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Investigating Elementary School Teacher Gestures in Mathematics Teaching and Learning

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ABSTRACT

Gestures was an important in mathematics teaching and learning because it can increase student's cognitive load. however, many teachers pay little attention to gestures in carrying out learning in class. This study aims to describe and compare the gesture of primary school teacher in mathematics teaching and learning. Qualitative of case study used in this study. Two teachers in "Islam *Athirah*" of elementary schools consist of one senior teacher and one prospective teacher as research subjects. Data was collected through audiovisual material and interview. The teachers were observed and recorded when performing mathematics teaching and learning. Interview were conducted with ten selected students to find out feedback from learning activity. The finding showed that pointing gesture was frequently used in mathematics teaching and learning. Furthermore, senior teacher better in performing gesture than pre-service teacher. Senior teacher has an excellence in pointing and writing gesture, while pre-service teacher has an excellence in performing representing gesture.

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A. INTRODUCTION

Gestures are essential in learning because they can help students focus their attention and understand the teacher's explanation (Cochet & Vauclair, 2014; Guidetti & Nicoladis, 2008; Rasmussen et al., 2004). Gestures increase cognitive load when describing mathematical problems from available resources (Goldin-meadow et al., 2012). Gestures support speech in conveying information from a particular academic discipline, especially when references are complex, general, or abstract (Corts & Meyers, 2002). Gestures combine ideas based on concrete and abstract domains; a framework for characterizing individual gestures, and semiotic bundle ideas (Arzarello et al., 2009).

The Gesture is a person's movement through speech, treatment and writing, which aims to convey information, attitudes or intentions of someone that appears accidentally or intentionally (Shein, 2012). Gesture prove that the body is involved in thinking and speaking about an idea (Alibali & Nathan, 2012). There are three types of gestures: (a) pointing gestures characterized by using fingers, hands, or sometimes writing instruments, to determine physical

objects, places, and people, and to show elements in gestural space that are mentioned in speech but are not visually visible (McNeill, 1992); (b) representational gestures are movements that describe aspects and meanings, either literally or figuratively (Alibali et al., 2001; Kita, 2000); and (c) writing gestures are movements that occur when stationery used leaves a permanent mark on new media (for example, worksheets, whiteboards, or visual representations). The three types of gestures above are interpreted as body movements or limbs used by the teacher in learning to have a significant role in conveying material and focusing student attention and understanding the speaker's explanation which is in line with what is stated (Cochet & Vauclair, 2014; Guidetti & Nicoladis, 2008; Rasmussen et al., 2004).

Several studies have classified gestures in several dimensions. Chue et al. (2015) classify gestures on a non-exclusive basis: deictic movement, which leads to an existing or virtual object; metaphorical movements that refer to abstract thought; using gestures used for emphasis, and iconic cues that are displayed directly related to semantic word content, then McNeill 2007, in Shein (2012) gestures are modified into three types of movements investigated: (a) pointing gestures characterized by the use of fingers, hand, writing, to determine a physical object, place, or person, to show elements in a gesture space called speech but not visually present (McNeill, 1992); (b) representational gestures are actions or movements that describe ideas and concrete and abstract entities, or events conveyed in words; and (c) writing gestures occur when the act of giving a signal leaves a permanent mark on new media. This study tries to describe these gesture types in teaching mathematics. It's also will try to reveal what kind of gesture are often used by senior and prospective teacher in teaching mathematics.

Several studies explain the "gestures" of teachers and students operationally in solving problems in mathematics by teachers and students, both individually and in groups (Alibali et al., 2014; Alibali & Nathan, 2012; Hord et al., 2016; Marrongelle, 2007; Reynolds & Reeve, 2001; Shein, 2012; Wagner Cook & Goldin-Meadow, 2006; Weinberg et al., 2015; Williams-Pierce et al., 2017). Another study examined gestures as depictions expressing actions and perceptions and simulated them as part of communication to help listeners create appropriate perceptual actions and simulations in their own minds (Alibali et al., 2014). Furthermore, according to Goldin-meadow et al. (2012), gestures can increase cognitive load, giving cues when explaining math problems must take from available resources. Gestures support speech in conveying information from a particular academic discipline, especially when references are complex, general, or abstract (Corts & Meyers, 2002). Gestures can facilitate the speaker's language and help listeners better understand the speaker's meaning, and contribute to specific learning (connecting ideas) and can improve students' memory in-depth (Alibali & Nathan, 2012).

