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Modeling Relationships of Affective and Metacognitive Factors on Grade Eleven Students' Mathematics Achievement

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Abstract

This study aimed at exploring causal relationships between two affective factors, self-confidence and positive emotion, and two metacognitive factors, self-reflection and insight components on high school students' mathematics achievement that assessed by formative and summative assessments. The study applied partial least squares based structural equation modeling (PLS-SEM) approach to test the path relationships for 86 eleventh-grade students. Results revealed that formative performance was the strongest predictor of summative performance followed by self-confidence. Positive emotion revealed as having a positive indirect effect on summative performance through insight component. Considering for formative performance, self-confidence revealed as the strongest predictor followed by insight component. Self-confidence accounted as the only affective factor that directed to self-reflection components, need for and engagement in self-reflection. On the contrary, positive emotion accounted as the only affective factor that related to insight. Need for self-reflection was related to engagement in self-reflection, which in turn, related to insight. Need for self-reflection also mediated the relationship between self-confidence and engagement in self-reflection. Understand different mental processes within mathematics studies are important for future intervention exercises, especially for high school students.

Introduction

For centuries, students' mathematics achievement has gained attention in education as success in mathematics improves college and career choices (Ramdass & Zimmerman, 2008). Despite many research intended to promote students' interest and mathematics achievement, students' motivation has gradually declined (Ng, Liu, & Wang, 2016). Research Committee of the National Council of Teachers of Mathematics [NCTM] (2011) has highlighted the number of students taking remedial mathematics courses has increased over the past few years. Further, students opted not to take the related mathematics courses when they entering university have worried the mathematics communities (Research Committee of the NCTM, 2011).

In view of social cognitive theory, human behavior regulates and motivates through the continuing exercise of self-influence (Bandura, 1991). Students can self-reflect and self-react to control their emotions, beliefs, motivations, and actions for self-directed change (Bandura, 1991). However, even though many variables related to self-regulation research have been examined in the literature, one area that has rarely been explored is self-consciousness variables such as self-reflection and insight.

Specifically, self-reflection and insight are two key metacognitive processes that central to self-regulation processes (Grant, Franklin, & Langford, 2002). These processes directed towards individual's behavior change. More recently, self-reflection and insight also appear as the two main self-consciousness variables in assessing one's self-focus attention. In the psychology context, self-consciousness refers to as the ability of individuals to privately self-focus, which is critical to personal growth and well-being (Harrington & Loffredo, 2011). In this study, self-reflection refers to "*the inspection and evaluation of one's thoughts, feelings and behaviors*", and insight (also known as the internal state of awareness) involves "*the clarity of understanding of one's thoughts, feelings and behaviors*" (Grant et al., 2002, p. 821). Students need insight to discover the problems and able to relate them to their professionalism (Roberts & Stark, 2008). Insight helps students be aware of own and others performance. While insight is critical for students to judge based on reflecting awareness, self-reflection is important in helping students integrate their learning with personal experiences (Roberts & Stark, 2008). Thus, self-reflection involves the judgments and evaluations of one's beliefs lead to influence the insight, whereby insight directed the change (Grant et al., 2002).

In the past, psychologists have found that disposition of private self-focus variables were associated with positive and negative characteristics (Harrington & Loffredo, 2011). In general, self-reflection is positively correlated with negative characteristics such as anxiety and stress, whereas insight is negatively correlated with these negative characteristics (Grant et al., 2002; Harrington & Loffredo, 2011). This is because of self-reflection corresponds more closely to the tendency to focus on oneself repeatedly, resulted in high self-reflect scores are associated with lower self-esteem, higher trait anxiety and depression, excessive rumination, and more social anxiety, guilt, and shame (Harrington & Loffredo, 2011). On the contrary, insight tends to maintain a general awareness of one's feelings and mental processes, and thus, has inverse relationships to the negative characteristics (Harrington & Loffredo, 2011). These negatively biased beliefs can caused individual's dysfunctional attitudes (Stein & Grant, 2014). In severe cases, dysfunctional attitudes can "*lead to depression and dysphoria, and are thought to generate the automatic and involuntary negative thoughts (i.e., rumination) and emotions observed during depression*" (Stein & Grant, 2014, p. 508). More recently, Stein and Grant (2014) have found that dysfunctional attitudes suppressed the relationship between self-reflection and insight, and thus, affected individuals' well-being.

Meanwhile, some studies have found that self-reflection was related positively to insight, some studies have found a negative relationship, and others have found a nonsignificant relationship (Stein & Grant, 2014). The inconsistent results may due to the lack of discrimination in the construct of self-reflection (Xu, 2011). Though Grant et al. (2002) conceptualized the construct of self-reflection from two domains, need for self-reflection and engagement in self-reflection, most of the previous studies involved construct of self-reflection as a coherent whole. The need for self-reflection assesses the motive of individuals to perform a specific act, whereas engagement in self-reflection captures the execution of the act. These two domains of self-reflection are logically independent (Grant et al., 2002). Xu (2011) argued misconceptualization may impede the role of self-reflection in cognitive functions. Thus, self-reflection encompasses the need for and engagement in self-reflection should be assessed in separate in future research.

