Improvement a positive attitude towards abstract algebra through APOS theory approach

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Abstract. Rate of students’ participation in teaching and learning Abstract Algebra (AA) depends upon attitude towards AA and Students’ success in AA depends upon rate of students’ participation in teaching and learning of AA. Thus it is very important to improve students’ attitude towards AA. This research was pre-experimental one shot case study design. The subject of this study were 50 students who participating in the AA course academic year 2018/2019 at Andalas University. A questionnaire was used to examine student’s attitudes towards AA and its learning. Descriptive statistics and t-test with level of significance α = 0.05 were used for data analysis. The results showed that: (1) APOS theory approach can improve students attitude towards AA and its learning (2) There was no a gender gap in students’ attitude towards AA and its learning. (3). There was a positive correlation between attitude towards AA and its learning.

1. Introduction

Abstract Algebra (AA) is one of very important subjects matter which exist in the curriculum of the department of mathematics and mathematics education at Indonesian universities and other countries. The main topics in AA include group theory, ring, integral domain, and field which is the generalization of algebraic structures that students have been studied at the school mathematics level, such as the set of functions with binary operation composition of functions, the set of integers with the binary operations addition and multiplication, and the set of real numbers with binary operations addition and multiplication [1],[2]. Through the course of AA, students will be provided with the ability to construct, analyze, and prove the theorems and then use definitions and theorems in AA problem solving.

The main ability that is expected possessed by students through the lectures of AA is the ability to prove that includes ability to construct a proof, the ability to validate the proof, and the ability to evaluate the proof. Most of students have difficulty in learning AA, for example, in the department of mathematics Andalas University, in each year the percentage of students have passed above “B” grade always under 40% as well as the score of his attitude, never more than 57. Results of international studies also show similar things, namely that most students have difficulty in proof ability task in AA [3-5].

Some research suggests that achievement in mathematics influenced by attitudes towards mathematics [6-9]. This means that students who have characteristics such as: (1) like the AA, (2)
want to engage actively in learning, (3) have the confidence that they will succeed in AA, and (4) realize that AA is very useful to learn, will likely great success in AA. Conversely, students who have characteristics such as: (1) do not like AA, (2) avoid getting involved in learning, (3) are not confident that they will succeed in AA, and (4) do not know the usefulness of studying the AA, will likely fail in AA. Thus enhancing achievements in AA can be done through increasing students' attitudes towards the AA.

Attitude toward mathematics is a an individual’s way of thinking, acting and behaving to mathematics in certain contexts (indifference to a math class, beliefs/confidence about success in math, interest in math, perceived task value) [9],[10]. According to Lavadas & Lay [11], classroom instruction is one factors that affecting students’ attitude toward mathematics, Hodges et al [9] have been tried to use motivational design model called the ARCS (Attention, Relevance, Confidence and Satisfaction) in order to improve students’ attitudes toward mathematics. In this study we use APOS theory approach as the guiding framework for the design of instructional treatment to improve students’ attitudes toward AA. Why APOS? (1) APOS theory approach is a constructivist theory of learning in undergraduate mathematics education [12], so student must be active in constructing definition and theorem in AA; (2) APOS theory approach pay attention to the mental construction of college students in understanding a mathematical concept [12], so student would be easier to understanding AA, so will hopefully appear in his belief that they will be successful in the AA; (3) APOS theory approach integrates the use of computer/ICT [12], so student is expected to be attracted towards the AA; (4) APOS theory approach using the learning cycle ACE (activities, classroom discussion, exercise) [12], in exercise session, student practices some problem solving in AA, especially with regard to everyday life, so the student is expected to realize the usefulness of AA.

Based on the indicators of attitude toward mathematics and the characteristics of the APOS theory approach, this study aims to answer the questions research as follows: (1) Are APOS theory approach can improve students’ attitude toward AA and its learning? (2) Are there the differences in students’ attitude towards AA and its learning between male and female students? (3) Are there the correlation between attitide towards AA and its learning?

