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UNDERGRADUATE STUDENTS SELF-CONCEPT AND THEIR MATHEMATICS PROCEDURAL KNOWLEDGE: THE RELATIONSHIP

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ABSTRACT

This study aimed to explain the relationship between self-concept and mathematics procedural knowledge among undergraduate students of mathematics education. This study investigated the affective and cognitive aspect of students in the learning of mathematics. The method in this study surveyed with non-probability sampling technique. The subjects were 133 undergraduate students of mathematics education from public and private university in Palembang, Indonesia. 66 of them were undergraduate students in public university. The rest of them were undergraduate students in a private university. The instruments that were used are questionnaire of self-concept and essay test of mathematics procedural knowledge. The result from the Spearman Rank Correlation showed Sig. = 0.006 < 0.05. From that result, we conclude that there is a significant relationship between undergraduate students' self-concept and their mathematics procedural knowledge.

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1. INTRODUCTION

The relation of affective and cognitive aspect to students in learning mathematics is an interesting issue to discuss. That issue involve not only about how students learn mathematics, but also how his/her psychology when learn it. Assessment that only observes cognitive dimension is not enough yet to describe students' mathematics achievement (Suryanto, 2008). Affective dimension also needs to be observed to students, because the characteristic can give an image to a teacher about students' psychology, such as attitude when he/she faces mathematics subject. Positive attitude to mathematics is an important part of mathematics education (Reyes, 1984). One of the affective aspects that describes an individual and relates to his/her cognitive dimension is self-concept (Ghazvini, 2011).

Self-concept is the way of individual views about he/she abilities in various aspects, such as academics, athletics, and social interactions. In social life, individual behavior corresponds to his/her self-concept. It determines individual reaction to people surrounding him/her (Mishra, 2016). According to Shavelson & Bolus (1982), self-concept can be categorized as two, that is, academic self-concept and non-academic self-concept. Self-concept that views from academic can be defined as academic self-concept. An academic self-concept is an individual psychological relate to belief about his/her ability in academic (e.g. mathematics) (Flowers, Raynor Jr, & White, 2013). Individual experiences in academic achievement related to the ways that he/she has learned to view his/herself and his/her relationships with others people. That individual view refers to his/her academic self-concept (Oluwatosin & Bamidele, 2014). According to Fin & Ishak (2014), an individual non-academic self-concept also influences his/her academic achievement, but indirectly. They explained that academic self-concept as a mediator between non-academic self-concept and academic achievement.

There are many aspects relate to individual self concept, that are, physical characteristic, individual concern, social identity, individual personality (Reyes, 1984), view of the future (Barongo & Nyamwange, 2013; Deshmukh, 2015; Lone & Lone, 2016; Rajeswari & Kalaivani, 2016), the influence of others who become role models (Andinny, 2015), and the influence of surrounding environment (Singh, 2015). Self-concept in academic, especially mathematics, according to Reyes (1984), Students' view of the mathematics is an important aspect in learning mathematics.

The studies that concern to the relationship between self-concept and mathematics achievement have been investigated by Ayodele (2011), Seaton et al. (2014), Andinny (2015), Jamaldini et al. (2015), Singh (2015) and Timmerman, Van Luit, & Toll (2017). They argued that there is a relationship between both variables. On the other previous studies, there is no correlation between self-concept and academic achievement (Yahaya & Ramli, 2009; Afuwape, 2011; Berg & Coetzee, 2014; Nalah, 2014; Yengimolki, Kalantarkousheh, & Malekitabar, 2015). That result also occurred to Adebule (2014), Awai & Ogori (2016) studies' in mathematics. We argued that inconsistence phenomenon because of mathematics achievement in their studies was unclear about what mathematical ability that they observed.

Students' academic achievement, according to Zulnaidi & Zamri (2017), can be interpreted as students learning ability. There are many aspects of learning ability in mathematics, that are conceptual, procedural, problem-solving, communication, reasoning, and representation ability. To make that problem clear, we investigated self-concept and mathematical procedural ability. We defined mathematical procedural ability as procedural knowledge in mathematics. We focused on that ability because it is fundamental that students should have in learning mathematics. Zulnaidi & Zamri (2017) stated that students need to acquire procedural knowledge at least. Mathematics procedural knowledge as a knowledge that knows about the symbols in a system and its structure and knows about the rules or procedures to solve mathematics problem (Star & Stylianides, 2013; Joersz, 2017; Zulnaidi & Zamri, 2017).

