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Effects of Self-Regulation Strategies Training on Secondary Students' Attitude and Self-Reflection Toward Mathematics

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Abstract: The purpose of this study was to examine whether practicing self-regulation strategies involved setting goals, self-evaluation and self-correction on formative tests improved students' positive attitudes toward learning mathematics. The students' attitudes toward mathematics were measured of the factors in their perceived confidence, motivation, usefulness of the subject, and perception about teacher's attitude toward their learning. The study also aimed at exploring self-regulation characteristics of different performing groups of mathematics achievement so that appropriate instructional design can be introduced and imposed within the mathematics classroom. The study utilized a one-group pretest-posttest design for exploratory purposes. The self-regulation strategies were introduced to 46 tenth-grade secondary students. Their perceived motivation, confidence, anxiety, usefulness of the subject, and perception about teacher's attitude were measured as the pretest measures before they were trained with setting goals, self-evaluation, and self-correction strategy training. These measures of the factors were compared at the end of the academic year. The study found that students' perceived confidence, motivation, usefulness of the subject, and perception about teacher's attitude toward student learning were significantly different after they underwent the training. The high-performing group of students was more confident, motivated, less anxious, and highly engaged in self-reflection as compared to their counterparts, low-performing group of students. In addition, students' confidence, motivation, anxiety, and engagement in self-reflection were found significantly correlated with mathematics performance.

Keywords: *Anxiety; Confidence; Motivation; Self-evaluation; Self-correction.*

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Introduction

In recent years, higher-order thinking skills development has gained attention across various fields because the three *Rs* (reading, writing, and arithmetic) are no longer enough for student needs (Ministry of Education Malaysia, 2015). All students should continue acquiring and linking knowledge for lifelong learning. In a recent contemporary research, Abdullah and Osman (2010) have formed six elements including ability to adapt and manage complexity, self-direction, curiosity, creativity, risk-taking, higher order thinking skills and sound reasoning

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as the most crucial elements for success in 21st-century. Obviously, self-directed learning is one of the fundamental educational goals in student learning. Self-directed learning had been gaining attention in education for many years since 1980s (Weinstein, 1987). Till now, a great number of studies have agreed students' mathematics achievement are related to their abilities to self-regulate, use of the effective learning strategies, and affective factors (e.g., Fadlelmula, Cakiroglu, & Sungur, 2015; Mousoulides & Philippou, 2005; Pape & Smith, 2002; Pintrich & de Groot, 1990; Zimmerman, 2002).

Nevertheless, individual differences in learning were attributed to different level of the self-regulation (Velayutham, Aldridge, & Afari, 2013). Self-regulation refers to "the processes people use to activate and sustain their thoughts, behaviors, and emotions to attain learning goals" (Ramdass & Zimmerman, 2008, p. 20). Self-regulation theorists proposed students can initiate efforts for knowledge acquisition if they are self-regulated learners (Zimmerman, 1989). In other words, self-regulated learners tend to use specified self-regulation strategies to attain learning goals (Zimmerman, 2002). Self-regulation strategies are defined as learning strategy used by the students to facilitate their learning. Planning, monitoring, evaluation, elaboration, organization, critical thinking skills, reflection, and self-correction are some of the examples of self-regulation strategies.

In literature, previous studies have been shown that self-regulation strategies improved academic performance (Caswell & Nisbet, 2005; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008). For example, Caswell and Nisbet (2005) found that students' engagement and understanding in mathematics learning were significantly improved after they engaged in the meta-awareness and self-regulation strategies. They attested that students who use self-regulation strategies are more likely to have better confidence and willingness to challenge complex mathematical tasks. Ramdass and Zimmerman (2008) concluded that when students were asked to analyze their learning outcomes using self-evaluation and self-correction strategy, they tended to be aware of what they were doing and further improved for better learning. Therefore, highly self-regulated students are more likely to be motivated and capable of using a repertoire of strategies in learning than low self-regulated students (Mousoulides & Philippou, 2005; Parvin, Vahid, & Gholamreza, 1998). They are those active and self-determine students who can process information in complex ways (Weinstein, Husman, & Dierking, 2000). Despite the importance of self-regulation is widely discussed in the literature but students' self-regulation has been found not sufficiently cultivated in the learning process (e.g., Labuhn et al., 2010; Ramdass & Zimmerman, 2008; Shaine, 2015). The question remains in what way teachers can practice to developing students' self-regulation skills for mathematics learning.