2. Materials dan Methods
This study using qualitative and quantitative research methods, qualitative methods were used to describe students’ attitude towards AA and its learning based on APOS theory approach and quantitative research methods with pre-experimental one shot case study design were used to analyze the effects of APOS theory approach on students’ attitude toward AA and its learning. The subject of this study were 50 students who participating in the AA course that based on APOS theory approach, academic year 2018/2019 at Andalas University. Instrument of this study was a set of attitude questionnaire consists of 33 items that have been developed in accordance with the indicators of mathematics’ attitude and its learning and have been validated by expert. In this questionnaire, all students were required to choose one of five point (strongly disagree-1 to strongly agree-5 points) that reflects their own views and stance on the statements. To answer the first question research, mean scores of the questionnaire were grouped into indicators of attitude toward mathematics and its learning, and to answer the second and third question research, three stages that are done are as follows: (1) applied a one-sample t test to compare mean scores of questionnaire versus 57; (2) applied a two-sample t test to compare mean scores of questionnaire for male versus female students; (3) applied the Pearson correlation to measure the correlation between attitude towards AA and its learning. All data were analyzed using SPSS 17.0 at level of significance $\alpha = 0.05$.

3. Result dan Discussion
Based on the questionnaire that released after completion of AA courses based on APOS theory approach, were obtained data on students' attitude towards AA and its learning as stated in table 1, table 2, table 3 and table 4.

| Table 1. Descriptive statistics per indicator of students’ attitude toward AA |
|---------------------------------|---------|---------|---------|---------|---------|
| Indicators                      | Total score | Ideal score | Mean | Std. deviation | Percentage from ideal attitude |
| Indifference to a math          | 950       | 1250      | 19.0000 | 2.83563 | 76.000 |
Table 2. Descriptive statistics per indicator of students’ attitude toward AA learning based on APOS theory approach

| Indicators                        | Total score | Ideal score | Mean    | Std. deviation | Percentage from ideal attitude |
|-----------------------------------|-------------|-------------|---------|----------------|--------------------------------|
| Use of cooperative learning       | 905         | 1000        | 18.1000 | 1.84336        | 90.500                         |
| Use of computer                   | 377         | 500         | 7.5400  | 1.09190        | 75.400                         |
| The role of lecturer in AA learning | 2011       | 2750        | 40.2200 | 4.84574        | 73.127                         |
| Overall                           | 3293        | 4250        | 65.8600 | 5.90403        | 77.482                         |

Table 3. Descriptive statistics of male and female students’ attitude toward AA

| Gender       | N  | Total score | Ideal score | Mean    | Std. deviation | Percentage from ideal attitude |
|--------------|----|-------------|-------------|---------|----------------|--------------------------------|
| Male         | 22 | 1339        | 1760        | 60.8636 | 6.88197        | 76.079                         |
| Female       | 28 | 1713        | 2240        | 61.1786 | 6.55492        | 76.473                         |
| Overall      | 50 | 3052        | 4000        | 61.0400 | 6.63313        | 76.300                         |

Table 4. Descriptive statistics of male and female students’ attitude toward AA learning based on APOS theory approach

| Gender       | N  | Total score | Ideal score | Mean    | Std. deviation | Percentage from ideal attitude |
|--------------|----|-------------|-------------|---------|----------------|--------------------------------|
| Male         | 22 | 1413        | 1870        | 64.2273 | 5.62250        | 75.561                         |
| Female       | 28 | 1880        | 2380        | 67.1429 | 5.89861        | 78.991                         |
| Overall      | 50 | 3293        | 4250        | 3293.00 | 65.8600        | 77.482                         |

Table 1 and table 2 showed that students have a positive attitude towards AA and its learning (percentage from ideal attitude for each indicator more than 70%) and the average students’ attitude towards AA, i.e 61.0400 more than 57. Meanwhile, table 3 and table 4 showed that attitude of female students better than male students, both for AA and its learning. To find out whether APOS theory approach can improve students’ attitude towards AA significantly, test of normality and test of one sample t-test were performed to data scores attitude toward AA, the result can be seen in table 5 and table 6.

Table 5. Normality test with Kolmogorov-Smirnov for students’ attitude toward AA

| Data       | Kolmogorov-Smirnov Statistic | df | Sig. | Decision          |
|------------|-------------------------------|----|------|-------------------|
| Overall    | .119                          | 50 | .073 | overall score was normal (0.073 > 0.05) |

Table 6. One sample t-test on students’ attitude toward AA

| Data       | t-statistic | df | Sig. (2-tailed) | Decision                |
|------------|-------------|----|-----------------|-------------------------|
| Overall    | 4.307       | 49 | .000            | 61.0400 different from 57 significantly (.000 < 0.05) |

