The Role of Gesture to Mathematics’ Fraction Base Concept Instruction

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Abstract. Gesture is a body movement as a form of representation in thinking and talking about the ideas that are owned by someone and expressed through body movement. Gesture has an important role for a teacher of mathematics learning, especially on the basic concept of fractions. Abstract mathematics makes teachers think how to communicate mathematical concepts to students in order to be more easily understood. The purpose of this study is to describe the role of gesture for elementary school teachers in Pamekasan. This research is descriptive research with qualitative approach. The results of this study show the type of gesture; (1) gesture point, as a gesture used to designate objects by using fingers, hands or stationery. (2) representational gestures, as gestures with hand or arm movements representing multiple objects, actions, concepts and relationships, (3) writing gestures, integrating teacher speech with hand movements in writing. The role of each gesture; (a) the gesture points; directing students' attention, keeping their eyes fixed for long periods of time, (b) representational gestures; helps to simulate actions and perceptions expressed in body movement and (c) writing gestures; can help students focus on understanding mathematical concepts, symbols, and mathematical notations.

1. Introduction

Gestures are defined as arm and hand movements that correspond to speech [1]. Gestures are all body movements that are integrated with speech or action to communicate something [2]. Teachers’ gesture in the learning process have a very important role to attract students’ attention on learning materials. The body movements of teachers when teaching mathematical concepts, partly because of their consciousness but not infrequently without their noticing [3]. The teacher uses limb movements to interact with students in learning. The use of body movements by these teachers proves that the body is involved in the interaction of learning. As it is argued that to convey ideas in learning, the body of a speaker is involved in it [4]. Morsella & Krauss’ research [5] shows that speakers do more gestures when describing objects that weigh on spatial working memory. Gestures often occur when speakers express information involving spatial information [6]. Gestures are performed because they have an important role in cognition [5]. Gestures arise when information is difficult to conceptualize [7]. Gestures can reduce cognitive load in all systems from verbal information systems to spatial information systems [6]. Gestures are part of the communication used to learn better and reduce errors.
Gesture has an important role in mathematics learning so it is interesting to note, this is in accordance with expert opinion, gesture is often used in the context of learning [8-10]. Kelly et al. [11] stated that teachers often use gestures to help students who have difficulty learning math concepts. Alibali et al [12] argues that teachers use gestures when explaining mathematical concepts and the use of gestures by teachers will increase when conveying new concepts in mathematics learning. Thompson [9] says that the gestures teachers use in learning have an impact on students’ understanding of the material being taught. So it can be said that gestures have a very important role to help students understand.

According to McNeill [1] there are two types of gestures: propositional gestures and non-propositional gestures. The propositional gesture is a gesture that has a component of the main picture whereas a non-propositional gesture is a speech gesture. Propositional gestures are divided into three:

1. an iconic gesture, is a gesture that contains a formal relationship closely related to what content is discussed semantically. Iconic gesture presents a picture of a concrete entity or action
2. a metaphorical gesture, a gesture that presents abstract ideas without physical form, and
3. a deictic gesture that points to objects, events, or people.

Non-propositional gestures are divided into two:

1. the beat gesture is a gesture in the form of rhythmic motion and is often repeated from both vertical and horizontal hands and fingers
2. a cohesive gesture.

Furthermore, McNeill [5] categorizes gestures into four main categories, namely iconic gestures, metaphoric, deictic, and beat.

Alibali & Nathan [3] modified the McNeill classification of gestures [1] in mathematics learning in the classroom. Alibali & Nathan [6] classifies gestures into three types, namely (1) pointing gestures, (2) representational gestures, and (3) writing gestures. Pointing gesture to none other than deictic gestures on the McNeill classification [1]. The representational gestures include iconic gestures and metaphoric gestures. Gestures write similar or go in the iconic symbolic gesture subcategory. In line with Shein’s opinion [13], the results of research on gestures consist of three; (b) representational gestures, as gestures with hand or arm movements representing multiple objects, actions, concepts and relationships, (c) gestures (gestures), gestures that are used to show objects by using fingers, hands and /or stationery; writing, as what the teacher is saying integrates with hand movements in writing.

Research on the role of teachers’ gestures in mathematics and science learning has not been the focus of educational research, although teachers’ gestures have an important role in learning teaching process [12]. Research on the role of teachers’ gesture in mathematics learning is needed in the future [4,6]. Based on these facts, researchers conducted this research on the role of teachers’ gesture in learning mathematics. Teaching materials delivered by the teacher is the basic concept of fractions. Researchers suspect the role of teachers’ gesture can help students in understanding the basic concepts of fractions. In this study, the classification of gestures used refers to the classification developed by [3,13]. The gestures studied were: (1) pointing gesture, (2) representational gesture, and (3) writing gestures. This is because the teacher gesture has an important role in learning that can help students in understanding the concepts of mathematics, symbols, mathematical notations and ideas in mathematics.