Besides, formative assessment and feedback are being underpinned in the literature as the great tools for empowering self-regulatory processes; however, how to integrate the formative assessment in support of self-regulation are less explored (Nicol & Macfarlane-Dick, 2006). Hattie and Timperley (2007) noted that assessment tasks provide rich information and interpretations about regulations, subsequently, students are committed and learn with confidence. Many research findings indicate that intentional application of assessment in the classroom does promote learning and student achievement (Earl & Katz, 2006; Olina & Sullivan, 2002). Earl and Katz (2006) propound that classroom assessment learning exists when students are aware of their knowledge, skills, and beliefs in learning. Nevertheless, self-reflection is seldom explored as a phenomenon in mathematics studies although reflection is always encouraged and assured importance within the classroom (Desautel, 2009). According to Desautel (2009), self-reflection serves as a goal of constructing metacognitive knowledge to make students conscious of what is happening.

Besides, a great number of studies have shown that student-related factors such as attitude toward mathematics increased their academic performance (Farooq, Chaudhry, Shafiq,

& Berhanu, 2011; Mlambo, 2011). Students' attitude is generally influenced by their motivational beliefs such as self-confidence, motivation, interest and preferences on the assigned tasks (Candeias, Rebelo, & Oliveira, 2011; Perkins, Adams, Pollock, Finkelstein, & Wieman, 2005). Research indicates that highly self-regulated students are more likely to be motivated and capable of using a repertoire of strategies in learning than low self-regulated students (Mousoulides & Philippou, 2005; Parvin et al., 1998). Therefore, self-regulation ability relies on how students attempt to adopt any strategies to achieve their learning goals that related closely with motivational beliefs and affective reactions (Butler & Winne, 1995; Zimmerman, 2002).

With regard to mathematics achievement, a research conducted by Kitsantas (2002) found high test achievers used more self-regulatory processes as compared to their counterparts. Specifically, high test achievers were reported to use more self-regulation strategies such as setting goals, organizing and transforming notes, and seeking helps before the test. High test achievers also found to be self-evaluated students. They tended to judge their test performance and sought help when necessary, ultimately improved their self-efficacy and motivation. In addition, they perceived test as an important task and displayed higher skill acquisition, self-satisfaction, and intrinsic interest than low test achievers. On the contrary, low test achievers were found to use rehearsal and memorization strategies that led them to not attaining deeper understanding of the material. Hence, Kitsantas (2002) suggests that students should develop a repertoire of self-regulation strategies for better learning.

Taking these suggestions and limitations, the present study aims at investigating whether students' use of self-regulation strategies involved setting goals before the formative test, self-evaluation and self-correcting after the test improved their attitude toward mathematics (motivation, confidence, anxiety, perceived usefulness of the subject, perception about teacher's attitude toward their learning). The study also aims at examining whether students displayed higher self-reflection beliefs after they were trained to use self-regulation strategies. Besides, the present study discussed the self-regulation characteristics of two performing groups namely, low- and high-performing group from the dimensions of attitude toward mathematics and self-reflection measures.

Theoretical Framework

Social Cognitive Theory of Self-Regulation

Self-regulation serves as a platform for greater understanding of the interplay between different aspects of learning (Fadlelmula et al., 2015). According to Zumbrunn, Tadlock and Roberts (2011), self-regulation is crucial in learning as it helps to build learning habits, strengthen study skills, tackle the learning strategies, monitor performance, and evaluate work progress. Most of the researchers in this area agreed that self-regulation is conceived of multi-component, iterative and self-controlling processes of individuals' goal, cognition, motivation, and action (Boekaerts & Cascallar, 2006). Besides, self-regulation theorists assume that academic performance is not only mediated by the self-regulatory activities but also constrained by the contextual, biological, or individual differences (Boekaerts & Corno, 2005). Generally, self-regulatory processes consist of three phases, namely forethought and planning, monitoring, and reflection. According to Pintrich (2004), students are required to set specific goals to accomplish the learning task during the forethought and planning phase. Subsequently, they apply appropriate self-regulation strategies to monitor and attain their learning goals during the monitoring phase. Students may take time to practice and learn the new strategy at this phase. They might be frustrated when they are unfamiliar with or unable to cope with a new strategy (Zumbrunn et al., 2011). Therefore, motivation component acts as the critical intervention in this stage for students to maintain their efforts to achieve learning goals (Boekaerts, Pintrich, & Zeider, 2000; Pintrich, 2004).