Table 6 showed that APOS theory approach can improve students’ attitude towards AA significantly. To find out if the attitude of female students different from male students towards AA significantly, test of normality, test of homogeneity and test two-independent sample t-test were performed for data female and male score attitude towards AA, the results can be seen in table 7, table 8 and table 9.
Table 7. Normality test for male and female score with Kolmogorov-Smirnov for attitude toward AA

| Data        | Kolmogorov-Smirnov Statistic | df | Sig. | Decision                      |
|-------------|------------------------------|----|------|-------------------------------|
| Male score  | .130                         | 22 | .200 | male score was normal (.200 > 0.05) |
| Female score| .120                         | 28 | .200 | female score was normal (.200 > 0.05) |

Table 8. Levene's test for equality of variances for attitudes toward AA

| Data        | Levene-statistic | df1 | df2 | Sig. | Decision                      |
|-------------|------------------|-----|-----|------|-------------------------------|
| Male score vs female score | .203 | 1   | 48  | .654 | variance score of male equal to female (.654 > 0.05) |

Table 9. Two independent sample t-test for male and female score for attitude toward AA

| Data        | t-statistic | df | Sig. (2-tailed) | Decision                      |
|-------------|-------------|----|----------------|-------------------------------|
| Male score vs female score | -.165 | 48 | .870 | mean score of male and female not different significantly (.870 > 0.05) |

Table 10. Normality test for male and female score with Kolmogorov-Smirnov for attitudes toward AA learning

| Data        | Kolmogorov-Smirnov Statistic | df | Sig. | Decision                      |
|-------------|------------------------------|----|------|-------------------------------|
| Male score  | .092                         | 22 | .200 | male score was normal (.200 > 0.05) |
| Female score| .079                         | 28 | .200 | female score was normal (.200 > 0.05) |

Table 11. Levene's test for equality of variances for attitude toward AA learning

| Data        | Levene-statistic | df1 | df2 | Sig. | Decision                      |
|-------------|------------------|-----|-----|------|-------------------------------|
| Male score vs female score | .045 | 1   | 48  | .833 | variance of male score equal to female score (.833 > 0.05) |

Table 12. Two independent sample t-test on male and female students for attitude toward AA learning

| Data        | t-statistic | df | Sig. (2-tailed) | Decision                      |
|-------------|-------------|----|----------------|-------------------------------|
| Male score vs female score | -.165 | 48 | .870 | mean score of male and female not different significantly (.870 > 0.05) |

Table 13. Pearson correlation test of attitudes toward AA and AA learning

| Data        | Coefisien Correlation | Sig. (2-tailed) | Decision                      |
|-------------|------------------------|----------------|-------------------------------|
| Overall-1 vs overall-2 | .524 | .000 | The correlation was significantly (.000 < 0.05) |

Based on table 6, mean score of attitude towards AA was increased significantly from 57 be 61.0400. There were many reasons why APOS theory approach can improve students attitude towards AA: (1) learning materials that used in the lecture of AA developed based on mental construction actions, process, object, and schemas (APOS) and already meets the criteria valid, practical and effective [13], so can improve students achievement in AA and then can improve students attitude towards AA, because, according to Adamu et al [14], there are a positive correlation between
students’ attitude and students’ achievements in mathematics; (2) APOS theory approach using the learning cycle ACE, i.e. there are special session for activities using computer, in this session students are given the opportunity to find out fact about definitions and theorems, so then can improve students interest in AA, because, according to Mohammad [15], students have a positive attitude towards the use of computer in learning; (3) In APOS theory approach, students learning cooperatively and actively involved during the learning process, that is active in understanding the definitions and theorems, according to Zakaria et al [16], cooperative learning can improve students’ attitude towards mathematics, and according to Srinath [17], active learning approach can improve students understanding in STEM and finally improve students Beliefs/confidence about success in AA.

Based on table 3, 4, 9 and 12, female students attitude towards AA and its learning more positive than male students but not significant, this suggests that both male and female students gain many benefits from AA learning based on APOS theory approach. Many research agreed with this finding, for example see [18] for research at secondary school level, see [19] for Junior High School and see [20] for research at university level. Table 13 showed that there were a positive correlation between students attitude towards AA and its learning. A success of students in learning mathematics relates to the attitude of the students themselves to mathematics and its learning process [14,21], so that how important it is for a lecturer to choose a learning model that fits to his subject of mathematics course, for example by the integration of technology in teaching and learning process [22].

4. Conclusion
Based on the result and discussion of this study can be concluded that: (1) APOS theory approach can improve student’ attitude towards abstract algebra; (2) There was no gender gap in attitude towards abstract algebra and its learning; (3) There was a significant correlation between attitude towards abstract algebra and its learning.

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