In recent years, there is growing evidence supported that self-reflection is important in improving student learning as it focuses on "*purposeful critical analysis of knowledge and experience so as to achieve deeper meaning and understanding*" (Lew & Schmidt, 2011, p. 530). Numerous researchers have proposed fostering students' self-reflection improved their mathematics achievement (Boekaerts & Cascallar, 2006; Boekaerts & Corno, 2005; Labuhn, Zimmerman, & Hasselhorn, 2010; Ramdass & Zimmerman, 2008). In a research conducted by Caswell and Nisbet (2005), they have found that self-reflection was statistically improved students' self-confidence and task value of mathematics. As progress, this will build up a deeper understanding of the contexts. Thus, students are more likely to engage in the self-reflection process and persistent to challenging mathematical problems. Caswell and Nisbet (2005) have assured that students' self-confidence is the most important predictor in determining students' competency in mathematics learning. In general, self-confidence raises test performance through perceived self-efficacy beliefs toward one's cognitive and motivational processes (Behncke, 2012). Self-confidence also associated with self-regulatory behavioral patterns such as persistence and preferences to challenge, which in turn, have an impact on mathematics achievement (Malmivuori, 2006). Malmivuori has found that low self-esteem (part of self-confidence measures) was strongly correlated with mathematics achievement and anxiety. These negative affective responses further weaken the self-regulatory behavioral patterns. Clearly, the positive effect of correlation between self-reflection and insight are relying on individual's awareness, actions, flexibility, and efficacy to adapt into a specific task (Grant et al., 2002). However, Lew and Schmidt (2011) argued there were no findings have supported the underlying assumption of individuals who are better at self-reflection will perform better academically. This is because of the positive effect of self-reflection may not necessarily be reflected by achievement test grades (Lew & Schmidt, 2011). Therefore, most of the past studies have mainly focused on self-motivational beliefs and self-regulation strategies (Fadlelmula, Cakiroglu, & Sungur, 2015; Mousoulides & Philippou, 2005; Ramdass & Zimmerman, 2008), relatively few studies explore the relationships between self-reflection and insight on various cognitive tasks (Xu, 2011). Furthermore, most of the previous studies involved self-reflection is either mainly in counseling, coaching, clinical, applied positive psychology, social and personality psychology (Silvia & Phillips, 2011; Xu, 2011) or in qualitative design (Pape, Bell, & Yetkin, 2003). Relatively little studies have focus on the relationships of self-reflection and insight with other self-consciousness and affective traits (Silvia & Phillips, 2011). Since self-reflection and insight are central to purposeful and directed individual's behavior change, it is important to strengthen understanding of their roles with other traits and how these self-consciousness variables affecting students' mathematics achievement.

Most of the mathematics achievement research uses schools' semester examination or standardized test scores in measuring the levels of students' academic performance (e.g., Hannula, Maijala, Pehkonen, & Nurmi, 2005;

Ismail & Awang, 2010; McGraw, Lubienski, & Strutche, 2006; OECD, 2013), relatively few studies stress the importance of also exploring the formative performance. Students' achievement is always accounted from formative and summative assessments, especially for primary and secondary schools. The effectiveness of formative assessments can largely influences students' summative performance (Hills, 1991). Summative performance is the accountability measure of the grading process for most of the schools (Garrison & Ehringhaus, 2007). Therefore, formative assessments provide information for teachers to adjust teaching and learning (Garrison & Ehringhaus, 2007), and also important for students to evaluate their learning progress (Tomlinson, 2008). These evaluations and inspections of learning outcomes are relevant to individuals' self-reflection process. In addition, Xu (2011) highlighted that most of the previous studies involved self-reflection and insight were mostly limited to college students. To our knowledge, no study used self-consciousness variables such as self-reflection and insight, and affective factors such as self-confidence and positive emotions to predict high school students' mathematics achievement.

Purpose of the Study

To fill the foregoing gaps, the present study was designed to explore the specific factors that best predict both formative and summative performance, and how these variables interact with each other in influencing students' mathematics achievement. Thus, the study aims:

1) To determine whether the factors of affective (i.e., self-confidence and positive emotion) and metacognitive (i.e., need for self-reflection, engagement in self-reflection, and insight) contribute to students' mathematics achievement (formative and summative performance).
2) To examine whether the construct of engagement in self-reflection mediates the relationship between need for self-reflection and insight.
3) To determine if any possible constructs mediate the relationship between affective factors and mathematics achievement.

Research Model and Hypotheses

Based on the above-discussed theories and empirical evidences, Figure 1 shows the research model of this study. This model consists of two exogenous latent constructs (i.e., self-confidence [SC], positive emotion [PE]) and five endogenous latent constructs (i.e., need for self-reflection [NEED], engagement in self-reflection [ENGAGE], insight [INSIGHT], formative performance [FP], and summative performance [SP]). The relationship between an indicator and a latent construct can be expressed as reflective or formative. Reflective measurement represents indicators are considered to be functions of the latent construct (i.e., the arrow of a latent construct is pointing to its respective indicators), whereas formative measurement indicates indicators are assumed to cause a latent construct (i.e., the arrows of the indicators are pointing to its latent construct). Thus, constructs for SC, PE, NEED, ENGAGE, and INSIGHT are formed as the reflective measurement models (i.e., dropping one of the indicators would not alter the conceptual domain of the constructs as indicators have similar content), whereas constructs for FP and SP have a formative measurement model (i.e., dropping one of the indicators would alter the conceptual domain of the constructs as indicators are not interchangeable) (Hair, Hult, Ringle, & Sarstedt, 2014). For instance, students who scored well on algebra tests do not necessary scored well on statistical tests or students who scored well for the first-semester examination do not necessary scored well in the second-semester examination as these assessments are generated from different content areas.