Finally, students evaluate their learning outcomes and effectiveness of the learning strategies during the reflection phase. Self-reflection is central to the process of purposeful and directed change (Grant, Franklin, & Langford, 2002). According to Zimmerman (2002), self-reflection encompasses processes that happen after each learning effort. At this phase, students self-evaluate their performance based on certain standards (Pintrich, 2004; Zimmerman, 2002). Self-evaluation is a critical aspect of self-satisfaction as it affects how students adapt appropriate strategies for future tasks (Labuhn et al., 2010). Research indicates that those who with self-evaluation capability are more likely to make necessary adjustments for learning (Grant et al., 2002; Labuhn et al., 2010; Ramdass & Zimmerman, 2008). In addition, according to Grant et al. (2002), self-evaluation is associated with internal state of awareness (i.e., the ability to identify and express feelings). In other words, when students monitor and evaluate their work progress systematically and accurately, they tend to take corrective changes based on their analysis of performance (Grant et al., 2002). As they progress, these students regulate their learning effectively. However, past research revealed that the majority of students are overconfident about their capability and lack self-regulatory skills (Labuhn et al., 2010).

On the other hand, students' causal attribution is vital in the reflection phase as it affects students' engagement and use of self-regulation strategies for similar tasks in future (Zumbrunn et al., 2011). Specifically, self-satisfaction and positive influence on one's performance enhanced one's personal motivation that further leads to adaptive or defensive learning (Pintrich, 2004; Zimmerman, 2002). Previous findings suggest that students taking control of their activities is critical if schooling aims at preparing them for lifelong learning (Martinez, 2006; Wilson & Jan, 2008). In particular, researchers in the self-regulation field propose that self-reflection is critical to success in mathematics (Labuhn et al., 2010; Ramdass & Zimmerman, 2008). Wilson and Jan (2008) also propound that reflection and metacognition are the essential skills to foster deep thinking and independent learning. Therefore, those who regularly monitor their thoughts, beliefs and behaviors are more likely to have higher levels of internal state of awareness and self-reflection (Grant et al., 2002). In order to endorse self-regulation within the classroom, teachers play a facilitator role to help students initiate and sustain their learning strategies (Labuhn et al., 2010; Ramdass & Zimmerman, 2008). Based on the discussion, figure 1 shows the research framework of this study.