Based on a preliminary study in elementary school, teachers use minimal gestures and several types of gestures which influence students' understanding in solving problems (Alibali et al., 2014; Keene et al., 2012; Mildenhall & Sherriff, 2018), and identifies the types of gestures in problem-solving (Parrill et al., 2019; Rasmussen et al., 2004; Richland, 2015; Soto-Johnson & Troup, 2014). Therefore, we interested in investigating elementary teacher in mathematics teaching and learning.

This study describes and examines the form of teacher gestures in mathematics teaching and learning. It suggests that movements are often taken as evidence that the body is involved in thinking and talking about the ideas expressed in this movement. Weinberg et al. (2015)

stated that activity in mathematics helps in thinking and communication, furthermore Goldin-meadow et al. (2012) stated that gestures could improve cognitive load, cues when explaining mathematical problems must take from available resources that are appropriate to the material. Corts & Meyers (2002) found that gestures support speech in conveying information from specific academic disciplines, especially when references are complex, general, or abstract. As well as other researchers investigating the mathematical content of teaching expressed through the way of speaking and writing in communication, in particular, the interplay between speech, writing and gestures Parrill et al. (2019); Weinberg et al. (2015), meanwhile Shein (2012) found that teacher movement is used as a basis for posing problems to find out students' strategies and tell the meaning of geometric parts but from findings from previous studies that did not examine gesture comparisons used by senior teachers and prospective teachers to improve students' understanding of problem-solving in class based on the content of the material presented by the teacher.

B. METHODS

This study used a qualitative approach with collective case study in which multiple cases are described and compared to provide insight into an issue (Creswell, 2012). The case in this research is a teacher gesture in mathematics teaching and learning. Two teachers of "Islam *Athhirah*" elementary school as participants were observed in mathematics teaching and learning. The selection of participants is a representation of one senior teacher (ST) and one preservice teacher (PT) who are considered to have teaching experience in the field of mathematics and usually use gestures in the mathematics learning process in the classroom. Selection of subjects through classroom observations had teachers who met three typological gesture characterizations by Shein (2012) consist of pointing, representational, and writing gestures, as shown in Table 1.

Table 1. Gesture Characterization by Shein (2012)

Gesture Characterization	Description
Pointing gesture	characterized using of fingers, hands, or sometimes a writing instrument, to specify a physical object, place, or person, or to indicate elements within a gestural space referred to in speech but not visually present
Representational gesture	actions or movements that depict concrete and abstract ideas, entities, or events that are conveyed in words
Writing gesture	occur when the act of gesturing leaves permanent marks on a new medium (e.g., worksheets, whiteboards, or visual representations).

Data in this study consisting of video recorded by research in teaching and learning process. Data was collected through audiovisual material and interview (Creswell, 2012). Collecting data by audiovisual material in this study conducted by recording teaching and learning process and transcribed every gesture conducted by teacher. Furthermore, ten students were randomly interviewed consist of five students from students who were taught by senior teachers and five students who were taught by prospective teachers. It is aim to find out the feedback about how quickly the understanding obtained by students while the Teacher carried out learning in class. During the interview, the researcher followed the previously developed

interview guidelines including asking students to explain the intent of exploring the gestures used by the teacher, such as depiction of teacher gestures, student understanding of teacher gestures, the intent of teacher gestures related to mathematical ideas and concepts, even to the type of teacher's gestures used.

C. RESULT AND DISCUSSION

The assessment of teacher gestures in this study was the mathematical gesture of the teacher when carrying out the mathematics learning process in class 5 in elementary school with the material "length unit". Based on video transcript, we identified the teacher's gestures in teaching mathematics based on the characterization gesture of Shein (2012) shown in Table 2.

Table 2. Teacher Gestures

Teachers	Gesture Type		
	PG	RG	WG
Senior Teacher	10	4	8
Preservice Teacher	7	5	5

Table 2 showed that pointing gesture was frequently used by teacher in mathematics learning and teaching. It's in line with Chikiwa (2021) research which has shown that iconic and pointing gestures were frequently used to link the teacher's verbal language and the diagrams on the chalkboard or what was previously learnt, to ground cognition into the physical teaching and learning environment.

1. Pointing Gestures

The initial discussion of this study found interesting things when the teacher used gestures to point at the time of delivering learning material and found them based on student interview transcripts as feedback for mathematics learning carried out by the teacher in class, and the findings were based on Figure 1.

Senior Teacher (ST)		Teacher explains the unit of length using a marker while pointing and moving the hand from top to bottom and vice versa from bottom to top while talking.
Preservice Teacher (PT)		Teacher explains the length unit while talking and points to the slide shown.