Mathematics procedural knowledge is a part of mathematics understanding. Mathematical understanding, according to Skemp (1976), consists of instrumental and relational understanding. A student that has instrumental understanding, if he/she can apply mathematics formula to a problem, whereas a student that has relational understanding, if he/she knows a mathematics rule, apply it, and the reason. It shows that instrumental understanding corresponds to procedural knowledge or action conception in APOS theory perspective (Afgani, Suryadi, & Dahlan, 2017). Mathematics procedural knowledge that was measured in this study is about calculus preliminary materials that are, simplification and factorization of algebra form in R system, quadratic equation, inequality, absolute value, linear equation, and function. One of the example of the items is "Determine the linear equation that through (2, -5) and perpendicular with $2x - 4y = 3$". A solution of that mathematics problem requires mathematics procedural knowledge of students. Firstly, they must transform the equation to become $y = ax + b$. the new equation shows that "a" is a gradient of the first line. The gradient that perpendicular to the first line is negative reciprocal of "a". Finally, they must substitute it and (2, -5) to a formula of the linear equation through a point with gradient is known and it produces only one answer. The procedure to solve that mathematics problem connects with some mathematics concept. This means that students also need to know mathematics concepts. In this situation, students must know the concepts that are needed to solve it so that they can operate the procedure completely. According to Kusuma & Masduki (2016), a student cannot choose a right procedure to solve mathematics problem due to he/she does not know the concepts that appropriate to solve the problem. In mathematical procedural ability, students only need to know or remember a mathematics concept and apply it and he/she does not have to understand the concept very well.

As the previous explanation, there is an inconsistence result about students' self-concept and their mathematics achievement. In this study, we still investigated both variables, but the scope of mathematics achievement is focused on mathematics procedural knowledge. The research question is tried to answer; is there a relationship between self-concept and mathematics procedural knowledge among undergraduate students of mathematics education.

2. METHOD

The method was used in this study is survey. The subjects were 133 undergraduate students of mathematics education from public and private university in Palembang, Indonesia. They were chosen through non-probability sampling. 66 of them were undergraduate students in public university which consists of 12 males and 54 females. The rest of them were undergraduate students in private university which consist of 9 males and 58 females.

The instruments that were used are questionnaire of self-concept and essay test of mathematics procedural knowledge. Self-concept instrument was developed from instruments that were used by Ferla, Valcke, & Cai (2009), Matovu (2012), Flowers et al. (2013) in form Likert scale. We used that form, because it easy to understand respondents' perception (Subedi, 2016). We developed the instrument to be appropriated with the condition to undergraduate students of mathematics education that take calculus of differential class. For test instrument, we used problems referenced from calculus book. Before we applied both instruments to field test, we did validity and reliability test to the instruments. The respondents are non-experiment subject. According to Subedi (2016), Likert scale can be assumed as a set of data arranged in sequential category and continuous. The data can be treated as interval data, so according to Joshi et al. (2015) implied that the validity test from interval data can use Pearson product moment and the reliability test use Cronbach's Alpha. Hence, the validity and reliability test in this study used both formulas and the result presented in Table 1.

Table 1. The Results of Validity and Reliability Test

Instrument	Type of Instrument	Number of items	Number of Respondents	Critical Value of Pearson (α = 0.05)	Cronbach's Alpha Value	Number of Valid Items
Self Concept	Non-Test	43	65	0.244	0.92	42
Mathematics Procedural Knowledge	Test	16	40	0.312	0.88	14

The result from Table 1 showed that one item of the non-test instrument and two items of test instrument were invalid because the correlation values were less than each of its critical value of Pearson. It because there was several respondents obtain same total score, but score of the items was different. That means a validity of the items was less convince (Arikunto, 2012). Hence, only 42 items of self-concept questionnaire and 14 items of mathematics procedural knowledge test were valid and reliable.

The procedures to investigate self-concept and mathematics procedural knowledge of undergraduate students of mathematics education are, Firstly, We collected the data of both variables. We examined mathematics procedural knowledge about calculus preliminary to the subjects during 2 hours. After they finished it, they were requested to fill self-concept questionnaire. The data of the questionnaire in this study were treated as interval according to Joshi et al. (2015), because the result of construct validity test from four experts in mathematics education implied each item is arranged logically, interconnected, coherent, and measure different elements from aspects of self-concept. Secondly, we processed the data. Because type of both data vairiables was interval, we converted the score from both variables become value ranging 0 – 100. The formula is $\frac{student\ score}{ideal\ score} \times 100$. Ideal score for the self-concept questionnaire was 168 and mathematics procedural knowledge test was 54. After that, we seek the average and standard deviation value of self-concept score in terms of overall. We categorized the average value of students' self-concept and their mathematics procedural knowledge become 5 categories, that are, very good (81 – 100), good (61 – 80), good enough (41 – 60), adverse (21 – 40), and very adverse (0 – 20). To test the hypothesis, there is a relationship between self-concept and mathematics procedural knowledge among undergraduate students of mathematics education, we do correlation test.