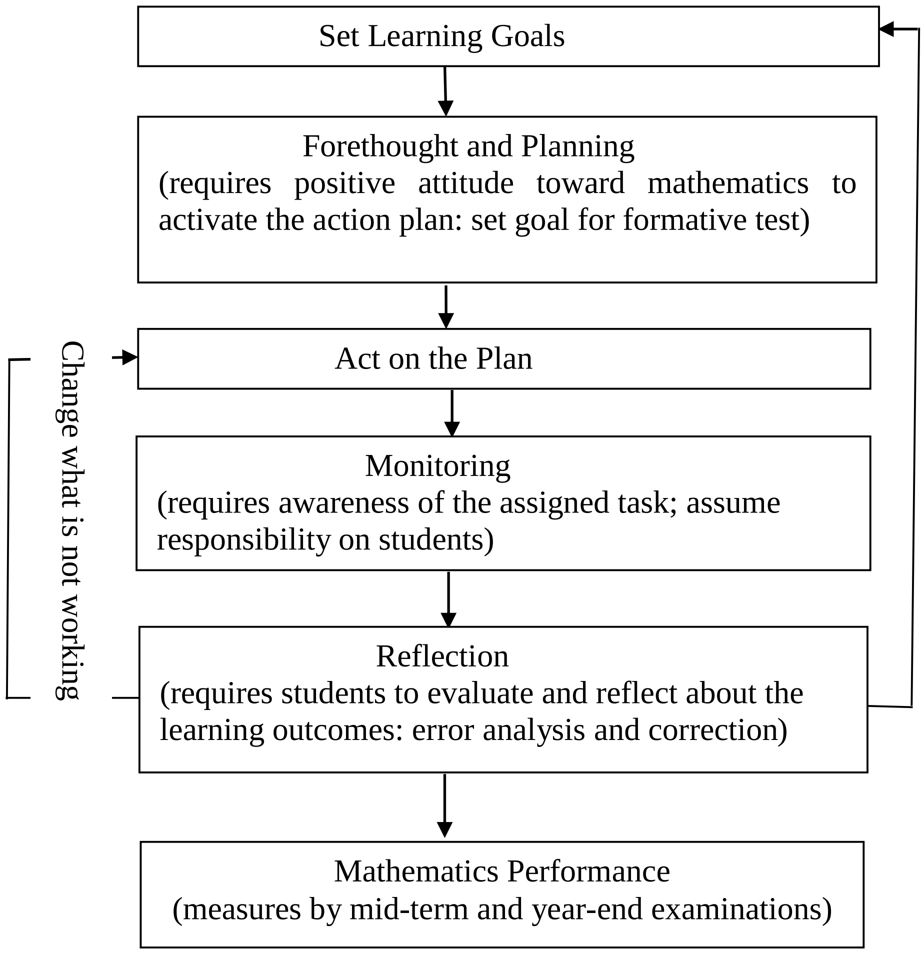

Figure 1. Research framework of the study

Research Hypotheses

The main purpose of this study was to compare the students' attitude toward mathematics measures (i.e., motivation, confidence, anxiety, usefulness of the subject, perception about teacher's attitude) after they were trained to engage in some self-regulation strategies (goal-setting, self-evaluation, and self-correction). The study also explores self-regulation characteristics of two performing groups: low- and high-performing group from the perspectives of their attitude and self-reflection beliefs (i.e., perceived needs of self-reflection, engagement in the self-reflection, internal state of awareness). This study differed from previous studies because it sought to test whether different processes in the three self-regulation phases would improve students' attitude toward mathematics and examined various profiles of performing groups. Accordingly, the following research questions were investigated:

1. Will training students to use self-regulation strategies to set goals for their formative tests, self-evaluate and self-correct to check their answers improve their attitudes toward mathematics?
2. Are there significant intercorrelations among measures in attitudes toward mathematics, self-reflection beliefs, and students' mathematics performance?
3. Which measures of the factors from the dimensions of attitudes toward mathematics and self-reflection beliefs are significant for performance groups?

The present study hypothesized that students' attitude toward mathematics learning increased after they engaged in self-regulation strategies. The study also hypothesized that all the measured variables are significantly associated with mathematics performance and that the high-performing group has greater positive attitude to learning and higher self-reflection beliefs as compared to their counterparts.

Methodology

Sample

This study aims at investigating whether the goal-setting before formative tests, self-evaluate and self-correct the formative tests helped in enhancing students' positive attitudes in learning mathematics. The study also explored the different self-regulation characteristics of performing groups so that appropriate instructional design can be imposed in future research for various profiles. Thus, the one group pretest-posttest experimental design seemed a good choice for the study. Due to accessibility and resources limitation, convenience sampling was chosen in this present study. The participants were 46 tenth-grade students (19 males and 27 females) from a private high school located in urban city of Malaysia. In Malaysia, mean age of grade ten students is generally 16 years old. Students came from a mixed ability class and their first language was Mandarin.

Intervention Design and Procedure

At the first week of the first semester, the students were asked to answer a questionnaire about their perceived beliefs in attitudes toward mathematics before they were trained with a set of self-regulation strategies. The school required students to take a formative test after the teacher has completed a chapter. These formative performances were accounted for 35% of grading purpose at the end of each semester. At the end of each semester, students need to sit for a semester examination. Therefore, the students in this school took eight formative tests and two summative assessments within an academic year (i.e., 40 weeks) when the study was conducted. This present study consistently imposed a set of self-regulation strategies into students learning according to three phases of self-regulation (forethought, monitoring, and reflection). When each chapter was completed, the teacher allocated a week for students to prepare and plan for their formative test. At this stage (forethought phase), students were asked to set relevant goals. The teacher helped in recording students' learning goals. The students also were asked to record their goals in their exercise books. For example, students wrote he/she aimed at achieving 80 marks for the upcoming test. During the monitoring phase, they were asked to monitor their planning and encouraged to use appropriate learning strategies to attain their learning goals. These strategies included seeking help from peers or teachers, spending time for revision, searching for more resources such as notes, reference books, or others. In this phase, teacher plays the facilitator role to encourage students to monitor their plans and seek help when necessary. Next, reflection phase occurred after the students took for the test and received back their test paper. The teacher circled the students' mistakes on the test paper. They were asked to self-evaluate their strengths and weaknesses based on these outcomes. They were guided to perform self-evaluation to locate the type of mistakes such as misconception, arithmetic problems, careless, or completely no ideas about the solutions. After this, they were asked to do the correction and re-submit to the teacher. Finally, they were asked to write a short reflection about their learning outcomes. Specifically, they were instructed to assess their goal attainment; reasoned why and why they did not achieve the learning goals. The students need to set a new goal for the next unit learning. The self-evaluation and self-correction sessions took place in the classroom and were monitored by the teacher. The sessions lasted for approximately 35 minutes. Students allowed to resubmit the evaluation and correction on the next class if they were not able to complete within the allocated time. These processes repeated for eight times because students were taking eight formative tests at 40 weeks of academic year. At the end of the academic year, students' attitude toward mathematics were re-measured and their perceived self-reflection beliefs were assessed.

Measures

Self-administered items were adapted from Kalder and Lesik (2011) and Grant et al. (2002) to assess students' attitude toward mathematics and self-reflection beliefs, respectively. Students rated the accuracy of each statement on a 6-point Likert scale ("1-Strongly disagree" to "6-Strongly agree").