In this research model, there are 19 direct effects of path relationships that can be assessed. Accordingly, this study formulated the following hypotheses:

H1: Self-confidence (SC) has a positive effect on the need for self-reflection (NEED).
H2: Positive emotion (PE) has a positive effect on the need for self-reflection (NEED).
H3: Self-confidence (SC) has a positive effect on engagement in self-reflection (ENGAGE).
H4: Positive emotion (PE) has a positive effect on engagement in self-reflection (ENGAGE).
H5: Need for self-reflection (NEED) has a positive effect on engagement in self-reflection (ENGAGE).
H6: Self-confidence (SC) has a positive effect on insight (INSIGHT).
H7: Positive emotion (PE) has a positive effect on insight (INSIGHT).
H8: Engagement in self-reflection (ENGAGE) has a positive effect on insight (INSIGHT).
H9: Self-confidence (SC) has a positive effect on formative performance (FP).
H10: Positive emotion (PE) has a positive effect on formative performance (FP).
H11: Need for self-reflection (NEED) has a positive effect on formative performance (FP).

H12: Engagement in self-reflection (ENGAGE) has a positive effect on formative performance (FP).
H13: Insight (INSIGHT) has a positive effect on formative performance (FP).
H14: Self-confidence (SC) has a positive effect on summative performance (SP).
H15: Positive emotion (PE) has a positive effect on summative performance (SP).
H16: Need for self-reflection (NEED) has a positive effect on summative performance (SP).
H17: Engagement in self-reflection (ENGAGE) has a positive effect on summative performance (SP).
H18: Insight (INSIGHT) has a positive effect on summative performance (SP).
H19: Formative performance (FP) has a positive effect on summative performance (SP).

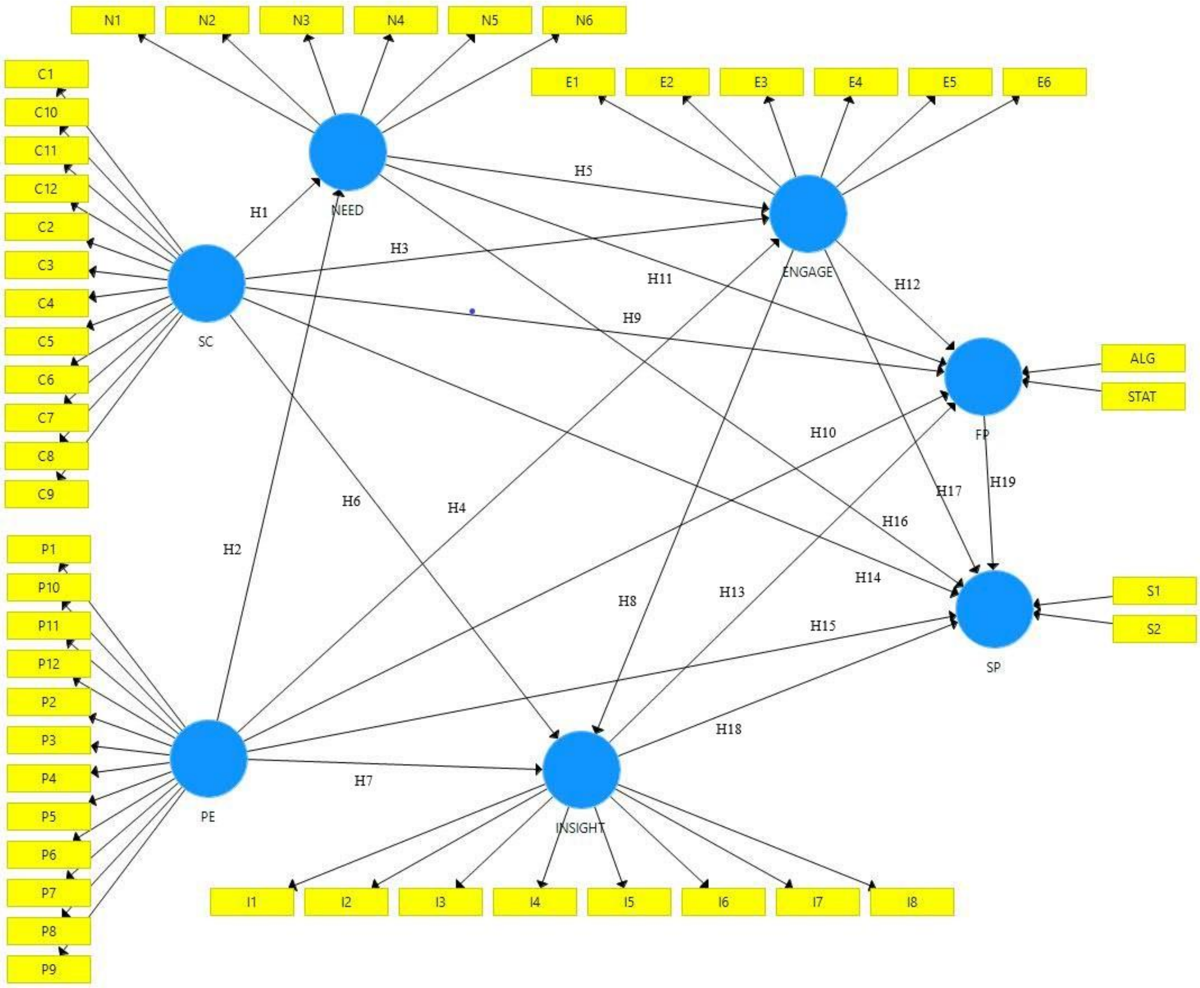

Figure 1. Research model of the study

Method

Sample

This study applied partial least squares based structural equation modeling (PLS-SEM) to test the relationships among self-confidence [SC], positive emotion [PE], the need for self-reflection [NEED], engagement in self-reflection [ENGAGE], insight [INSIGHT], formative performance [FP], and summative performance [SP]. The PLS-SEM (also known as PLS path modeling or variance-based structural equation modeling, VB-SEM) is flexible for exploratory study, especially for study involves small sample sizes and formative measurement models (Hair et al., 2014). PLS-SEM is a non-parametric method which is also suitable for non-normally distributed data. This study met the requirement of PLS-SEM as it is an exploratory study in nature and the research model has both reflective and formative models, which is not applicable to covariance-based structural equation modeling (CB-SEM) (see Figure 1).

