

The Different Patterns of Gesture between Genders in Mathematical Problem Solving of Geometry

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Abstract. This article discusses about students' gesture between genders in answering problems of geometry. Gesture aims to check students' understanding which is undefined from their writings. This study is a qualitative research, there were seven questions given to two students of eight grade Junior High School who had the equal ability. The data of this study were collected from mathematical problem solving test, videoing students' presentation, and interviewing students by asking questions to check their understandings in geometry problems, in this case the researchers would observe the students' gesture. The result of this study revealed that there were patterns of gesture through students' conversation and prosodic cues, such as tones, intonation, speech rate and pause. Female students tended to give indecisive gestures, for instance bowing, hesitating, embarrassing, nodding many times in shifting cognitive comprehension, forwarding their body and asking questions to the interviewer when they found tough questions. However, male students acted some gestures such as playing their fingers, focusing on questions, taking longer time to answer hard questions, staying calm in shifting cognitive comprehension. We suggest to observe more sample and focus on students' gesture consistency in showing their understanding to solve the given problems.

1. Introduction

According to Mustafa [1], gesture widely can be defined as hands' or body's movement to state or help in expressing thought or feeling. In the last decade, gesture improved exponentially from literature work [3]. One of them was a study done by Roth [1]. In this study, some cases were given to students, then the function of gesture was observed in supporting students' conceptual comprehensive. The findings showed that gesture was a bridge between experience of body language and conceptual abstraction. This study has significant impact toward teachers to diagnose students's understanding about geometry. Furthermore, Kelly [5] said that gesture has specific correlation with what the students say in facing a problem.

In addition, Alibali [6] has opinion that mathematical cognition can be created by two main keys, perception and action. This claim is strongly supported by fact where teachers and students do the



gesture while they are showing their ideas and concepts about mathematics. The previous study was done by Edwards [7], he did it to 14 college students who took mathematics course. He used David McNeill's work as a basic foundation to analyze spontaneity movement that he observed from the students. The findings showed that gesture could be divided into four kinds: iconicphysical, icon-symbolic, metaphoric, and deictic. He also proved that the hypothesis that is showed by McNeill where students have specific gesture in solving mathematical questions.

These studies generally see the correlation between gesture and students' comprehension in answering mathematical questions. It is rarely found that a study sees the consistency of students' gesture in solving a problem. This study described the difference patterns of gesture between male and female whether they are consistent or unique individually. But, this study has not done repeatedly to different subjects but based on different case.

The previous study about gender was a study which explored male and female communication way [8]. This study referenced to Reynold's research [4]. The study reported the function of gesture generally in dyadic communication where the main concept was hard to describe. A study was done to two students by giving mathematical questions about graphic and route of a bus. The students were set to collaborate to make sense in solving about speed and time. The report showed by Reynold [4] was completed with prosodic signs such as tone of voice, intonation, speech rate and pause so the signs help the observer in understanding the two students. These studies include a few functions of gesture to solve collaborative problem in interpreting the given problems, they are: 1) gesture helps to reach and keep on the same cases, 2) gesture takes part as a cognitive media, if there is students' shifting comprehensive, it indicates that there is uncertain cognitive, 3) gesture is an index from cognitive understanding [4]. Reynold's study left a question for us, Is gesture unique for each individual? or Are the differences used to identify student's gesture patterns in different age, gender, and so forth? The difference patterns of gesture as a diagnostic tool teachers to see the male and female students' understanding when the material is delivered.

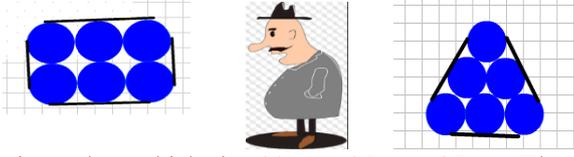
This study answered about the questions: 1) what gestures does the female student show in solving mathematical problems? 2) What gestures does the male student show in solving mathematical problems? The problems given to the students were about geometry. It was chosen based on Junior High School teacher's report where that topic was a hard topic to be understood by the students.