Attitudes toward mathematics (ATM) scale. The ATM scale contains measures of confidence (e.g., "I have felt secure about attempting mathematics"), motivation (e.g., "mathematics is enjoyable and stimulating to me"), anxiety (e.g., "mathematics makes me feel uneasy and confused"), usefulness of subject (e.g., "mathematics is a worthwhile and necessary subject"), and perception about teacher's attitude toward students' learning (e.g., "my mathematics teachers have been interested in my progress in mathematics") that were assessed with 57 items adapted from the modified version of the "Fennema-Sherman Mathematics Attitude Scales (FSMAS)" (Kalder & Lesik, 2011).

Self-reflection scale (SRIS). The SRIS scale contains measures of engagement in self-reflection (e.g., "I frequently take time to reflect on my thoughts"), perceived needs of self-reflection (e.g., "It is important for me to evaluate the things that I do"), and internal state of awareness (e.g., "I usually have a very clear idea about why I have behaved in a certain way in mathematics") that were assessed with 18 items adapted from the "Self-Reflection and Insight Scales (SRIS)" (Grant et al., 2002).

Mathematics performance. Mean scores of the mid-term and year-end summative assessments were used as the proxies for students' mathematics achievement (out of 100 marks). Two performing groups (low- and high-performing) were formed in the study. Top 33% of the students were grouped as high-performing group of students and others as low-performing group of students.

Data Analyses

Cronbach's alpha was used to assess the internal consistency of the scales used in the present study. Table 1 shows internal consistencies of the ATM and SRIS scales. A paired *t*-test analysis was employed to examine whether students' measures in attitudes toward mathematics have increased after the students were trained to set goals, self-evaluation, and self-correction for their test outcomes throughout the entire academic year. Then, a bivariate correlation analysis was performed to determine the correlations of the measured variables. Finally, a multivariate analyses of variance (MANOVA) and univariate analysis of variance (ANOVA) were performed to assess significant effects between the variables between low- and high-performing group. All the data analyses were performed using SPSS software.

Table 1

Internal Consistencies of the Scales

Construct	No. of Items	Cronbach's α	
		Pretest	Posttest
ATM			
Confidence	12	.920	.900
Motivation	12	.918	.910
Anxiety	12	.896	.915
Usefulness of Subject	12	.947	.951
Teacher's Attitude	9	.839	.733
Self-Reflection			
Engagement in Self-Reflection	6	-	.801
Needs of Self-Reflection	6	-	.832
Internal State of Awareness	6	-	.737

Results

Table 2 shows the means and standard deviations of the variables before and after the goal-setting, self-evaluation and self-correction strategy training. First, it is noted that students' confidence was significantly increased after the training ($M_{pretest}$ = 3.64, $M_{posttest}$ = 4.02). Their motivation level also improved significantly ($M_{pretest}$ = 3.70, $M_{posttest}$ = 4.04), which in turn had reduced their anxiety level ($M_{pretest}$ = 3.49, $M_{posttest}$ = 3.28). In terms of perception about subject and teacher, students' perceived usefulness of the subject was significantly reduced ($M_{pretest}$ = 4.48, $M_{posttest}$ = 4.20), whereas perceived teacher's attitude about student learning was significantly increased after the training ($M_{pretest}$ = 4.35, $M_{posttest}$ = 4.63).

Table 2

Means and Standard Deviations of Self-efficacy and Perception Before and After Training

Variables	Pretest		Posttest		Sig.
	M	*SD*	*M*	*SD*	
Confidence	3.64	1.05	4.02	.77	.001
Motivation	3.70	.97	4.04	.89	.003
Anxiety	3.49	.94	3.28	.89	.058
Usefulness of Subject	4.48	1.02	4.20	1.06	.012
Teacher's Attitude	4.35	.75	4.63	.51	.003

Table 3

Correlation Coefficient of the Measures

Measures	Performance	1	2	3	4	5	6	7
1	.71**							
2	.61**	.78**						
3	-.64**	-.85**	-.80**					
4	.26	.30*	.35*	-.12				
5	.15	.17	.19	-.06	.24			
6	.31*	.32*	.43**	-.29	.15	.29*		
7	.09	.18	.23	-.10	.44**	.48**	.33*	
8	.12	.28	.01	-.30*	.01	.06	-.32*	-.02

Note. * $p < .05$ level (2-tailed); ** $p < .01$ level (2-tailed).
1. Confidence; 2. Motivation; 3. Anxiety; 4. Usefulness of subject; 5. Teacher's attitude; 6. Engagement in self-reflection; 7. Needs of self-reflection; 8. Internal state of awareness.

