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Focus group discussion in mathematical physics learning

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Abstract. The Focus Group Discussion (FGD) activity in Mathematical Physics learning has helped students perform the stages of problem solving reflectively. The FGD implementation was conducted to explore the problems and find the right strategy to improve the students' ability to solve the problem accurately which is one of reflective thinking component that has been difficult to improve. The research method used is descriptive qualitative by using single subject response in Physics student. During the FGD process, one student was observed of her reflective thinking development in solving the physics problem. The strategy chosen in the discussion activity was the Cognitive Apprenticeship-Instruction (CA-I) syntax. Based on the results of this study, it is obtained the information that after going through a series of stages of discussion, the students' reflective thinking skills is increased significantly. The scaffolding stage in the CA-I model plays an important role in the process of solving physics problems accurately. Students are able to recognize and formulate problems by describing problem sketches, identifying the variables involved, applying mathematical equations that accord to physics concepts, executing accurately, and applying evaluation by explaining the solution to various contexts.

1. Introduction

In previous research, the stages of the Cognitive Apprenticeship-Instruction (CA-I) model consisting of modeling, coaching, reflection, articulation, and exploration have been applied in mathematical physics subject. Nine out of ten indicators of reflective thinking abilities in solving mathematical physics problems have been adequately trained using these stages, although their achievements are not yet optimal. One remaining is the ability to accurately analyze the problems of mathematical physics still cannot be improved significantly [1]. According to the research, the most effective step of CA-I model in improving reflective thinking is the coaching stage. But this stage is less effective when applied in face-to-face mode in the classroom. The coaching stage is usually applied in the discussion form. The discussion process takes time and will reduce the time allocation for the next mathematical physics concept. Therefore, special strategies are needed to be able to implement effective discussion and simultaneously overcome the obstacles in analyzing problem accurately experienced by the students.

The strategy chosen in this research is Focus Group Discussion (FGD). Formulated from a series of opinions of experts, a focus group is defined as a small gathering of persons who have a common interest or characteristic, assembled by a moderator, who uses the group and its interactions as a way to gain information about a particular issue [2]. This strategy has benefits among others, easier to do than other qualitative methods; allows exploring topics according to the researcher's interest and generating hypotheses of group interactions; the data collected has high validity because it is dealing directly with the research subject; and if the sample size is not enough then it can easily add the sample [3].

Based on the definition and benefits, in this study gathering information can be obtained through FGD by exploring in depth about the problems faced by students in performing an accurate analysis of mathematical physics problems. There is no strong consensus regarding the exact characteristics of the FGD, the research topic itself will help to lead flexibly and uniquely to acquire it profoundly with respect to the topics covered. The number of FGD participants recommended is very diverse by some experts. In the United States the number of FGD participants ranges from 8-12 people, in the UK between 5 to 6 people, but some researchers also involve 10-32 participants. The length of the discussion also varies greatly, but overall it lasts from one to two hours. The time and place of discussion is suggested to be organized in such a way that as far as possible from disturbance and allow participants to be able to express their arguments freely. There is usually compensation given to participants for their attendance, but this is not a requirement. To ascertain who is appropriate to participate in this FGD activity is usually pre-tested on a number of samples [4].

2. Methods

Considering review of FGD criteria [4] and based on the pretest of mathematical physics, some students have problems in doing the analysis accurately. However, after being offered to them, 9 students expressed their willingness to participate in FGD activities. The chosen location is in "saung" which is in the middle of Campus Park. This location was chosen because there is a large round table and a comfortable chair for discussion. In addition, because it is in the middle of the park and away from passing students and campus staff is relatively quiet as a place of discussion. The selected time is in student's free time, usually during the day after the end of active hour of college. Thus the students have enough rest and the campus atmosphere is not too crowded. Discussions last for one and a half to two hours once a week and last for 5 weeks. During the discussion sessions student are provided with snacks and drinks. All discussion activities were recorded using handycam and assisted by an assistant to record the discussion.