2. Experimental Method

This study reports one aspect to see gesture that is showed by the students in solving mathematical problems about geometry. Two students from Junior High School with different gender were chosen to answer seven questions about mathematical problems. They have same ability in mathematics. It was done based on their mathematical achievements. The reason for choosing Junior High School for this study was they could give expression and movement (gesture) to indicate understanding because they are in in way to change from kids to teenagers. The things observed were how male and female student shows his or her gesture while he or she is solving the mathematical problems.

Here the three examples of seven given problems were chosen in geometry topic can be seen in Table 1 below:

Table 1. Description of the problems

No	Problems in geometry material
1.	Mr. Hok Guan, the owner of pipes shop wants to tie his pipes with rope, each tie is 6 pipes. He is confused to tie them ($r= 10$ cm). Should it be tied in triangle or square model? Because he has a limited rope to tie the pipes. He expects that he will save the rope to tie. Please help him to solve it. Which tie should he follow to save the rope?
	
2.	Mr. Ahmad wants to put several books into a box which size 30cm x 25cm x 25 cm. The books are in the same sizes: length is 20 cm, width is 15 cm, and thick is 2 cm. How many books can be put in the box maximumly?
3.	It is known that there is a swimming pool with the length is 60 meters, width is 15 meters, depth on the left is 1 meter and it goes to slope slightly until 5 meters. How much water is needed to fill it until full?

The problems given were set and designed by mentioning all problem solving strategies like guessing, and checking, drawing picture, making list, making table, revising, looking at the patterns, using a logic reason, solving a simple problem, and making questions. Both of two students were asked to answer the seven questions. Then, they were interviewed by using semi structural approach. They were also asked to explain orally about what they had done.

The data collection of students' presentation and interview recording among researcher and students were taken after the students finished answering the questions. The recordings are videos while presentation and interview process where the researcher observed and found the information through several questions to see students' comprehension about the given problems in order to see the gesture of the students. The result of interview is explained clearly in this paper. Based on the findings, it was found that the patterns of both two students' gesturs in answering the questions. It was showed not only the interview with the students but also prosodic signs such as tone of voice, intonation, speech rate, and pause that might help in understanding the both two students' gestures. The interview questions aimed to see the consistency of both two students' gesture.

3. Result and Discussion

Here is the description of the result video recording from male and female student and the prosodic signs such as voice pressure, intonation, speed of talking, a pause that might help in understanding the both two students' gestures completely.

3.1. Episode 1: Oral presentation on question one for female student

Annisa answered the question number 1 with less correct answer. Annisa only tried to answer the length of the rope to tie the pipes squarely than for pipes which are tied in triangle, she could not answer it. For the last answer, she said that using the triangle pattern to tie the pipes is better because it saves more rope. It is a wrong answer because the two patterns of tie need the same length rope. Figure 1 is the description of her answer on the question in writing.

$$\begin{aligned}
 & 1((n \times d) + k) \checkmark \\
 & (6 \times 20) + 2 \cdot 3 \cdot 14 \cdot 10 \checkmark \\
 & (120) + 82,8 \checkmark \\
 & = 102,8 \text{ cm} \checkmark
 \end{aligned}$$

mana jawaban nya??

bisa di buatkan

Logika : yang paling hemat segitiga, karena peralannya ditumpuk
 2. Bisa di buatkan.

Figure 1. Annisa's answer for question number 1

Related to the answer, Annisa was interviewed with semi structural questions to see her gesture in showing her comprehension about the question. The Table 2 below will show the recording of interviewee and Annisa.