Table 3 shows the correlation coefficient of all the measures in the study. The results revealed that confidence (r = .71), motivation (r = .61), and anxiety (r = -.64) related significantly with mathematics performance, respectively. Perceived usefulness of the subject and teacher's attitude showed an insignificant association with mathematics performance. On the other hand, only one of the self-reflection beliefs, engagement in self-reflection, revealed significant and positive association with mathematics performance (r = .31). Usefulness of the subject was found significantly and positively related to students' confidence, motivation, and perceived needs of self-reflection. Students' perception about teacher's attitude toward student learning tend to have a medium association with self-reflection components, engagement in self-reflection and perceived needs of self-reflection. The ATM's variables did not relate with perceived teacher's attitude. Two ATM components, confidence and motivation, revealed significant and moderate association with engagement in self-reflection. However, variable anxiety showed negative association with internal state of awareness. In addition, students' engagement in self-reflection was positively related with perceived needs of self-reflection, but showed a negative correlation with internal state of awareness. A partial correlation test was conducted for controlling self-reflection measures. The results showed that correlation coefficient of ATM measures associated with mathematics performance reduced to $r = .65$ for confidence, $r = .54$ for motivation, and $r = -.57$ for anxiety.

Performance Groups

In order to assess which measures of attitudes and self-reflection beliefs significantly differed across various performance groups, multivariate analyses of variance (MANOVA) were carried out. Before MANOVA were tested, assumptions of MANOVA were checked.

First, eights continuous dependent variables (i.e., confidence, motivation, anxiety, usefulness of subject, teacher's attitude, engagement in self-reflection, needs of self-reflection, and internal state of awareness) and an independent variable consists of two categorical performance groups (i.e., low- and high-performing group) were used in the analysis. There were 24 low-performing students and 22 high-performing students in the present study. The number of cases in each group were more than the number of dependent variables used in the study, indicating there was adequate sample size for MANOVA. The mean score of mathematics performance was 45.19 ($SD = 14.98$) for the low-performing group whereas 80.68 ($SD = 8.39$) for the high-performing group. Besides, maximum Mahalanobis' distance obtained in this study was 20.85 which is less than the critical chi-square value of 26.13 for *df* = 8 with *p* < .001, indicated there was no presence of multivariate outliers. Multivariate normality was assessed using the Shapiro-Wilk test. The results showed that all the predictors in the study yielded *p* > .05 indicated data were normally distributed, excepted for the measure in needs of self-reflection (see Table 4). However, all the dependent variables had correlation coefficients less than .90 with each other (see Table 3), indicated there were no multicollinearity issues detected in the study. Further, a scatterplot matrix for each performance group was plotted. Figure 1 shows that there was a linear relationship between each pair of dependent variables for each performance group. Lastly, significance level of Box's M test of equality of covariance and Levene's test of homogeneity of variance yielded values of *p* > .05, indicated homogeneity of variance-covariance matrices assumption was met in the study. Therefore, the data were considered fulfilled the assumptions of MANOVA.

Table 4

Test of Multivariate Normality

Variables	Shapiro-Wilk Test Statistic	*df*	Sig.
Confidence	.964	46	.169
Motivation	.962	46	.139
Anxiety	.969	46	.258
Usefulness of Subject	.976	46	.453
Teacher's Attitude	.961	46	.131
Engagement in Self-Reflection	.975	46	.430
Needs of Self-Reflection	.945	46	.029
Internal State of Awareness	.976	46	.456

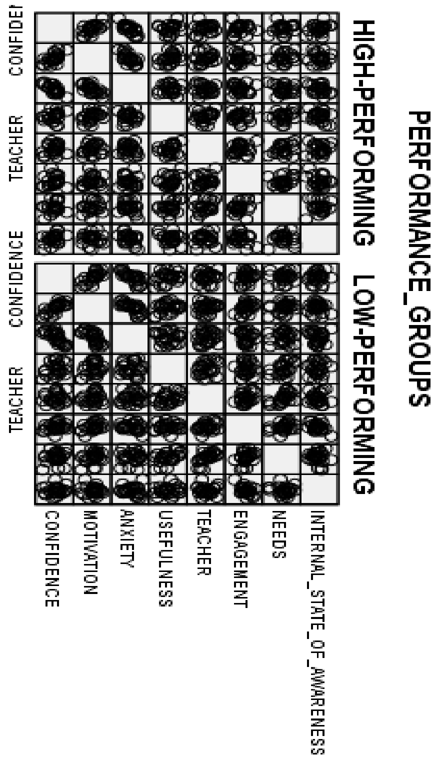

Figure 2. Scatterplot matrix for each performance group

Table 5 shows the descriptive statistics of the dependent variables for high-performing and low-performing groups. At the end of the study, students displayed a considerable high level of engagement in self-reflection (M = 4.22, SD = .79) and perceived needs of self-reflection (M = 4.95, SD = .64). However, the internal state of awareness scored a medium level (M = 2.89, SD = .74).