3. Result and Discussion

It is recommends the FGD stage for introducing the group discussion includes welcome, overview of the topic, ground rules, and first question [5]. In this research the discussion process begins with some questions that refer to the stages suggested. After welcoming the students with greetings and welcome proceed with a quick overview of the FGD's objectives, topics to be discussed, discussion rules, discussion begins with questions. Data related to student difficulties in performing the analysis accurately then classified. Based on the classification, the most appropriate approach is chosen to help students overcome the difficulties.

Discussion process flows in form of questions and answers are conducive. Students are from different classes. In the first week students are start getting used to greet each other. This is consistent with the research results [6]. Each individual will make a significant contribution and the acquaintance of each individual still has not been proven to be influential, but the homogeneity of participants in the same interest will improve the quality of the discussion [3]. The unique thing about this discussion is the application of the Cognitive Apprenticeship-Instruction model stages during the discussion.

The modeling stage is done by giving the material a glimpse of repeating what they have gained in the classroom. But since students come from different classes and are taught by different lecturers as well, then the modeling stage is more on discussion activities to equate perceptions related to the material to be discussed. At this stage also explored the problems faced by students in mastering the

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topic. Problems are then classified and determined together in the discussion to find a solution to overcome them.

The next stage is coaching, which is done by giving a context-related topic to the students and they are asked to complete with their nearest sitting buddy. At this coaching stage students learn from each other and moderators function as facilitators when students experience problems. The coaching stage is also used as a means for moderators to provide gradual assistance or scaffolding in accordance with the difficulties faced by students from the discussion results in the modeling stage. The aid is called the reflective scaffolding [1]. Stages of coaching can be a reflection event for students. Through the process of solving the contextual problems of mathematical physics, the student performs a process of reflection, among others, recognizing the relationship between concepts, seeing the similarities and differences between the two concepts, and raising problems related to the concepts studied [7].

Stages of articulation and exploration is done by asking students to explain their work and then responded by other students. The articulation stage may include any method in which students can explicitly state their knowledge, their reasoning, and even the problem-solving process they have done [8]. Students articulate in the process of exposure and other students explore their own ability in responding to the exposure of their friend. At the time of articulation, a peer teaching process is inadvertently occurred.

To see the development of reflective thinking process during the discussion, one student has been selected to observe the development of her reflective thinking skills in solving the mathematical physics problems. This student was chosen for being honest when doing pre-test and being positive while discussing by actively answering and responding to questions. Here in after referred to in this study as S. In order to obtain accurate and real data, S is not informed that she is being observed. The data obtained from the observations showed satisfactory results as in Figure 1, Figure 2, and Figure 3.