The study used convenience sampling due to accessibility limitation. To decide on the requirement of sample size for the present study, we followed the guidelines that stated by Hair et al. (2014, p. 20), "*10 times the* *largest number of formative indicators used to measure a single construct; or 10 times the largest number of structural paths directed at a particular construct in the structural model*". Figure 1 shows the largest number of formative indicators used to measure a specific formative measurement model (either FP or SP) was 2, therefore 10 times of it required a minimum of 20 subjects. Whereas the largest number of structural paths directed at a particular construct (i.e., summative performance, SP) was 6, thus 10 times of it required a minimum of 60 subjects. The study also used the *G-Power* software to determine the minimum sample size. The results showed that a minimum sample size of 75 is needed to detect a minimum R^2 value of .20 in any of endogenous constructs in the structural model for the significance level of 5% with the statistical power of 80% for maximum 6 arrows that directed at a specific construct (i.e., SP in this model). In total, 86 eleventh-grade students (40% boys and 60% girls) were included in the data analysis. These students were selected from two mixed ability classes from one of the private high schools which located in Malaysia.

Instruments

The students were asked to rate their feelings on a 6-point Likert-type scale (1: *strongly disagree* to 6: *strongly agree*) on all of the measured scales. First, 12 items of the self-confidence scale (e.g., "*I am sure I could do advanced work in mathematics*") and 12 items of the positive emotion scale (e.g., "*Mathematics does not scare me at all*") were adapted from the Fennema-Sherman Instrument (Kalder & Lesik, 2011). The positive emotion is measured instead of negative emotion in this study so that the construct has a consistently positive direction with other measure constructs.

Second, 6 items of need for self-reflection scale (e.g., "*I am interested in analyzing my behavior*"), 6 items of engagement in self-reflection scale (e.g., "*I often think about my thoughts on the wrong answer questions after receiving the test papers*"), and 8 items of the insight scale (e.g., "*I am usually aware of my thoughts during mathematics examinations*") were adapted from the self-reflection and insight scale (Grant et al., 2002). All of the constructs and measurements of previous research were adapted with a slight modification so that they suit best with mathematics context.

Third, formative performance was measured by using two indicators, ALG and STAT. Indicator ALG refers to the mean score of formative tests (out of 100 marks) on the Algebra topics. These topics included simultaneous equations, inequalities, sequences and series, matrices and determinant, and binomial expansion. The indicator STAT refers to the mean score of formative tests (out of 100 marks) on the Statistics and Probability topics. These topics included permutation, combination, descriptive statistics, and probability for independent or dependent events. Analogous to formative performance, summative performance was measured by using two indicators, S1 and S2. The indicator S1 refers to the sum scores of the first-semester examination (out of 100 marks) and the indicator S2 refers to the sum scores of the second-semester examination of mathematics subject (out of 100 marks).

Results

The present study used the *SmartPLS 3.2.7* software (Ringle, Wende, & Becker, 2015) to test the research hypotheses. In the PLS-SEM context, statistical parameters such as factor loadings, weights, path coefficients, and others are estimated using PLS algorithm settings (i.e., path weighting scheme, stop criterion value of $1*10^{-7}$, maximum of 300 iterations). A non-parametric bootstrapping procedure (i.e., 5000 subsamples, no sign changes, bias-corrected and accelerated (BCa bootstrap), two-tailed test, 5% significance level) is applied to determine the significance levels for the estimated parameters. Before the relationships of the proposed latent constructs can be assessed, validity and reliability of the measurement models have to be tested (Hair et al., 2014).

Common Method Bias

Researchers have suggested to assess whether the data are contaminated by common method variance (CMV) as both independent and dependent variables were measured from the same participants (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Therefore, this study applied Harman's single factor test to evaluate CMV. The results showed that the restricted extraction of a single factor explained 33.04% of the variance (less than 50%), indicating the data are free from CMV problem.

Evaluation of Reflective Measurement Models

The study examined the outer variance inflation factors (VIFs) of the manifested indicators prior to assessment of reflective measurement models to avoid the multicollinearity problem. Data are contaminated by collinearity issues if the VIF value is more than 5. As such, two indicators, N4 and N5, with VIF values more than 5 were omitted from the measurement models.

In the PLS-SEM context, researcher has to examine indicator reliability, internal consistency reliability, convergent validity, and discriminant validity of reflective measurement models. Specifically, indicator reliability indicates variance of the indicator that can be explained by an underlying latent construct and should be at least higher than .70 (Hair et al., 2014). Therefore, indicators for I4, I5, I6, I7, C1, C4, C6, P2, P6, P10, and E6 with factor loadings less than the recommended value of .70 were omitted from the reflective measurement models. Table 1 shows all of the retained reflective indicators had factor loadings higher than .70 ($p < .005$). In regard to the evaluation of internal consistency reliability of a latent construct, Latan (2018) argued that use of composite reliability is too liberal, and thus, he recommends researchers to report Cronbach's alpha or Dijkstra-Henseler's rho (ρ_A). However, Hair et al. (2014) argued that Cronbach's alpha assumes that all indicators are equally reliable and sensitive to the number of items in the scale, and thus, they suggest researchers report composite reliability (CR). Taken both arguments, the present study used Cronbach's alpha, ρ_A, and CR to assess the internal consistency reliability of reflective constructs. Table 1 shows that all of the reflectively measured constructs in the study had Cronbach's alpha, ρ_A, and CR values higher than the recommended value of .70 ($p < .005$), which fulfilled the internal consistency reliability.