The data analysis that was used in this study is descriptive statistic to categorize the data and Pearson product-moment to test the correlation between self concept and mathematics procedural knowledge among undergraduate students of mathematics education. To assist all that analysis, we used SPSS 16.0.

3. RESULTS AND DISCUSSION

Descriptively, the results of data analysis showed that mean value of students' self-concept is 82.63 with standard deviation is 6.39. From 0 – 100 scale, it means that students' self-concept was categorized good. This result is also supported by a study of Suryanto (2008). Mean value of students' mathematics procedural knowledge is 21.31 with standard deviation is 14.94. It means that students' mathematics procedural knowledge was categorized adverse. According to Barongo & Nyamwange (2013), the result reveals incongruence between students self-concept with their mathematics procedural knowledge. It will congruence if both aspects in the same category.

To answer the research question, is there a relationship between students' self-concept and their mathematics procedural knowledge, firstly, we did preliminary analysis test to both variables. From Table 2, the normality test of Self-Concept (SC) value has sig. = 0.200 > 0.05 and Mathematics Procedural Knowledge (MPK) value has sig. = 0.002 < 0.05. It means distributions of the data are normal, except MPK value.

Table 2. Summary of Normality Test of Self Concept and Mathematics Procedural Knowledge Value

Variable	Skewness	Kurtosis	Statistic	Sig.
SC	0.123	- 0.661	0.068	0.200
MPK	1.266	2.558	0.101	0.002

For the homogeneity test between public and private university, the Sig. value of SC was 0.746 and the Sig. value of MPK value was 0.448. It shows that both sig. value > 0.05. It means that the data is homogenous variance. The result is summarized in Table 3.

Table 3. Summary of Homogeneity test of Self Concept and Mathematics Procedural Knowledge Value

Variable	Levene statistic	Sig.
Self Concept	0.105	0.746
Mathematics Procedural Knowledge	0.580	0.448

From that result, to test the hypothesis there is a significant relationship between self-concept and mathematics procedural knowledge of undergraduate students of mathematics education used Spearman rank correlation.

Table 4. Summary of Relationship between Self-Concept and Mathematics Procedural Knowledge Value

Variable	N	Mean	Standard Deviation	Coefficient Correlation	Sig.
SC	133	82.63	6.39	0.238	0.006
MPK	133	21.31	14.94		

The result from Table 4 showed that Sig. = 0.006 < 0.05. It means there is a significant relationship between students' self-concept and their mathematics procedural knowledge. Furthermore, the correlation coefficient showed 0.238 and its determination coefficient was 5.66%. It means that the correlation between both variables is positive but low, moreover student self-concept only influenced his/her mathematics procedural knowledge equal to 5.66% and the rest by other variables. This result also equivalents with Timmerman et al. (2017) study. According to Andaya (2014), self-directed learning, attitude towards mathematics, motivation, and time spend in learning mathematics were the other factors that can influence students' success in mathematics. The results of the study had shown that there is a significant relationship between students' self-concept and their mathematics procedural knowledge. The result could be convinced, because type of both data variables is not different. This result was relevant to the study of Leonard & Supardi (2010). They reported that students' self-concept influence his/her mathematics learning outcome, because positive view, perception, and his/her confidence will improve mathematics learning outcome. Othman & Leng (2011) reported little different from the previous study. They claimed that students' self-concept relate to his/her academic achievement, but weak. From our analysis, that because an academic achievement involve many school subjects area. In line with Leonard & Supardi, Ayodele (2011) implied that students' self-concept relate to his/her mathematics performance moderately, that because students thought or felt about, attitude, perception to mathematics was moderately positive.