Table 2. Protocol from conversation and gesture between Annisa and interviewee

Turn	Conversation	Gesture
1.1	Interviewee: triangle pattern is better cause it will save more rope and the pipes are piled, [1.02 sec] ... the square pattern is also piled, isn't it? (Reading Annisa's answer).	She pointed to the last answer by using a pen and moved the pen to the piled square pattern.
1.2	Anissa: hehehe, [1.53 sec.] But the pile is up not to the sideline.	She played her tip veil, put her head down then let her left hand on the table, moved her right hand to make a triangle, and touched her eyes.
1.3	Interviewee: So to know a better rope to save is based on the pile, right? Should we find what we have to look for first, should not we?	The interviewee's hands moved from the question to Annisa's answer then the interviewee looked at Annisa.
1.4	Anissa: hehehehe, No, we should not [2.38 sec] but I usually cannot answer this question, I mean only for this one.	She leaned her body to the interviewee and pointed to the counted answer. She pointed to the square picture and matched it with her answer sheet.
1.5	Interviewee: Why don't you use the same formula to find the square pile?	The interviewee moved his or her body tall and looked at Annisa seriously.
1.6	Anissa: Mmm [2.01], If I use the same formula, the answer will be same.	She leaned her body to the interviewee seriously and tried to set her veil and put her head down.
1.7	Interviewee: Oh, why will the answer be same? This is used for all. By the way, what formula is this?	The interviewee pointed to formula Annisa wrote for the length of the rope and the pile of the pipes.
1.9	Anissa: [104 sec]... around formula	She nodded her head and played her hands like a circle.
1,10	Interviewee: around formula, right? This formula can be used, can't it? Whatever the patterns of the pile pipes, n is the number of the pipes, isn't it?	The interviewee pointed to formula nxd that was written by Annisa.
1.8	Anissa: [2.34 sec] oh yeah. This formula can be used, isn't it? And will the result be same?	She leaded her body more to the researcher by playing her pen to the picture of the question.
1.9	Interviewee: What do you think, is the result same? How to count it? What is n ?	The interviewee pointed to the two pictures tied pipes and moved to formula that is done by Annisa on her answer sheet.
1.10	Anissa: mmmmm... [1.24 sec]. The number of pipes...[2.03 sec].	She node her head then counted the number of the pipes on the square pile pattern of the question.
1.11	Interviewee: By the way, what rope does show the length $6x20$?	The interviewee turned around the question sheet to Annisa and asked her to point out which rope on the question.
1.12	Anissa: [2.34 sec]..What does it mean?	She pointed the question and leaned her body forward to the interviewee.
1.13	Interviewee: Pay attention on 6 ropes which ones.	The interviewee pointed to all rope on the picture.
1.14	Anissa: it means all...[2.43]	She turned her pen around and followed the whole ropes.
1.15	Interviewee: Why all? The formula has to sides, doesn't it? $nxd + kll$ of the circle, which ones are the nxd ?	The interviewee tried to illustrate a half of picture by trying one.
1.16	Anissa: I see... don't continue it...this one...this one...this one..one sideline, one diameter, and next.. they are six.	She was spirit by following the length of the rope and underlined what she wanted.
1.17	Interviewee: yes, that is right, then what twice around circles do you mean?	The interviewee asked Annisa again to look at the picture.
1.18	Anissa: I know...I know...this part...here it is...here...and here...it becomes a round of circle.	She followed the left around circle by pen.
1.19	Interviewee...that's really correct.	The interviewee gave thump to Annisa.

We found five dominant patterns of gesture on Annisa. She often put her head down. It can be seen on turn 1.2 and 1.6. This happened when she felt that she was blamed or what she did was wrong. In addition, she showed her lessconfidence and hesitating by playing her tip veil. It also can be seen on turn 1.2 and 1.6. Hesitating also can be seen when Annisa often laugheda bit longer. We can see it on turn 1.3, 1.6, 1.8, 1.10. She often nodded her head when the shifting cognitive comprehension. This can

be seen on turn 1.10 and 1.9. When the interviewee tried to make her understand about the concept, she directly showed a gesture by nodding her head and when her own cognitive comprehension moved to a new one. She suddenly would move her body forward to the interviewee and asked a question if there was something she did not understand. This is the dominant gesture done by Annisa when she found a new knowledge. The turn that showed it is turn 1.6, 1.4, and 1.8.

3.2. Episode 2: oral presentation on question 1 for male student

Alvaro also answered the question number 1 with less correct answer but he counted the length of the rope for both square and triangle pipes. For the last answer, he said that the square pattern is better than triangle to save the rope. It is a wrong answer cause both of the patterns need a same length rope. Figure 2 is the description of his answer in writing.