With regard to convergent validity, the study used an average variance extracted (AVE) to measure the extent to which the average variance of the indicators is explained by an underlying latent construct. Table 1 shows the AVE values for all reflectively measured constructs were higher than the recommended value of .50 ($p < .005$), and thus, fulfilled the convergent validity.

Table 1. Convergent validity and reliability of reflective measurement models

Constructs	Indicators	Factor Loadings	Cronbach's Alpha	ρ_A	CR	AVE
SC	C2	.798	.929	.937	.941	.640
	C3	.832				
	C5	.836				
	C7	.783				
	C8	.841				
	C9	.734				
	C10	.746				
	C11	.816				
	C12	.805				
PE	P1	.764	.920	.934	.933	.608
	P3	.780				
	P4	.715				
	P5	.726				
	P7	.798				
	P8	.713				
	P9	.835				
	P11	.830				
	P12	.841				
NEED	N1	.762	.833	.855	.888	.665
	N2	.892				
	N3	.834				
	N6	.767				
ENGAGE	E1	.813	.858	.859	.898	.638
	E2	.774				
	E3	.825				
	E4	.810				
	E5	.770				
INSIGHT	I1	.851	.811	.810	.876	.640
	I2	.745				
	I3	.832				
	I8	.767				

In terms of discriminant validity, researchers are encouraged to use Heterotrait-Monotrait ratio of correlations (HTMT) rather than Fornell-Lacker criterion or cross-loadings as both are substantially over-estimated and biased in measuring discriminant validity (Hair, Hult, Ringle, & Sarstedt, 2017; Latan, 2018). Hair et al. (2017, p. 140) stated that HTMT is "*the ratio of the between-trait correlations to the within-trait correlations*" to estimate the true correlation between the two constructs. Thus, an HTMT value higher than .90 suggests a lack of discriminant validity. Table 2 shows that all HTMT ratios were below the recommended value of .90 and significant at .05 levels, indicating all of the reflective constructs met the requirement for its discriminant validity.

Table 2. Discriminant validity (HTMT ratio of correlations) of reflective measurement models

Constructs	ENGAGE	INSIGHT	NEED	PE
INSIGHT	.442			
NEED	.855	.274		
PE	.349	.736	.209	
SC	.457	.642	.326	.823

Evaluation of Formative Measurement Models

In this research model, there are two formative measurement models (i.e., SP and FP). In the PLS-SEM context, researchers should assess the values of indicator's weight and indicator's significance of formative measurement models. Since the indicators are formed formatively, they should not highly correlate with each other (Hair et al., 2014). Thus, the VIF value of the formative indicators should be examined to detect collinearity issues. Table 3 shows all of the formative indicators had the outer VIF values less than 5, indicating no collinearity issues were detected across the formative indicators. The results showed that all of the formative indicators' weights were above .10 and significant at .005 levels, which met the requirements of convergent validity and discriminant validity for formative measurement models. Therefore, this proposed research model is adequately fit for exploratory purposes (Garson, 2016; Hair et al., 2014).

Table 3. Assessment of formative measurement models

Constructs	Indicators	Weights	*t* Value	Sig.	VIF
FP	ALG	.608	4.902	.000	4.204
	STAT	.424	3.318	.001	4.204
SP	S1	.524	5.816	.000	3.095
	S2	.523	5.822	.000	3.095

Evaluation of Structural Model

The inner VIF values between measured constructs are assessed to detect any collinearity issues before path coefficients of the relationships are estimated. Table 4 shows that inner VIF values between the constructs were less than the recommended value of 5, indicating collinearity issues are not presented in the structural model.

Table 4. Collinearity assessment of structural model

Constructs	NEED	ENGAGE	INSIGHT	FP	SP
PE	2.520	2.540	2.520	3.114	3.158
SC	2.520	2.705	2.721	2.753	3.373
NEED		1.111		2.296	2.296
ENGAGE			1.205	2.556	2.664
INSIGHT				1.844	1.996
FP					2.171

In the PLS-SEM context, the significance of path coefficients is examined using a non-parametric bootstrapping method. Table 5 shows the standardized path coefficients, R^2, effect size f^2, and predictive relevance Q^2 that estimated in the structural model. Specifically, effect size f^2 indicates changed in the R^2 value when a specified exogenous construct is omitted from the model (Hair et al., 2014). Effect size f^2 values of .02, .15, and .35 indicate that an exogenous construct has a small, medium or large effect on an endogenous construct, respectively. The predictive relevance of the structural model is assessed by using R^2 values and the Stone-Geisser's Q^2 values. The predictive relevance Q^2 value is assessed using the blindfolding procedure in the PLS-SEM. According to Hair et al. (2014), R^2 values of .02, .13, and .26 indicate weak, moderate, and substantial predictive accuracy, respectively; whereas the model is considered has predictive relevance if Q^2 is greater than zero.

Table 5. Significance of path relationships, effect size, and predictive relevance of structural model

Hypotheses	Path Relationships	Direct Effects	Total Indirect Effects	Total Effects	f^2	R^2	Q^2
H1	SC → NEED	.408*		.408*	.073	.100	.051
H2	PE → NEED	-.134		-.134	.008		
H3	SC → ENGAGE	.127	.282*	.408**	.015	.598	.346
	SC→NEED→ENGAGE		.282*				
H4	PE → ENGAGE	.097	-.092	.005	.009		
H5	NEED → ENGAGE	.690***		.690***	1.065		
H6	SC → INSIGHT	.063	.068	.131	.003	.457	.249
H7	PE → INSIGHT	.551***	.001	.552***	.222		
H8	ENGAGE → INSIGHT	.166*		.166*	.042		
	NEED → INSIGHT		.114*	.114*			
	NEED→ENGAGE→INSIGHT		.114*				
H9	SC → FP	.534***	.126*	.660***	.225	.539	.443
H10	PE → FP	-.141	.147	.006	.014		
	PE→INSIGHT→FP		.146*				
H11	NEED → FP	.000	.184**	.185**	.000		
H12	ENGAGE → FP	.224	.044	.267**	.042		
H13	INSIGHT → FP	.264**		.264**	.082		
H14	SC → SP	.300***	.512***	.812***	.162	.835	.713
	SC→FP→SP		.418***				
H15	PE → SP	-.158*	.010	-.148	.048		
H16	NEED → SP	-.006	.140*	.135*	.000		
H17	ENGAGE → SP	-.008	.211*	.203	.000		
H18	INSIGHT → SP	.009	.207**	.216*	.000		
H19	FP → SP	.783***		.783***	1.714		