2. Method
In this study, a descriptive qualitative is used to describe teacher’s gesture role in instructional mathematics. The subject in this study is an elementary school teacher of mathematics, grade 3, who teaches material about base concept of fraction. The Collected data is obtained during process of teaching-learning in the classroom. The researcher is a main instrument as the researcher herself who design the research, collect and analyze the data, draw a conclusion and report the result of the study. To strengthen data of the study, a supporting instrument is needed, namely: camera, it is used to record gestures audio visually during the process of teaching-learning occur in the classroom. Techniques used in analyzing the data: (1) data reduction, it is a process of selecting, focusing, simplifying all obtained raw data, (2) serving data, it is an activity to serve the result of reduction in narrative form which enables to draw conclusion (3) drawing conclusion and verification is a process of providing conclusion concerning result of estimation, and evaluation involves meaning searching and explanation of given.
3. Result and Discussion

In this study the material presented about the basic concept of fractions, which means as follows; the fractional number can be written as $\frac{a}{b}$, with $a$ and $b$ integers, where $b \neq 0$ with a number whose symbol consists of an integer pair $a$ and $b$, $a$ is called numerator and $b$ is called denominator. There are three concepts in the fraction; namely part-to-whole concept, division concept and ratio concept [14]. The focus of the fractional basic concept material described by the teacher is part-to-whole concept. Material of fraction number is important to be taught by virtue of its characteristic, i.e. abstract. In early age, students tend to meet the growing in level of pre-concrete operational. Due to this case, the teachers needed to consider how deliver the material easily to be understood the students by utilizing teacher’s gesture in explaining, as what Alibali, M.W & Nathan [4] said that gesture played a leading role in communication of teaching. Hence the present study focuses the role of gesture employed by the teacher as the communication form in delivering the material which refers to the classification developed by Alibali & Nathan [3] and Shain [13], that is to classify the gesture into three: pointing gesture, representational gesture, and writing gesture. This following is the explanation:

3.1 The role of pointing gesture

The opinion of Alibali, M.W & Nathan [4] said pointing gestures are often used along with speech, and they manifest speakers’ indexing of speech content to objects, locations, or inscriptions In the physical environment. By “physical environment” we mean the setting for the interaction (e.g., a classroom, tutoring session, or experimental session) including the interlocutors (e.g., students, teacher, experimenter); the focal tasks; and the representations, notational systems, tools, and technological resources that are used.

![Category 1](image1.png)  ![Category 2](image2.png)

**Category 1**

The teacher uses gestures to point out in explaining the basic concept of fractions as part of the whole, the example used a on the whole piece of watermelon. Category (1) indicates that the teacher using pointing gestures to chunks $\frac{1}{4}$ which is accompanied verbally with meaning that the number of watermelon pieces there are 4 equal parts of 1 part overall. The number of 4 pieces of the piece as 1 whole, using the teacher’s fingers pointing to the object that aims to provide abstract ideas $\frac{1}{4}$ into a concrete form.

**Category 2**

Category (2), indicating that the teacher explains fraction $\frac{1}{8}$ by using pointing gesture involving the fingers on the objects of watermelon snippet and followed the saying that the number watermelon pieces there are 8 equal parts of 1 whole. 8 parts of the piece are 1 whole, 1 is the numerator and 8 is the denominator. Categories 1 and 2 show that what teachers do in explaining material to students using pointing gestures can lead to fixations on speakers and listeners. Fixation is a point in the field of gaze where the eye remains staring at it in a relatively long time [15] and aims to show location, check and direct attention.
This is in accordance with the opinion of Alibali & Nathan [3] which states that motion pointing is used to indicate something (object, person, event, location). Most pointed movements are generated from gestures by the fingers/hands or objects carried (for example, pencils, markers or chalk) that serve as a pointer. In accordance with the opinion of Shein [13] states that in particular, seeing the pointed movement refers to artifacts and visual representations related to tasks (eg, worksheets, whiteboards, and manipulatives).

3.2 The role of representational gestures

Figure 2. Teacher utilizes representational gesture in category 1, 2 and 3

The teacher uses representational gestures in explaining the basic concept of fractions is part of the whole. Category 1 is a representational gesture used by teachers by involving open-handed gestures into the air to simulate the object of cognition in the visual image of a mathematical idea that is 1 part of the whole apple, then divided into 2 equal parts ie in category 2, the teacher moves the right and left hands to air with a second opening hands, right hand as \( \frac{1}{2} \) part apple and left hand as another \( \frac{1}{2} \) part apple, namely 2 part from 1 whole of apple. In category 3, the teacher moves his gesture as his action previously by opining his hands going up in the air, his right hand moves forward and his left hand goes up in the air but its position is not parallel to his right hand, this gesture can simulate apple from \( \frac{1}{2} \) part which is previously divided 2 with the same size, that is as visual reflection of mathematics notion 2 part from \( \frac{1}{2} \) which every part has size \( \frac{1}{4} \).