In Seaton et al. (2014) perspective, academic self-concept has reciprocal relation with achievement. According to Andinny (2015), self-concept influence mathematics performance in form extends an opportunity to students to solve a mathematics problem. Jamaldini et al. (2015), and Singh (2015) also reported that students' self-concept relate to his/her academic achievement in mathematics. Singh (2015) added an argumentation that self-concept was a consequence from high achievement. It means students' academic ability influence his/her self-concept. More detail, Timmerman et al. (2017) reported that the correlation between math self-concept with math achievement was weak in measurement and relations subject and moderate in numbers and scale subject. He argued that students' attitude and perception about his/her mathematical ability is a main factor of self-concept that influence students' math achievement. That means the result of this study supports the result of previous study, because students' mathematics achievement can be observed through their mathematical abilities. One of that ability is mathematics procedural knowledge. In this study, it covered simplification and factorization of algebra form in R system, quadratic equation, inequality, absolute value, linear equation, and function. Nevertheless, the result also showed the correlation between both variables was low and incongruence. It means that student with high self-concept does not certainly have high mathematics achievement. This is because undergraduate students' self-concept was categorized good, whereas their mathematics procedural knowledge was categorized adverse. In this study, most of the undergraduate students difficult to solve mathematics problems related to linear equation and function.

4. CONCLUSION

Based on the result of this study, we conclude that there is a significant relationship between self concept and mathematics procedural knowledge. Besides that, this study has a few limitations. First, the sample was used non-probability sampling and a number of samples were too limited, so the conclusion cannot be generalized to all undergraduate students majoring mathematics education in Palembang, Indonesia. Second, both instruments only valid and reliable to sample has characteristic that resembles the sample involved in this study. For next studies, we recommended to investigating self-concept and others mathematical ability or relation between mathematics procedural knowledge and others affective aspect to an amount of representative samples. So that, the relationship between affective and cognitive dimension in mathematics education can explain clearly.

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REFERENCES

Adebule, S. O. (2014). Self concept and academic performance in mathematics among secondary school students in Ekiti–State. *Scholars Journal of Engineering and Technology (SJET), 2*, 348-351.

Afgani, M. W., Suryadi, D., & Dahlan, J. A. (2017). Analysis of Undergraduate Students' Mathematical Understanding Ability of the Limit of Function Based on APOS Theory Perspective. In *Journal of Physics: Conference Series*(Vol. 895, No. 1, p. 012056). IOP Publishing.

Afuwape, M. O. (2011). Students' self-concept and their achievement in basic science. *African Research Review*, *5*(4).

Andaya, O. J. F. (2014). Factors that affect mathematics achievements of students of Philippine Normal University-Isabela Campus. *Researchers World*, *5*(4), 83.

Andinny, Y. (2015). Pengaruh konsep diri dan berpikir positif terhadap prestasi belajar matematika siswa. *Formatif: Jurnal Ilmiah Pendidikan MIPA, 3*(2).

Arikunto, S. (2012). *Dasar-dasar evaluasi pendidikan edisi 2*. Jakarta: Bumi Aksara.

Awai, D., & Ogori, E. (2016). Emotional intelligence and self concept as predictors of students academic achievement in mathematics. *International Journal of Sciences: Basic and Applied Research*, *29*(3), 223-231.

Ayodele, O. J. (2011). Self-concept and performance of secondary school students in mathematics. *Journal of Educational and Developmental Psychology, 1*(1), 176-183.

Barongo, S., & Nyamwange, C. (2013). Contribution of self-concept in guidance and counseling among students. *Research on Humanities and Social Sciences*, *3*(13), 7-12.

Berg, G. V. D., & Coetzee, L. R. (2014). Academic self-concept and motivation as predictors of academic achievement. *International Journal of Educational Sciences*, *6*(3), 469-478.

Deshmukh, K. P. M. (2015). Comparison of Self-Concept of School Children Belonging to High and Low Fitness Groups. *International Journal of Physical Education, Sports and Health*, *1*(3), 61-64.

Ferla, J., Valcke, M., & Cai, Y. (2009). Academic self-efficacy and academic self-concept: Reconsidering structural relationships. *Learning and individual differences*, *19*(4), 499-505.

Fin, L. S., & Ishak, Z. (2014). Non-Academic Self Concept and Academic Achievement: The Indirect Effect Mediated by Academic Self Concept. *Research Journal in Organizational Psychology & Educational Studies*, *3*(3), 184-188.

Flowers, L. O., Raynor Jr, J. E., & White, E. N. (2013). Investigation of academic self-concept of undergraduates in STEM courses. *Journal of Studies in Social Sciences*, *5*(1).

Ghazvini, S. D. (2011). Relationships between academic self-concept and academic performance in high school students. *Procedia-Social and Behavioral Sciences*, *15*, 1034-1039.

Jamaldini, M., Baranzehi, H., Farajpour, N., & Samavi, A. (2015). The causal relationship of self-efficacy, self-concept, and attitude towards mathematics with academic achievement in mathematics by mediation of approaches to learning. *International Journal of Review in Life Sciences*, *5*(2), 41-45.