Note. *$p < .10$; **$p < .05$; ***$p < .005$

The results, as shown in Table 5, found that self-confidence as the sole affective factor that significantly predicted the need for self-reflection with a small effect (SC → NEED: $\beta = .408$, $p < .10$, $f^2 = .073$). Though self-confidence was not directly predicted engagement in self-reflection, the need for self-reflection statistically mediated the relationship between self-confidence and engagement in self-reflection (*SC→NEED→ENGAGE*: $\beta = .282$, $p < .10$). In the PLS-SEM context, the effect size of an indirect effect can be assessed by calculating its ratio of indirect effect to the total effect (also known as variance accounted for, VAF). Thus, path *SC→NEED→ENGAGE* had a VAF value of 69.12% (i.e., .282/.408). In other words, 69.12% of the effect of self-confidence on engagement in self-reflection is explained through the indirect effect of the need for self-reflection. Need for self-reflection was strongly influenced engagement in self-reflection (NEED → ENGAGE: $\beta = .69$, $p < .005$, $f^2 = 1.065$), whereas engagement in self-reflection had a small effect on insight (ENGAGE → INSIGHT: $\beta = .166$, $p < .10$, $f^2 = .042$). As a result, the need for self-reflection predicted insight through engagement in self-reflection (*NEED→ENGAGE→INSIGHT*: $\beta = .114$, $p < .10$). On the other hand, positive emotion was not significantly predicted any of the self-reflection components, however, it revealed as the sole affective factor that predicted insight with medium to large effect (PE → INSIGHT: $\beta = .551$, $p < .005$, $f^2 = .222$).

Regarding the predictors of mathematics achievement, though positive emotion is not the main factor in predicting students' mathematics achievement, surprisingly, it was found negatively influenced summative performance with a small effect (PE → SP: $\beta = -.158$, $p < .10$, $f^2 = .048$). In this study, self-confidence revealed as the main affective factor in predicting both formative and summative performance. Specifically, the effect of self-confidence on formative performance is larger than the effect of self-confidence on summative performance (SC → FP: $\beta = .534$, $p < .005$, $f^2 = .225$; SC → SP: $\beta = .300$, $p < .005$, $f^2 = .162$). In addition, there were significant indirect effects of self-confidence on both formative and summative performance. In particular, formative performance explained 51.48% of the variance in the relationship between self-confidence and summative performance (VAF = .418/.812). In other words, 51.48% of the effect of self-confidence on students' summative performance is explained through the indirect effect of formative performance. Thus, formative performance revealed as the dominant predictor of students' summative performance (FP → SP: $\beta = .783$, $p < .005$, $f^2 = 1.714$).

In addition, although the need for self-reflection was not directly predicted students' mathematics achievement, its indirect effects were significant, resulted in a significant total effect. Likewise, there were significant total effects of engagement in self-reflection on formative performance but not on summative performance. However, the indirect effects of engagement in self-reflection on summative performance were significant at .10 levels. Insight revealed as a significant factor in predicting formative performance with a small effect (INSIGHT → FP: β = .264, p < .05, f^2 = .082). However, insight is not directly predicted summative performance, but its indirect effects (β = .207, p < .05) were pronounced, resulted in a significant total effect (β = .216, p < .10). Figure 2 shows the significant and nonsignificant path relationships according to their total effects.