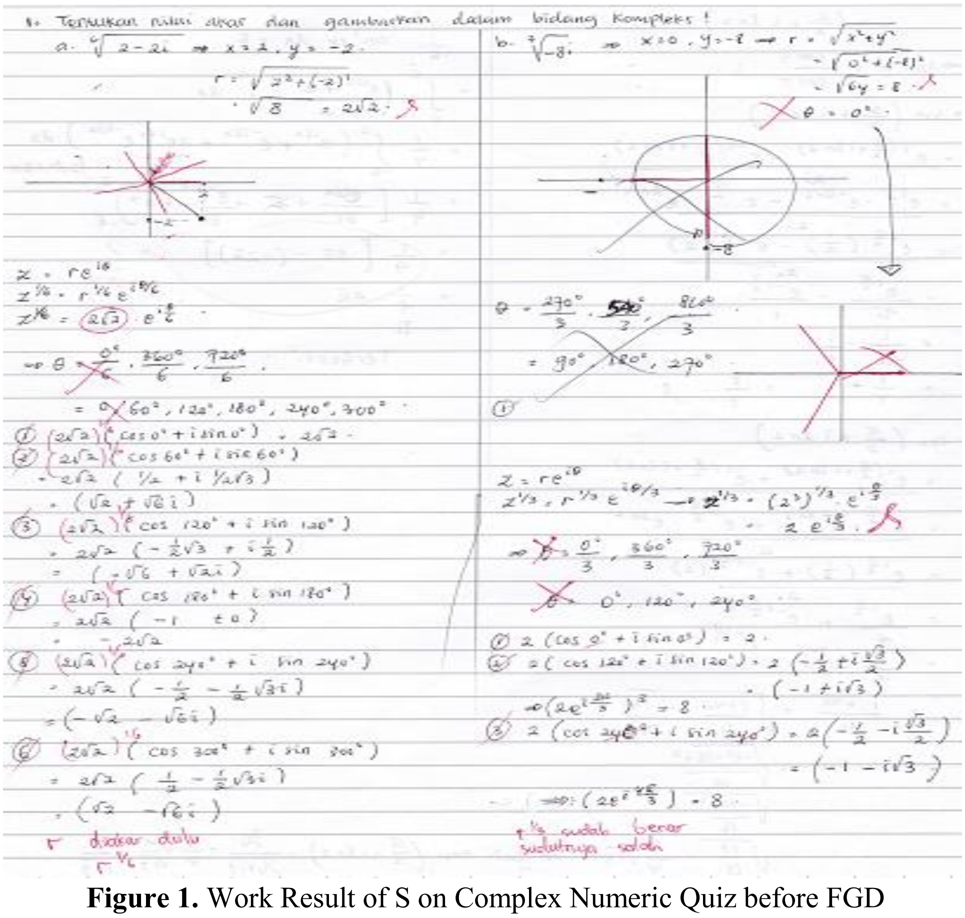

Figure 1. Work Result of S on Complex Numeric Quiz before FGD

In Figure 1, S has understood that the meaning of $\sqrt[n]{x}$ is that there are a number of n roots of the number x. It appears that S has already written down six solutions to Problem 1.a, and also written down three solutions to problem b to determine each root. S has also found the r value of each question, but still has the constraint of accurate completion of the final calculation and plotting the root values in the complex plane. After following the FGD, in week two of FGD, S is able to answer correctly as in Figure 2.

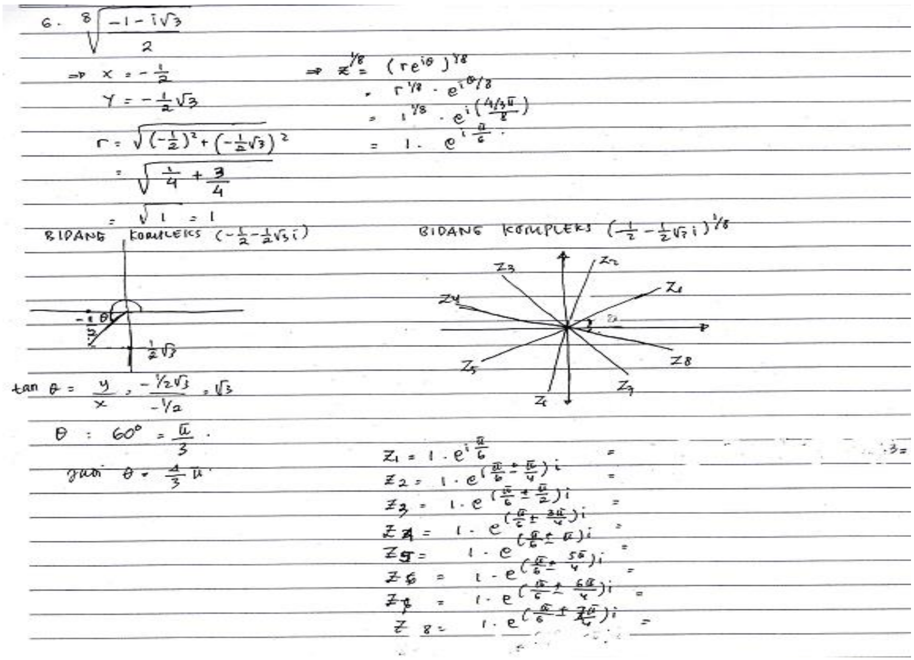

Figure 2. Work Result of S on the Problem of Complex Numbers in midterm exam after FGD.

