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STUDENTS' ACADEMIC SELF-CONCEPT AND THEIR ABILITY IN SOLVING MATHEMATICAL PROBLEMS

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ABSTRACT.
The connection between academic self-concept and mathematics achievement has been widely studied, but the consideration from students' internal process when solving a mathematical test is surprisingly rare. Students' mathematical problem-solving ability was evaluated from their ability to solve trigonometry problems, while students' academic self-concept was obtained from a questionnaire. The result indicated that students' academic self-concept is linearly connected with their ability to solve mathematical problems. Students with high academic self-concept also possess an excellent ability to solve mathematical test problems and vice versa.

Keywords: academic self-concept; problem-solving; mathematics learning achievement

ABSTRAK
Hubungan antara konsep diri akademik dan hasil belajar matematika telah banyak diteliti namun pertimbangan dari sisi proses internal siswa ketika memecahkan suatu masalah dalam suatu tes matematis, ternyata masih jarang ditemukan. Kemampuan siswa dalam memecahkan permasalahan matematis diukur berdasarkan kemampuan siswa dalam memecahkan soal-soal trigonometri sedangkan konsep diri akademik siswa diperoleh melalui angket. Hasil mengindikasikan bahwa konsep diri akademik memiliki hubungan yang linear dengan kemampuan siswa dalam memecahkan masalah matematis. Siswa dengan konsep diri akademik yang tinggi juga memiliki kemampuan yang sangat baik dalam memecahkan masalah matematis, dan sebaliknya.

Kata kunci: konsep diri akademik; pemecahan masalah; capaian belajar matematika

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INTRODUCTION

Self-concept is a person's perception of himself in which it essential and useful in predicting how one acts (see Shavelson, Hubner, and Stanton, 1976). One's belief of competence in academic domains is called academic self-concept (for example, Bong and Skaalvik, 2003). Ma and Kishor (1997) meta-analysis of 143 studies further unravels that academic self-concept strongly correlated with achievement, in which studies found statistically significant reciprocal effects of academic self-concept to subsequent math achievement (Marsh, Byrne, and Shavelson, 1988; Lent, Brown, and Gore, 1997; Rao, Moely, and Sachs, 2000; Guay, Marsh, and Boivin, 2003; Choi, 2005; Marsh and O'Mara, 2008; Chiu and Klassen, 2010; Ghazvini, 2011; Seaton, Parker, Marsh, Craven, and Yeung, 2014). Marsh and Martin (2011) affirmed the causal relationships in which increases in academic self-concept lead to increases in subsequent achievement and other educational goals. Further, achievement based on increasing learning in an academic domain will not persist unless the student's academic self-concept is well maintained (Chen, Yeh, Hwang, and Lina, 2013).

Factors connected to achievement are also closely related to academic self-concept, and specifically for the mathematics, academic self-concept were statistically connected with students' interest in math (Marsh, Trautwein, Ludtke, Koller, and Baumert, 2005; Ferla, Valcke, and Cai, 2009). Students with high academic self-concept proved to be academically accountable in which they tend to cheat less (Rost and Wild, 1994). Skaalvik and Skaalvik (2005) study suggested that self-concept is a predictor for students' motivational orientation and learning strategies, in which Marsh et al. (1988) encourages teachers to evaluate the internal process of math self-concept to enable the teacher in providing motivation and reinforcement for students from different ability level.

Contrary to the numerous studies exploring the connection between academic self-concept and mathematical achievement, the study investigates

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the internal process when learners solve mathematical problems and in relation to their academic self-concept is surprisingly rare. The studies mentioned above mainly focused on overall achievement scores and not on understanding students' internal processes, such as reflected on their answers sheet. The understanding of students' internal processes is crucial to provide necessary guidance and teaching strategy. Therefore, this present study explored the connection between academic self-concept with mathematical achievement reflected in students' answers in a mathematical trigonometry test.

METHOD

In this descriptive study, 36 high school students' academic self-concept and mathematics achievement were evaluated using test and academic self-concept questionnaire. The questionnaire consisted of three academic self-concept dimensions with indicators according to Calhoun and Acocella classification (1990). Students' perception of mathematics and their perception of their mathematical ability (knowledge dimesion); perceptions of the benefit of mathematics and learning mathematics (expectation dimension); interest in mathematics (appraisal). The written test consisted of three trigonometry questions, and students' answers were evaluated based on their abilities in following Polya (1985) mathematical problem-solving technique. Academic self-concept categorization was based on score range (Arikunto, 2010): High academic self-concept ($66 \leq x \leq 90$), moderate ($42 \leq x < 66$), and low ($x<42$). Two students from each academic self-concept category were interviewed, and their answers' sheet was subjected to further evaluation.