Figure 1. Teacher's pointing gesture

In Figure 1 above, ST performs a pointing gesture using a marker while moving teacher's hands from bottom to top and top to bottom in explaining the material to gives students' understanding of calculating process of length unit. For example, ST performs a pointing gesture using markers while talking "if you go up one stair (divided by 10), if you go up 2 stairs (divided by 100), if you go up 3 stairs (divided by 1000)". More ever, ST perform a points gesture using a marker by moving the hand along with talking: "It's the same if you go down one stair (multiplied by 10), if you go down two stairs (multiplied by 100), and if you go down 3 stairs (multiplied by 1000)". Meanwhile, PT perform a pointing gesture by pointing the displayed slide while talking "if you go up one stair (divided by 10), if you go up two stairs (divided by 100), if you go up 3 stairs (divided by 1000)". Likewise, PT pointing displayed slides accompanied by talking "if you go down one stair (multiplied by 10), if you go down two stairs (times 100), and if you go down 3 stairs (times 1000). Based on interview, students revealed that when teacher did not point, they have an obstacle in understanding what teacher explain about unit length. They feel confused about when to multiply by 10 or 100 and when divide by 10 or 100. In addition, students revealed that teacher's pointing gesture helps students in remembering the position of length unit.

2. Representation Gestures

Representation gestures is a mental simulation of actions and perceptions (actions or movements that describe ideas, or concrete and abstract events conveyed in words) with treatment, iconic, metaphorical, simulation and connection. It was presented at Figure 2.

Senior Teacher (ST)		Teacher illustrates with both hands starting in the middle of the table and moving each hand to the side of the table how to measure the length of the table accompanied by talking.
Preservice Teacher (PT)		Teacher just talks and says if you want to measure the length, for example, a table or a door, you can use your hands, a ruler and a rope or something like that.

Figure 2. Teacher's Representation Gesture

In Figure 2 above, ST shows a simulation with both of hands on the table and moves each hand sideways accompanied by asking: "how to measure this table? and what we used to measure?". Students simultaneously answer "meter". Meanwhile PT shows a representation gesture by saying "if you want to measure the length, such a table or a door, you can use your hands, a ruler and a rope or something other".

Based on interview, students revealed that when teacher asking only, they were silent for a moment, but when teacher asking accompanied by hand simulation on table, they answered

immediately. Furthermore, students stated that teacher's hand simulation emphasizes what teacher asking and it helps the students in representing length unit.

3. Writing Gestures

Writing gestures is any writing or drawing that occurs accompanied by speech with the treatment of writing movements occurring when the gesture action leaves a permanent mark such as on a sheet of paper, or media such as a visual representation, as shown in Figure 3.

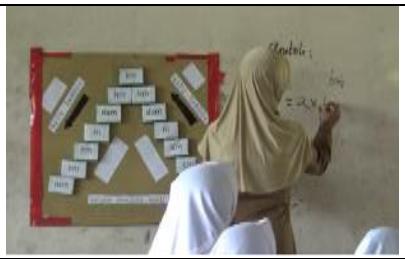
Senior Teacher (ST)		Teacher writes an example problem and solving the problem on the length unit material.
Preservice Teacher (PT)		Teacher clarifies the slides by writing back on the blackboard an example and problem-solving questions accompanied by answers.

Figure 3. Instructor gesture showing writing

In Figure 3 above, ST writes on the board using markers about problem-solving tasks accompanied by explanation according to what ST wrote. ST shows a writing gesture in hope that students who do not really understand the ST's speech can immediately see the written explanation directly. Meanwhile, PT shows a writing gesture by clarifying the slide that have been prepared. PT realized that slides only are not enough to provide explanations to students.

Based on interview, students revealed that they feel helped by teacher writing and explaining. Teacher's writing could facilitate students in understanding the material. In addition, students revealed that teacher's writing can immediate the meaning of teacher conversation. Quality of teacher's writing also influence in student's understanding. Students stated that a good quality writing accompanied by good explanation can improve the students understanding in mathematics. After learning finished, we selected ten students to be interviewed to obtain student's responses in teacher's gesture was displayed during teaching and learning. Student's responses were presented in Table 3.