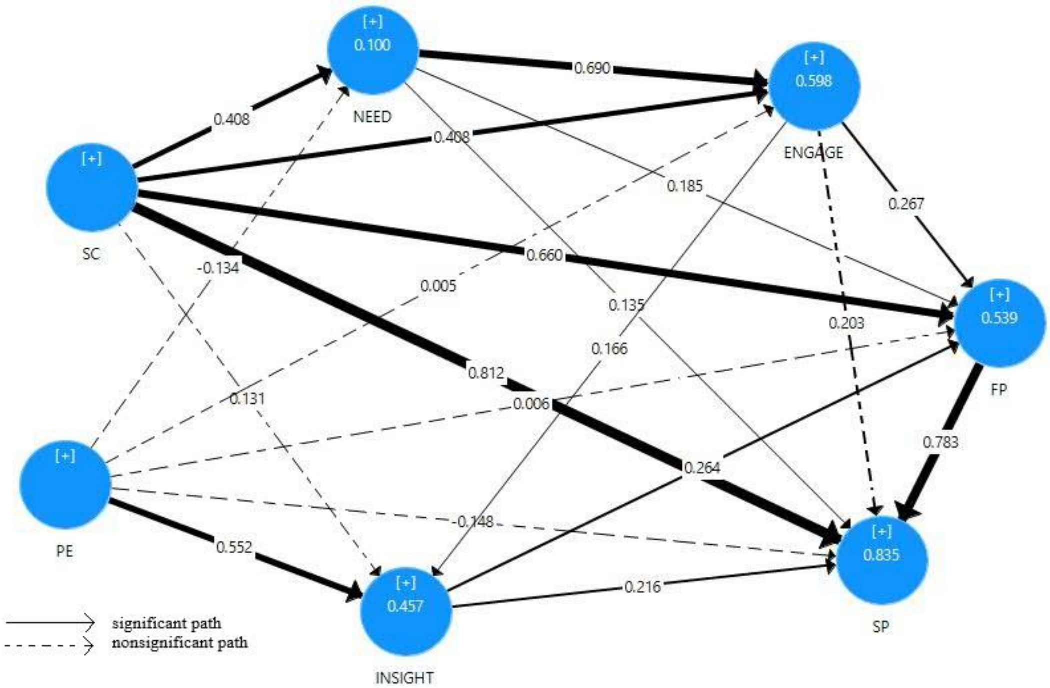

Figure 2. Significant and nonsignificant path relationships

Discussions and Conclusions

This study intends to unearth the possible affective and metacognitive factors that may affect students' formative performance and summative performance in mathematics for eleventh-grade high school students. The study also examines if construct for engagement in self-reflection (i.e., one of the domains of self-reflection) mediates the relationship between the need for self-reflection (i.e., another domain of self-reflection) and insight. The study also attempts to examine the mediating effects of affective factors on students' mathematics achievement in the research model to have a clearer view on how these measures of factors are interrelated in predicting students' mathematics achievement.

Previous research has shown that both self-confidence and formative performance are associated with students' academic achievement (Behncke, 2012; Caswell & Nisbet, 2005; Hills, 1991; Ismail, 2009; Malmivuori, 2006). Individuals with higher levels of self-confidence experience greater competency in learning mathematics, which in turn, perform better academically. Consistent with past studies, the present study provides evidence for a significant positive relationship between self-confidence and mathematics achievement. Students' formative performance is the decisive factor in predicting their summative performance. The relationship between self-confidence and summative performance was found to be significantly mediated by formative performance. Therefore, this study suggests that students with greater self-confidence level and perform well on the formative assessments are expected to perform better on summative assessments. One of the possible explanations is that the measured formative performance is accounted for 35% of grading purposes for participants in this study. Thus, students may uphold more efforts on formative assessments rather than summative assessments.

Besides, although positive emotion was not directly predicted formative performance, the relationship between positive emotion and formative performance was found to be significantly mediated by insight. Students with higher levels of positive emotion are expected to perform better in their formative assessments if they experience higher levels of the internal state of awareness. In other words, students with higher internal state of awareness are less anxious and less stressed when dealing with mathematical problems. This suggests that students who are displayed higher scores of positive emotional beliefs will uphold more efforts to score well on formative assessments. Surprisingly, positive emotion revealed as having little negative impact on students' summative performance. This indicates that students with higher positive emotion scores are likely less anxious and less stressed towards their formative assessments, but tended to be more anxious when dealing with summative assessments.

In general, self-reflection and insight are the two main measures that can be used to assess individual differences in three stages of mental processes: initial mental state (i.e., the motive), the mental process (i.e., the acts of it), and the final mental state (i.e., the outcomes) (Xu, 2011). As predicted, the results showed that the three different stages of mental processes were interrelated. In a study conducted by Stein and Grant (2014), they have tested the construct of self-reflection as a coherent whole was significantly predicted insight (a path coefficient of .13), but which domains of self-reflection is related to the construct of insight was not tested. In addition, there is no mediating relationship was tested in the past studies. This study resolved these issues by showing that engagement in self-reflection was positively influenced insight (a path coefficient of .166) and the relationship between the need for self-reflection and insight was mediated by engagement in self-reflection. Therefore, individuals with higher levels of self-reflection and insight are expected to have clearer distinctions about one's actual conceptual understanding (Xu, 2011). This means, the motive of reflection directed the acts of it, ultimately, the acts of the reflection related to the outcomes of the process. In short, the perceived need for and engagement in self-reflection are critically driven students to create awareness of own behaviors and actions.

Hence, the present study found that these self-consciousness variables were more pronounced and positively related to students' formative performance rather than summative performance. More specifically, the need for and engagement in self-reflection had no direct effect on students' mathematics achievement. These components indirectly influenced mathematics achievement through insight. Insight was not directly related to summative performance, but it was indirectly influenced summative performance through formative performance. This may due to the need for self-reflection is strongly related to short-term processes rather than long-term processes (Xu, 2011). As stated by Xu (2011, p. 54), a short-term process is "*an indication of an individual's effort to uphold the level of performance on an immediate task*", suggesting students' short-term goal-settings are more important in fostering their motive and execution of self-reflection process. Another possible reason is that some students may not take the assigned task seriously and some may doubt on the need to reflect on how and what they have learned, and thus, resulted in no changes in the learning (Lew & Schmidt, 2011). This is construed to Grant et al.'s (2002) theory on the relationship of self-reflection and insight. As stated by Grant et al. (2002, p. 830), the extent of individuals "*consciously engages in acts of self-reflection, the psychological mechanisms and behaviors that they use in the process of self-reflection, and the reason that they engage in self-reflection*" are the factors influencing the relationships of self-consciousness variables. This may explains why some empirical studies have revealed no association between self-reflection components and students' academic performance (e.g., Carr & Johnson, 2013; Lew & Schmidt, 2011). Therefore, the present study suggests that self-consciousness variable such as self-reflection and insight are contributing more relevantly to short-term attainment. Accordingly, engagement in self-reflection mediates the relationship between the need for self-reflection and internal state of awareness.