RESULTS AND DISCUSSION

Test score and academic self-concept questionnaire revealed that most students (24 students or 67%) have a moderate academic self-concept in which their average problem-solving ability score was 63.69. Only eight (22%) have high academic self-concept and problem-solving ability, while the remaining four students (11%) was categorized as having low academic self-concept (Table 1). The results indicated that academic self-concept connected to students' problem-solving ability. In a similar vein, studies proved that math self-concept positively correlated with math achievement or test score (Marsh et al., 1988; Lent et al., 1997; Rao et al., 2000; Guay et al., 2003; Choi, 2005; Marsh and O'Mara, 2008; Chiu and Klassen, 2010; Marsh and Martin, 2011; Seaton et al., 2014).

In the attempt to understand students' internal processes, six students (Table 2) from different ability levels were interviewed, and their test's answers were analyzed: High (OT and RN), Moderate (IH and HAB), and Low (HR and AG). OT and RN were able to solve all three questions in the test but in varying degrees of ability. OT, for example, could systematically solve every question. She could devise correct mathematical strategies in solving the problems and highly capable in making calculations and inference. Although OT was highly capable, she was still making a small mistake in answering the questions. In the interview, OT was asked to analyze her answer, and she wholeheartedly analyzes her mistake and quickly pointed out her error. Her drive to solve mathematical problems proved that academic self-concept is positively related to her success in solving mathematical problems. As suggested by Dermitzaki et al. (2009), academic self-concept is related to students' initiatives and levels of activation during problem-solving. In OT's case, her high self-concept propelled her to take active action in a problem-solving activity.

Unlike OT who almost correctly answered all of the test questions, RN failed to answer question No. 2 correctly. She could not use the correct problem-solving strategy so that RN failed to arrive at the correct solution (Figure 1). As depicted in Figure 1, RN understood the purpose of the question but unable to translate the information into a correct trigonometry representation. In the interview, RN was asked to analyze her test answer and we probed her thought process when answering Question No. 2. RN stated that she understood the question but unable to move beyond drawing the problem because she struggles to remember what the drawing represents trigonometrically. When she was given the time to recheck her drawing, she excitedly redraws the drawing while mumbling to herself. After thinking for a while, she drew the correct problem' scheme and answered the question correctly. The interviewer only reinforces RN to recheck the drawing she previously made without giving clues on how to answer the question, and RN herself did not ask for any clues. Positive academic self-concept correlated with motivational behaviors such as efforts

Table 1. Overall Students' Academic Self-Concept and Test Score

Academic Self-Concept Category	Number of Students	Trigonometry Test' Score
High	8	82.75
Moderate	24	63.69
Low	4	25.38

Table 2. Interview Respondent' Academic Self-Concept and Test Score

Academic Self-Concept Category and Students Code	Academic Self-Concept	Problem Solving Ability
High-OT	73	96
High-RN	69	71
Moderate-IH	59	87.5
Moderate-HAB	44	58
Low-HR	41	35
Low-AG	41	12.5

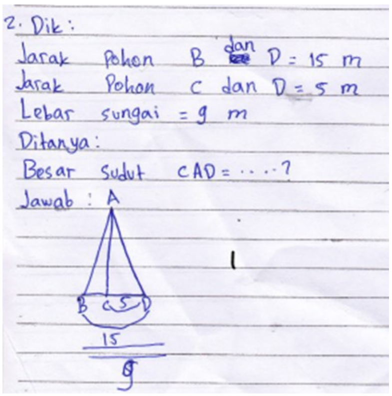
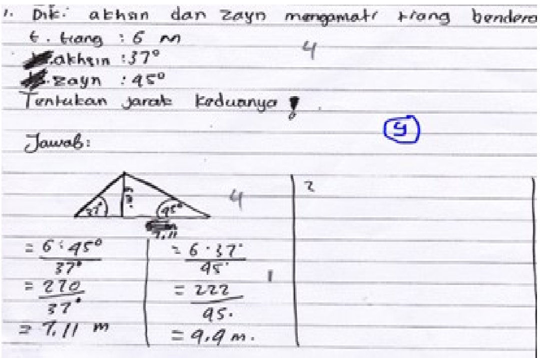
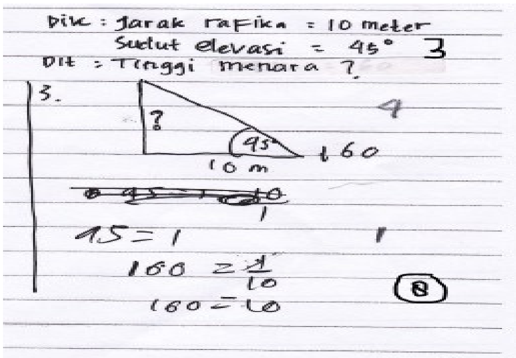


Figure 1. RN answer for Question 2: "A child stands in position A on the bank of a river. He observed three trees on the other side of the river in a row: B, C and D. Tree B is directly opposite of A. The distance of tree B and D is 15 meters, the distance of tree C and D is 5 meters and the width of the river is 9 meters. Determine the angle of CAD!"





