Russo, J. (2020). Threats and opportunities in remote learning of mathematics: Implication for the return to the classroom. *Mathematics Education Research Journal, 32*, 551–559. https://doi.org/10.1007/s13394-020-00339-6

Syah, R. H. (2020). Dampak covid-19 pada pendidikan di Indonesia: Sekolah, keterampilan, dan proses pembelajaran [The impact of covid-19 on education in Indonesia: Schools, skills and learning processes]. *SALAM: Jurnal Sosial dan Budaya Syar-I, 7*(5), 395–402. https://doi.org/10.15408/sjsbs.v7i5.15314

Temple, C., & Doerr, H. M. (2012). Developing fluency in the mathematical register through conversation in a tenth-grade classroom. *Educational Studies in Mathematics, 81*(3), 287–306. https://doi.org/10.1007/s10649-012-9398-6

Uygun, T., & Akyüz, D. (2019). Developing subject matter knowledge through argumentation. *International Journal of Research in Education and Science, 5*(2), 532–547. https://www.ijres.net/index.php/ijres/article/view/568/pdf

ISSN 2356-2684 (print), ISSN 2477-1503 (online)

Wicaksana, E. (2020). Efektifitas pembelajaran menggunakan moodle terhadap motivasi dan minat bakat peserta didik di tengah pandemi covid-19 [The effectiveness of learning using moodle on the motivation and talent interest of students in the midst of the Covid -19 pandemic]. *EduTeach: Jurnal Edukasi dan Teknologi Pembelajaran, 1*(2), 117–124. https://doi.org/10.37859/eduteach.v1i2.1937

Zolkower, B., Shreyar, S., & Pérez, S. (2015). Teacher guidance of algebraic formula building: Functional grammatical analysis of a whole-class conversation. *ZDM – Mathematics Education*, *47*, 1323–1336. https://doi.org/10.1007/s11858-015-0701-8

ISSN 2356-2684 (print), ISSN 2477-1503 (online)