Representational gesture is utilized by the teacher in category 1, 2 and 3 of this study reveals that teacher’s gesture is accompanied with or without his utterances. This regard agrees with Thompson’s opinion [11] he asserts that gesture can be accompanied with or without utterances. Representational gesture is accompanied with utterances occur when the subject is thinking or trying to explain something either for himself or for another person. Besides, Representational gesture can contribute to listener’s comprehension by assisting listener to simulate action and perception expressed in speaker’s gesture [3]. This fact indicates that gesture is not always accompanied with utterances, this case agrees with Alibali & Nathan’s outlook [4] they claim that speaker employs Representational gesture when thinking. Accordingly, gesture is used not only to explain notions but also to express notion [12] which can come about without using utterances at all.

This statement is strengthened by Alibali, M.W & Nathan [4] which state evidence from representational gestures suggests that explaining mathematical thinking involves simulations of actions on mathematical objects, simulations of visual images of mathematical ideas (often mental images of inscriptions), and simulations of the real-world situations that mathematical problems address. Speakers produce such gestures when they think and speak about mathematical ideas, and indeed they may
intentionally produce such gestures in order to facilitate thinking about such ideas or to promote effective communication about such ideas.

3.3 The role of writing gesture

Teachers using writing gestures to explain the basic concept of fractions are part of the whole by involving motion, arms, shoulders and fingers using chalk to write on the board followed by speech as an emphasis in explaining. Teacher writes $\frac{1}{2}$ which constitutes as a form 2 part from 1 a whole of apple having similar size, and it looks the teacher puts the used writings on the blackboard $\frac{1}{2} + \frac{1}{2} = \frac{2}{2}$ or 1 while giving an explanation if 2 part $\frac{1}{2}$ the apple is combined to be 1 part of whole apple, where 1 indicates numerator and 2 is called as denominator. Then the teacher rewrite on the blackboard for fraction $\frac{1}{8}$ which is accompanied with brief utterances that $\frac{1}{8}$ is 8 part from 1 a whole watermelon exemplified previously and then the teacher writes $\frac{1}{8} + \frac{1}{8} = \frac{2}{8}$ or $\frac{1}{4}$ on the blackboard by giving explanation if 2 part $\frac{2}{8}$ cuts of watermelon when it is combined will be $\frac{1}{4}$ part of cuts of watermelon.

Figure 3 is a form of writing gesture which occurs when one’s action leaving a permanent sign in a new media (such as: a working paper, a blackboard representing a visual thing). Shein [13] states that a writing gesture is focused on writing or drawing which is followed by utterances.

4. Conclusion

The role of gestures used by teachers in mathematics learning on the basic concepts of fractions: (1) Pointing gesture, teachers use fingers to point objects in communicating abstract ideas $\frac{1}{4}$ and $\frac{1}{8}$ in concrete form followed by utterance. (2) The representational gesture involves the motion of the second open hand to the air in an open position to simulate the object present in the cognition of the visual image, 1 being the whole apple, $\frac{1}{2}$ and $\frac{1}{4}$, with or without being followed by utterance (3) writing gesture, the teacher involves hand gestures, shoulders, arms and fingers in writing on the blackboard and greeting to write fractions $\frac{1}{2}$ and $\frac{1}{4}$. Each gesture has its own role. Pointing gestures designate to attract the learners’ attention which creates gaze where one’s eyes remain watch the teacher’s gesture very closely for a long time gaze, representational gestures help simulate actions and perceptions expressed in gestures, and writing gestures have a role that can help students focus in understanding mathematical concepts, symbols, mathematical notations and ideas in mathematics. In this case, research on the role of teacher’ gesture in mathematics learning is needed in the future [3,12]

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Acknowledgments
With best reverence to Lembaga Pengelola Dana Pendidikan Educational Fund Management Institution (LPDP), Indonesian Endowment fund for Education, Ministry of Finance of Republik Indonesia. I am highly indebted to LPDP, that which is funding this publication and giving me precious support for studies. I deeply appreciate the allocation of fund to participate in my experimental studies where gave me insightful spirit and strong motivation to produce another and more useful publication. Hopefully the strong mission of LPDP to improve human capital competency in Indonesia will be soon achieved.