Table 3. Student responses about teacher gestures

No	Question	Student Response	
		Yes	No
1	Are important gestures made by the teacher?	10	-
2	Should teachers and students learn gestures?	10	-
3	Is the media sufficient for the teacher to use?	3	7
4	Is the material quickly understood if the teacher uses gestures?	10	-
5	Is problem-solving quickly understood if the teacher uses gestures?	10	-

6	Is it good for the Teacher to talk while pointing at what is explained?	10	-
7	Is it good for teachers to talk while simulating?	10	-
8	Is it good for teachers to write while talking?	10	-
9	Do teachers still need to bring up gestures even though they use visual media?	10	-
10	Do teachers still need to bring up gestures even though they use audio-visual media?	10	-

The results showed that gestures could be investigated in detail based on gesture typology Shein (2012) consist if pointing gestures, representation gestures, and writing gestures, in contrast to previous studies that examined gestures on the deixis dimension based on (McNeill, 2005) framework. Pointing gesture was indicated using a marker is accompanied by talking while moving the hand using a marker from top to bottom and from bottom to top pointing at the media on the blackboard, in explaining the material to give students an understanding of the process of calculating the desired length unit for each problem-solving. It shows that there is an attempt by the teacher to understand the material and solve problems with pointing gestures. Bringing up pointing gestures not only with fingers, but also with, hands, other physical objects or show visuals to speak objects or writing, and gestures to make use of the physical environment in various ways (Butcher et al., 1991; Morford & Goldin-Meadow, 1997). In addition, pointing gestures can provide students with an understanding of the material being taught, and pointing is the most commonly used gesture to give signals (Alibali et al., 2011).

Gesture Representation was indicated by simulating with both hands on the table, precisely in the middle of the table. Then move the right hand to the right, and the left hand is moved to the right side along with talking. This suggests that the teacher seeks to provide understanding by simulating actions and perceptions involving activating the neural areas involved in action planning Jeannerod, (2001) and produced as attitudes that depend on the strength of the active components of the simulation (Hostetter & Alibali, 2008, 2010). Representational gestures come from simulations and actions and perceptions, which also underlie language and mentality (Hostetter & Alibali, 2008).

The writing gesture was indicated by writing on the board using a problem-solving task marker accompanied by discussion while speaking aloud according to what the teacher wrote. The teacher shows the form of a writing gesture in the hope that students who do not really understand the teacher's speech can immediately see the teacher's written explanation directly. This shows that the teacher's effort to understand students in solving problems is by writing and speaking aloud. As explained by Vygotsky (1997), the movement of writing in the air and written signs is very often done according to the movement. In this study, each teacher explains the material accompanied by talking and simulations, the teacher writes back on the blackboard the material explained, besides this writing movement serves a highlighting function (Goodwin, 1994) and as a form of action that can be evidence according to what is completed (Goodwin, 2003).

Based on the student's responses, it shows that gestures are still very important for the teacher to appear when explaining the material and solving problems. It would be better if the material is difficult, because gestures support speech in conveying information from a particular academic discipline, especially when references are difficult, general, or abstract

Corts & Meyers (2002) and as a tool to improve communications (Chamberlain, 2020). In addition, the researcher also found other results that when the teacher consistently used the three types of gestures in each part of the mathematics material, students were not only quick to understand, but also able to solve math problems and was even able to pose problems according to the content described, and this finding was in line with the movement which can be a source of information about internal representations that underlie important mathematical concepts, meanwhile (Rasmussen et al., 2004).

D. CONCLUSION AND SUGGESTIONS

This study found that pointing gesture was frequently used in mathematics teaching and learning. Pointing gesture was indicated using a marker is accompanied by talking while moving the hand using a marker from top to bottom and from bottom to top pointing at the media on the blackboard, in explaining the material to give students an understanding of the process of calculating the desired length unit for each problem-solving. Gesture Representation was indicated by simulating with both hands on the table, precisely in the middle of the table. Then move the right hand to the right, and the left hand is moved to the right side along with talking. The writing gesture was indicated by writing on the board using a problem-solving task marker accompanied by discussion while speaking aloud according to what the teacher wrote. The teacher shows the form of a writing gesture in the hope that students who do not really understand the teacher's speech can immediately see the teacher's written explanation directly.

The finding also shown that senior teacher better in performing gesture than pre-service teacher. Senior teacher has an excellence in pointing and writing gesture, while pre-service teacher has an excellence in performing representing gesture. The result of this study suggest that gesture have an important role in mathematics teaching and learning, as Goldin-meadow et al. (2012) assert that gestures can improve cognitive load, cues when explaining mathematical problems must take from available resources that are appropriate to the material. Mathematics teacher need to understand and develop characterize of gesture such as pointing gesture, representation gesture and writing gesture (Shein, 2012). This study has limitations, including the selection of elementary teacher as research subjects who are specific cases that cannot be generalized. The study was also conducted in only one season of learning. Therefore, for development future research, a study of gesture be required for several learning season.

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