(2a) (2b)

Figure 2a-b. 2a. HR Answer for Question No. 2: Akhsin and Zayn were observing a flagpole which was 6 meters high. If Akhsin and Zayn look at the top of the pillar with elevation angles of 37 ° and 45 ° respectively and they are opposite each other. Determine the distance between the two! (sinus 37° = 0.60, tangent 37° = 0.75, and sinus 45° = 0.70 and tangent 45° = 1). 2b. HR Answer for Question No. 3: Rafika stands 10 meters from a tower. Rafika saw the peak with an elevation angle of 45°. If Rafika's height is 160cm. How high is the tower?

to maintain motivation while facing a task and facing difficulties (Dermitzaki et al., 2009). While solving the problem, RN steadfast motivation indicated that her high academic self-concept influenced her perseverance in completing a task.

Both students with moderate self-concept (students IH and AHB) have two main problems in answering test questions. Although IH made less errors, both students' difficulties in answering the questions were categorically the same: calculation errors and incorrect mathematical strategy. Like in high academic self-concept students, IH and AHB were separately interviewed and asked to analyze their answers. Both IH and AHB needed the interviewer's assistance in rework the questions, but AHB needed more guidance in answering the questions. AHB occasionally indirectly asked for guidance and clues by saying, "I do not know what I should do next" or "I am confused, Miss." Skaalvik and Skaalvik (2005) study explored the relationship between self-seeking behavior and self-concept. Their study found that students with high self-concept tend to perceived help-seeking as threatening behavior, i.e. students with high self-concept tend to avoid seeking help from other people. Unlike students with high academic self-concept such as OT and RN who did not seek guidance and help from the interviewer, students with moderate academic self-concept occasionally seek help (indirect and direct ones) in solving the questions. The tendency to openly seek help was transparent in students with low self-concept (HR and AG). HR, for example, asking questions such as, "I do not remember the equation, which one should I use? Sinus, cosinus, or tangent?"

Unlike high and moderate academic self-concept who tend to be more steadfast, low self-concept students (HR and AG) tend to give up their problem-solving agenda readily. HR and AG admitted that they were sometimes guessing while answering the questions, or if they do not understand the questions at all, they will leave it blank. The frequency of calculation and mathematical strategy errors also high in students with low academic self-concept. Overall, students with high academic self-concept tend to be more steadfast and resilient when completing a mathematical task than their peers with lower academic self-concept. The steadfastness and resilience were decreased along with academic self-concept reduction. In solving mathematical problems, the help-seeking strategy tends to increase along with academic self-concept reduction; with high academic self-concept students become the least likely to ask for assistance in solving the problems. The improbability in searching for help or assistance is not rooted in the sense of superiority or arrogance but rather the belief of their competence. When students believe that they are competent, they show more remarkable persistence in mathematics tasks (Rao et al., 2000).

As we previously discussed, the importance of academic self-concept on math achievement is indisputable. It is then also important for educators to understand how to increase academic self-concept to achieve the desired learning outcome. Bong and Skaalvik (2003) stated that academic self-concept is stable over time and persistent to change. Relich (1996) corroborated this notion in which his study found that low math self-concepts in preservice teachers resulted from traumatic school experiences such as poor grade, failures or teacher over-reaction back in their upper primary school years. A more recent study by Ireson and Hallam (2009) found that students' intentions to learn are strongly affected by academic self-concept. These studies indicated that developing positive self-concept is vital even from students' early school days. Bong and Skaalvik (2003) suggested that teachers' should try to (1) strengthen students' self-efficacy especially when the primary learning goal is to improve near future attainment, (2) create a learning environment that reduces students' fixation with ability comparisons, and (3) reducing the effect of academic self-concept on students' self-esteem. The suggestion for creating a supportive learning environment was also encouraged by Trautwein, Ludtke, Koller, and Baumert (2006) because a supportive learning environment is a moderator of self-concept development.

CONCLUSION

Students' academic self-concept is linearly connected with their ability to solve mathematical problems. Students with high academic self-concept also possess a high ability to solve mathematical test problems and vice versa. Students with high academic ability are highly capable and a reflective problem solver while students with low academic self-concept showed a tendency to make calculation and mathematical strategy error and tends to be a somewhat defeatist problem solver. Since academic self-concept is a multidimensional construct, factors contributing to academic self-concept and in improving students'academic self-concept are worthy considerations for future research. This present study offered a snapshot of how internal factors such as academic self-concept connected with students' ability to do mathematics, but further study should also evaluate the connection with a far larger number of students so that generalization can be made and improvement effort can be formulated.

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