Table 5

Descriptive Statistics of the Dependent Variables for Performance Groups

Dependent Variables	Low-Performing (N = 24)		High-Performing (N = 22)		Total (N = 46)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Confidence	3.66	.73	4.41	.63	4.02	.77
Motivation	3.64	.88	4.48	.68	4.04	.89
Anxiety	3.69	.79	2.83	.79	3.28	.89
Usefulness of Subject	4.06	1.20	4.35	.88	4.20	.06
Teacher's Attitude	4.58	.46	4.67	.57	4.63	.51
Engagement in Self-Reflection	3.97	.87	4.49	.59	4.22	.79
Needs of Self-Reflection	4.95	.65	4.95	.64	4.95	.64
Internal State of Awareness	2.76	.78	3.04	.68	2.89	.74

In addition, the results showed that high-performing students possessed higher mean scores in all the dependent variables except for needs of self-regulation when compared to low-performing students (see Table 5). The multivariate result was significant for performance groups, Wilks' Lambda = .650, $F(8,37) = 2.49$, $p = .028 < .05$, partial eta squared = .350, indicating a difference in the levels of attitudes and self-reflection measures between high-performing and low-performing students. The relationships between performance groups and these dependent variables were further analyzed using analysis of variance (ANOVA). Significant univariate effects were found on three dimensions of attitudes measures (confidence, motivation, anxiety) and a dimension of self-reflection measures (engagement in self-reflection) such that high-performing students scored significantly higher on these factors (see Table 6). The results showed that the mean of confidence scores significantly differed between two performance groups, low-performing ($M = 3.66$) and high-performing ($M = 4.41$) for $F = 14.03$ with $p = .001$. Mean for motivation scores also increased from low-performing ($M = 3.64$) to high-performing groups ($M = 4.48$) for $F = 12.98$ with $p = .001$. Mean for anxiety scores reduced significantly from low-performing ($M = 3.69$) to high-performing ($M = 2.83$) for $F = 13.64$ with $p = .001$. The mean for engagement in self-reflection scores, however, increased from low-performing (M = 3.97) to high-performing (M = 4.49) for *F* = 5.54 with *p* = .023.

Table 6

Significant Univariate Effects for Performance Groups

Effects	*MS*	*F*	*df*	*df error*	Sig.	Partial Eta Squared
Confidence	6.51	14.03	1	44	.001	.242
Motivation	8.14	12.98	1	44	.001	.228
Anxiety	8.44	13.64	1	44	.001	.237
Engagement in Self-Reflection	3.11	5.54	1	44	.023	.112

Discussion

The present study aims at comparing students' attitude toward mathematics after they engaged in setting goals before the formative tests, self-evaluation and self-correction to check their answers. The findings showed a considerable improvement in confidence, motivation and anxiety scores after the students exercised these strategies within the entire 40 weeks of academic year. Students' perception about teacher's attitude toward their learning also improved, but perceived usefulness of the subject was slightly reduced. One of the possible explanations is that the mathematical concepts focus on the trigonometry and algebra domain within the study are not easily related to real life problems. Nevertheless, students displayed a high engagement and perceived needs of self-reflection with moderate level of internal state of awareness after they were trained in some self-regulation strategies. Therefore, this study confirms that fostering goal-setting, self-evaluate and self-correct students' formative mathematics tests facilitated and promoted positive attitude toward mathematics learning and enhanced self-reflection. The findings showed that students' internal state of awareness was not improved significantly after the training. This result indicated that engagement in self-reflection might not necessarily develop clarity of awareness. This might be because internal state of awareness is affected by the individual acts in self-reflection, use of the strategies, behaviors, and the reason for engaging in the self-reflection (Grant et al., 2002).

According to Grant et al. (2002), people require self-reflection to monitor task progress and evaluate what is not working. As such, self-evaluation is internalized with internal state of awareness (i.e., the ability to identify and express feelings) to adapt and re-adjust the learning. In view of this aspect, the present study showed that students possessed high monitoring capability to accomplish a task but lacked action for corrective changes. Therefore, in order to improve this situation, Grant et al. (2002) suggested that teachers should provide students with opportunity to monitor their learning goals tightly and foster use of the appropriate strategy to promote self-evaluation capability. Future research can provide students with the remedial exercises, opportunity to re-sit the formative tests, and monitor closely their learning goals.