Handwritten mathematical work for question 1. Part a shows a calculation: $6 \times 20 + 4 \left(\frac{1}{4} \times 62.8 \right) = 192.8$, marked "benar" (correct). Part b shows a calculation: $6 \times 20 + 4 \left(\frac{1}{2} \times 62.8 \right) = 214.2$, marked "salah" (wrong). There are also some scribbles and other numbers like 15.7, 31.4, 62.8, 170, 69, 1.2.

Figure 2. Alvaro's answers for question number 1

Based on the answers, Alvaro was asked with several semi structural questions to see his gesture in showing his understanding of the questions. The Table 3 below will show the recording of interviewee and Alvaro.

Table 3. Protocol from conversation and gesture between Alvaro and interviewee

Turn	Conversation	Gesture
1.1	Interviewee: Where does the formula come from?	The interviewee pointed to the formula that Alvaro wrote.
1.2	Alvaro: 6 is the number of the circles, 20 is diameter.	He pointed to the pile pipes picture.
1.3	Interviewee: So, where did you get 4?	The Interviewee pointed to 4 on the picture.
1.4	Alvaro: 4 is from...[2.45 sec].. What is that...ohhh number arch circles.	He kept calm and pointed to each arch circles.
1.5	Interviewee: How big is the arch?	The interviewee pointed to the arch.
1.6	Alvaro: 90 degrees.	He pointed to angle arch of the circle.
1.7	Interviewee: And how big is angle arch on triangle pile pipes?	The Interviewee pointed to the triangle
1.8	Alvaro: 180 degrees.	He put his pen up and pointed to angle arch of triangle.
1.9	Interviewee: what, Why 180?	Interviewee underlined the triangle pile.
1.10	Alvaro: [2.40 sec]...That's right 180.	He followed to draw the arch circle on a half triangle pile without considering left edges of circle.
1.11	Interviewee: why is it straight? If there is a line that touches the circle, what is it? You drew it like this, how could it be like this?	The Interviewee pointed to the line which touches the circle and tried to draw a correct one.
1.12	Alvaro: [3.63 sec] I don't know. I have never learned it before...	He kept looking at the question and didn't ask to the interviewee.
1.13	Interviewee: What is the relationship if a line touches circle.	The Interviewee followed to draw to the arch circle.
1.14	Alvaro: As vertical, yeah... oh yes I forgot...so from here the corner becomes 120.	He described a corner on triangle pile arch circles.
1.15	Interviewee: that's really right... so, how long is the rope for this one and this one?	The Interviewee pointed to the circle.
1.16	Alvaro: [3.45 sec]... one around circle	He remarked all the arch circles.

In general, there are four gestures that can be seen from male student. Male student is always active to move his hands while transferred his knowledge to the interviewee. It can be seen on turn 1.8, 1.10, and 1.14. On these turns, Alvaro always moves his hands on picture of the questions. If he cannot answer the questions, he will not look wonder by moving his body down like the female student does but he keeps looking at the questions. It can be seen on turn 1.12, think a bit longer when he cannot answer a question. It can be seen of pause on turn 1.14 and 1.16, Alvaro thought first before showing a question while the female does. He keeps calm when the shifting cognitive comprehension. It can be seen on turn 1.14 and 1.16. Alvaro changes his comprehension from 180 to 120 degrees. He does not laugh, nod his head, and hold something that shows his worry while the female student does.

4. Conclusion

Some gestures showed by female student were she often put her head down, looked less confidence, hesitated, nodded her head when the shifting cognitive comprehension, directly moved her body to the interviewer, and showed question when there something was not understood. Furthermore, some gestures showed by male student were he moved his hand, kept to see the questions, thought a bit longer on question he could not answer, and stayed calm when the shifting cognitive comprehension. In conclusion, there was a significant difference of gesture between female and male student. This study was just for one sample and in description step. For further study, it is suggested to see the consistency of gesture between male and female student. Does it usually happen to each individual or each individual has different and unique gesture in showing his or her comprehension in facing problems. These patterns were found when the students were asked repeatedly by using the questions. The weakness of this study was it only used one subject of the research. To further study, it is suggested to do in some subjects of the research. The findings of this study can help teachers to diagnose how male and female students' face the problems, shift the cognitive comprehension, and when they do not understand about the problems.

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