Joersz, J. R. (2017). Changing the Way That Math is Taught: Conceptual Versus Procedural Knowledge. *Learning to Teach*, *5*(1), 4.

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *British Journal of Applied Science & Technology*, *7*(4), 396.

Kusuma, H., & Masduki, M. (2016). How students solve the logarithm? Conceptual and procedural understanding. *(JRAMathEdu) Journal of Research and Advances in Mathematics Education*, *1*(1), 56-68.

Leonard, L., & Supardi, U. S. (2010). Pengaruh Konsep Diri, Sikap Siswa pada Matematika, dan Kecemasan Siswa terhadap Hasil Belajar Matematika. *Cakrawala Pendidikan*, *XXIX*(3), 341-352.

Lone, P. A., & Lone, T. A. (2016). A Study on Relation between Self Concept and Academic Achievement among Secondary School Students of Jammu District. *Journal of Education and Practice*, *7*(31), 19-23.

Matovu, M. (2012). Academic self-concept and academic achievement among university students. *International Online Journal of Educational Sciences*, *4*(1), 107-116.

Mishra, S. K. (2016). Self Concept-A Person's Concept of Self–Influence. *International Journal of Recent Research Aspects, Special Issue: Conscientious and Unimpeachable Technologies*, 8-13.

Nalah, A. B. (2014). Self-concept and Students Academic Performance in College of Education Akwanga, Nasarawa State, Nigeria. *World Journal Young Researcher*, *3*(2), 31-77.

Oluwatosin, S. A., & Bamidele, E. F. (2014). Self-concept and academic performance of secondary school students in chemistry. *International Journal of Social Sciences & Education*, *4*(4), 946-952.

Othman, N., & Leng, K. B. (2011). The relationship between self-concept, intrinsic motivation, self-determination and academic achievement among Chinese primary school students. *International Journal of Psychological Studies*, *3*(1), 90.

Rajeswari, V., & Kalaivani, M., (2016). The Role of Academic Motivation and Academic Self Concept in Students Academic Achievement. *International Journal of Research Granthaalayah*, *4*(9), 37 – 49.

Reyes, L. H. (1984). Affective variables and mathematics education. *The elementary school journal*, *84*(5), 558-581.

Seaton, M., Parker, P., Marsh, H. W., Craven, R. G., & Yeung, A. S. (2014). The reciprocal relations between self-concept, motivation and achievement: juxtaposing academic self-concept and achievement goal orientations for mathematics success. *Educational psychology*, *34*(1), 49-72.

Shavelson, R. J., & Bolus, R. (1982). Self concept: The interplay of theory and methods. *Journal of educational Psychology*, *74*(1), 3.

Singh, P. (2015). Interaction effects of self-concept and study habits on academic achievement in mathematics. *International Journal of Science and Research (IJSR), 4*(11), 482-485.

Skemp, R. R. (1976). Relational understanding and instrumental understanding. *Mathematics teaching*, *77*(1), 20-26.

Subedi, B. P. (2016). Using likert type data in social science research: confusion, issues and challenges. *International journal of contemporary applied sciences*, *3*(2), 36-49.

Suryanto, S. (2008). Aspek afektif hasil pembelajaran matematika. *Paedagogia*, *11*(1).

Star, J. R., & Stylianides, G. J. (2013). Procedural and conceptual knowledge: exploring the gap between knowledge type and knowledge quality. *Canadian Journal of Science, Mathematics and Technology Education*, *13*(2), 169-181.

Timmerman, H. L., Van Luit, J. E., & Toll, S. W. (2017). The relation between math self-concept, test and math anxiety, achievement motivation and math achievement in 12 to 14-year- old typically developing adolescents. *Psychology, Society, & Education*, *9*(1), 89-103

Yahaya, A., & Ramli, J. (2009). The relationship between self-concept and communication skills towards academic achievement among secondary school students in Johor Bahru. *International Journal of Psychological Studies*, *1*(2), 25.

Yengimolki, S., Kalantarkousheh, S. M., & Malekitabar, A. (2015). Self-concept, social adjustment and academic achievement of Persian students. *International Review of Social Sciences and Humanities*, *8*(2), 50-60.

Zulnaidi, H., & Zamri, S. N. A. S. (2017). The effectiveness of the geogebra software: the intermediary role of procedural knowledge on students' conceptual knowledge and their achievement in mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(6), 2155-2180.