Considering the relationship between attitude toward mathematics and self-reflection beliefs on mathematics performance, the findings converged with past related research in a few statements. First, students' confidence, motivation, and anxiety level have significant impact on mathematics performance (e.g., Bandura, 1991; Malmivuori, 2006; Ng, Liu, & Wang, 2016). When students observed and recorded their learning outcomes, the findings showed that effects of students enrichment in self-reflection tend to have a positive impact on their mathematics achievement. Specifically, when the partial correlation test was conducted for controlling self-reflection measures, measures of attitude as in confidence, motivation, and anxiety associated with mathematics performance have been reduced dramatically, indicating that self-reflection activities were mediating these self-beliefs to some extent. In particular, self-regulation theorists assume that the self-regulatory strategies engaged by the students mediate their achievement (e.g., Boekaerts & Corno, 2005; Pintrich, 2004).

On the other hand, although perceived usefulness of the subject did not affect students' mathematics performance, it was correlated with students' confidence and motivation, and ultimately linked to perceived needs of self-reflection. The findings agreed with Ng et al. (2016) that students tend to take ownership of their learning when they perceived autonomous support from their teacher. Teacher-student interpersonal interactions might influence student trajectories of motivation. Many of the past studies revealed that profiles of students are influenced by their perception about teacher and subject (Ng et al., 2016). Pintrich (2004) also stated that regulation of motivation involves one's attempts to regulate the various motivational and affective beliefs such as goal orientation, self-efficacy, task difficulty, task value, and personal interest. The present study found that teacher's attitude toward student learning significantly contributed to students' engagement in self-reflection and perceived needs of self-reflection. However, students do not automatically self-evaluate their own learning outcomes (Ramdass & Zimmerman, 2008). Teachers should seize the opportunities for students to evaluate their learning outcomes to promote self-regulatory skills (Ramdass & Zimmerman, 2008).

In addition, the study found that engagement in self-reflection significantly and negatively related to internal state of awareness. Internal state of awareness also negatively correlated with anxiety. These results converged with findings by Grant et al. (2002). Grant et al. (2002) explained that inconsistencies in the relationship between reflection and internal state of awareness might be related to individuals acting differently in self-reflection. Therefore, this study confirms that measures of attitude toward mathematics (confidence, motivation and anxiety) were strongly associated with mathematics performance and students' self-reflection plays a crucial role in mediating students' motivational beliefs to some extent. The present study argues that more research is needed on these issues in future.

Regarding the effects for performance groups, the findings showed that three self-beliefs factor (confidence, motivation, and anxiety) and a component of self-reflection beliefs (engagement in self-reflection) were significant differed between the high-performing and low-performing students. The results showed that the high-performing group revealed the most confident profile; they are highly motivated and less anxious in learning mathematics. High-performing group also tend to engage themselves in self-reflection process. In other words, students with high perception about their competencies and capabilities are more likely to have higher perceived self-reflection beliefs, ultimately perform better in mathematics learning. This aligned with the past numerous research showing that motivational factors, self-efficacy, and goal-setting enhance students' self-regulatory behaviors and achievement (e.g., Bandura, 1991; Boekaerts & Corno, 2005; Desautel, 2009; Fadlelmula et al., 2015; Zimmerman & Cleary, 2006; Zumbrunn et al., 2011). Therefore, it is important to note that use of various self-regulation strategies is related to student's control bounded with individuals' motivational beliefs. Self-motivated students are generally more likely to use higher-order metacognitive and cognitive strategies (Ng et al., 2016).

Conclusions

Overall, the present study concluded that fostering goal-setting, self-evaluation and self-correction on the students' formative tests enhance their positive attitude toward mathematics and self-reflection. As they progress, students have better confidence and motivational level, are less anxious, and tend to engage in self-reflection for their mathematics learning. However, transfer of reflection does not happen automatically unless teachers teach for it as the study found that students' engagement in self-reflection and needs of self-reflection are related to teacher's attitude toward student learning. Therefore, the findings imply that teachers play a significant role in encouraging students to set learning goals, self-evaluation, and self-correction. Through these activities, students may gain meaningful information about what they have learned, understand their misconceptions after evaluating mistakes, tackle strategies to improve and plan for the next learning unit. Larsen (2013) suggests that when teachers motivate students to exert in learning, provide feedback, or activate students' self-regulated learning, students tend to enjoy the learning environment. Therefore, teachers play the crucial role in helping the students by providing them the opportunities to practice the self-regulation processes. Hence, it is important for teachers to understand the multidimensional factors that may affect students in becoming active self-regulators (Fadlelmula et al., 2015).

The findings, however, might not be generalized to other grade levels or schools as the study was conducted on a small sample and the tenth-grade students were selected from just one school. Future studies can replicate the training using other research design or causality relationships can be explored between the significant factors. Despite the small sample size used, this study takes the first step to integrate the formative mathematics test in support of goal-setting, self-evaluation and self-correction strategy training over a 40-week of academic year. Future research can consider different duration to determine whether the results are seen.

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