On the other hand, previous research has shown that negative emotions such as depression, anxiety, stress or alexithymia were negatively associated with insight (Grant et al., 2002; Harrington & Loffredo, 2011). Silvia and Phillips (2011) found that insight covaried with lower negative affective traits, higher positive affective traits and higher self-esteem, but not self-reflection. However, in this study, positive emotion was the sole affective factor that positively predicted insight, whereas self-confidence revealed as the sole affective factor that positively predicted self-reflection components (need for and engagement in self-reflection). These results demonstrating higher levels of positive emotional scores are more likely to have a greater awareness of personal mental processes, and higher levels of confidence about own capability to perform a task are more likely to evaluate and inspect one's feelings, motivations, behaviors, and actions, but it may not necessarily generate a true self-awareness.

Despite that, the need for self-reflection was found to mediate the relationship between self-confidence and engagement in self-reflection to some extent although the impact is small. One of the reasons is that some people required little or not much of effort to self-reflect as reflection is seen as an automatic appraisal process and some people required a conscious application of effort in self-reflection especially when they are anxious (Grant et al., 2002). For those who focused on negative emotional aspects, they may lack the skills or resources to move self-reflection to action and create awareness. On the contrary, for those who are confident and solution-focused, they are likely to reflect constructively for goal attainment (Grant et al., 2002). Therefore, this study suggests that students' self-confidence is related to self-reflection components and positive or negative emotions are affecting their insight thoughts. However, self-confidence and positive emotion only accounted for 10% of the variance in explaining self-reflection components, indicating a number of other factors at play in the relationship between affective factors and self-reflection components.

Implications

Theoretical Implications

The present findings have extended the understanding of the roles of affective and metacognitive factors in mathematics achievement from the perspectives of formative performance and summative performance. While expanding affective traits such as self-confidence and positive emotion to the relationship between self-reflection and insight, and how these constructs interrelated to influence eleventh-grade students' mathematics achievement, self-confidence contributed relevantly to the prediction of mathematics achievement. However, the impact of self-confidence is more pronounce to formative performance rather than summative performance. Nevertheless, formative performance is the dominant factor in predicting students' summative performance. The findings of the study confirmed that formative performance is a mediator that mediated the relationship between self-confidence and summative performance, whereas insight mediated the relationship between positive emotion and formative performance. The model holds true to that self-reflection components have significant total effects on students' mathematics achievement, especially in formative performance. While insight is contributed directly to the prediction of formative performance, it contributed indirectly to the prediction of summative performance.

Considering the relationships between affective factors and metacognitive factors, the present study found that self-confidence contributed relevantly to the prediction of self-reflection components, whereas positive emotion contributed relevantly to the prediction of insight. The model holds true to the relationship between self-reflection and insight, of which need for self-reflection relates to engaging in self-reflection, which in turn, linked to insight. Therefore, this study confirmed that self-reflection and insight components are interrelated to individuals' mental processes. As Grant et al. (2002, p. 832) stated, there are two types of self-reflection that can be identified, "*productive problem-solving or solution-focused approach*" and "*self-focused approach or emotion-focused*". Productive problem-solving approach refers to "*individuals constructively reflect on how best to reach their goals*", while self-focused approach refers to "*individuals attempt to understand, contain or dissipate their negative emotional, cognitive and behavioral reactions rather than focusing on moving towards goal attainment*". Stein and Grant (2014) proposed that the implementation of a constructive style of self-reflection that focuses on problem-solving approach and positive experiences generally help in avoiding students tapped into dysfunctional attitudes or self-focused reflection. These productive problem-solving approaches ultimately will increase one's insightful thoughts, enhanced self-evaluation, and subjective well-being. Students who are not expressing dysfunctional attitudes generally can differentiate the motive (need for self-reflection) and acts of reflection (engagement in self-reflection), which lead to higher self-insight (internal state of awareness). These insightful thoughts are central to purposeful and directed individual's behavior change.

Practical Implications

In view of the current results, teachers should implement formative assessments with care. To enhance students' clarity of awareness of what they are doing, feedback and corrective changes on formative assessments should be imposed for reflective thinking. When students regulate and reflect on their learning outcomes, they are more likely to assess their strengths and weaknesses so that corrective actions can be taken for improvement. As progress, this will boost up their self-confidence, ultimately enhanced academic performance. Previous studies have found that negative beliefs such as depression and anxiety will suppress the relationship between self-reflection and insight (Stein & Grant, 2014). These negative emotions also will impede students' self-confidence (Stuart, 2000). One of the ways to improve motivation, self-confidence, reduce test anxiety, and enhance test performance is through the practice of self-affirmation (Behncke, 2012). Behncke (2012) suggests teachers can always remind students about their past successes. This will boost up students' confidence in challenging mathematical problems. Taking all of the current results, this study suggests relevant policies or interventions should be seized to focus on fostering students' positive characteristics and impose the importance of self-reflection process within the classroom. It should be noted recent calls for self-regulation have been increased across different fields, including mathematics education (Pape & Smith, 2002). In nature, students will not automatically self-evaluate and self-reflect (Ramdass & Zimmerman, 2008). Therefore, teachers can help by providing opportunities for students to evaluate and inspect their learning outcomes. As progress, students will actively engage in reflecting on own learning process and initiates their insightful thoughts in order to develop self-regulation skills.

Limitations

The present study is conducted within a school and limited to eleventh-grade students with a considerable small sample size. This school has a different curriculum compared to the national curriculum. Therefore, the study cannot be generalized to other populations. However, most of the self-regulation theorists proposed that self-regulation behaviors may vary across their biological background, contextual factors, or environmental factors (Pintrich, 2004; Zimmerman, 2002). Since self-regulating mathematics studies are limited in mathematics education, especially for high school students, it is interesting for future researchers to replicate the research to compare and contrast the findings of the hypothesized model. Self-regulation is ascribed importantly in fostering students' lifelong learning, and thus, the present study urges policymakers, educators, or teachers to take present findings into consideration when designing instructional programs.

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