A month after FGD session, the mastery of the concept of complex number operations is well applied by S to the solution of ordinary second-order differential equations, even including an explanation, although not asked in the question as in Figure 3. The implementations of stages of Cognitive Apprenticeship-Instruction model results in the FGD session have a positive impact on the reflective thinking skills development of S in solving the problem.

The result of this research shows that the scaffolding done by moderator will strengthen student's thinking scheme, reduce the inhibiting aspects of the learning process, sharpen intuition aspect of the students, and help the effectiveness of the learning process [9].

During the FGD activities it was also revealed that through peer teaching activities students learn from each other. Students also have good study preparation because they have the provision of knowledge gained from the results of group discussion. In cooperative learning students work together in small groups and their personal intelligence increases along with the increase of group collective intelligence [10]. This is also in accordance with the theory that group learning allows learners to gain higher abilities when they have lower abilities of self-taught [11].


3.

$f_g = -\ell\left(\frac{dx}{dt}\right)$, $\ell > 0$

$F = -kx - f_g$

$m \cdot a = -kx - \ell\left(\frac{dx}{dt}\right)$, $(\ell > 0)$

$m\left(\frac{d^2x}{dt^2}\right) = -kx - \ell\left(\frac{dx}{dt}\right) \rightarrow \omega^2 = \frac{k}{m}$, $2b = \frac{\ell}{m}$, $(b > 0)$

$\left(\frac{d^2x}{dt^2}\right) = \frac{-k}{m}x - \frac{\ell}{m}\left(\frac{dx}{dt}\right)$

$\left(\frac{d^2x}{dt^2}\right) + 2b\left(\frac{dx}{dt}\right) + \omega^2 x = 0$

$D^2 + 2bD + \omega^2 = 0$

$D = \frac{-2b \pm \sqrt{4b^2 - 4\omega^2}}{2} = -b \pm \sqrt{b^2 - \omega^2}$

diperoleh nilai b yang berbeda, sehingga akan tjd beberapa kemungkinan.

gerak overdamped jika $b^2 > \omega^2$
critically damped jika $b^2 = \omega^2$
underdamped / gerak osilasi jika $b^2 < \omega^2$.

① overdamped motion / gerak overdamped.
sejak $\sqrt{b^2 - \omega^2}$ adalah real dan lebih dari b. akar dari kedua persamaannya adalah negatif.
$y = Ae^{-\lambda x} + Be^{-\mu t}$, dimana $\lambda = b + \sqrt{b^2 - \omega^2}$, $\mu = b - \sqrt{b^2 - \omega^2}$

② critically damped motion
sejak $b = \omega$, sehingga nilai akar-akarnya sama
$y = (A + Bt)e^{-bt}$

⇒ pada gerak overdamped dan critically damped motion, benda m bergerak

③ underdamped motion / gerak osilasi
pada gerak osilasi $b^2 < \omega^2$, sehingga $\sqrt{b^2 - \omega^2}$ adalah imajiner.
misal $\beta = \sqrt{\omega^2 - b^2}$
$i\beta = \sqrt{b^2 - \omega^2}$

Jadi akar-akarnya $= -b \pm i\beta$
sehingga diperoleh
$y = Ce^{-bt}\sin(\beta t + \gamma)$

Figure 3. Answers of S to a Reflective Thinking Test

4. Conclusion

The scaffolding stage in the CA-I model plays an important role in the process of solving physics problems accurately. The tiered assistance provided during the scaffolding process has helped students solve the mathematical physics problem. Students are able to recognize and to formulate problems by describing problem sketches. They can identify the variables involved, apply mathematical equations that accord to physics concepts, execute accurately, and apply evaluation by explaining the solution to various contexts

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