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Validation of Motivated Strategies for Learning Questionnaire: Comparison of Three Competing Models

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Students who are self-regulated leaners have been reported to perform more successfully in higher education institutions (HEIs). Therefore, instruments that can monitor students' motivation and learning have been devised and implemented. The aims of this work were to investigate the dimensionality of the motivated strategies for learning questionnaire (MSLQ) and compare the validation of the three competing models. Three competing measurement models (1-factor, 2-factor, and second-order factor) were selected as candidates. To reveal which model explained the original MSLQ most effectively and meaningfully, the original 15 indicators and 81 items were used, for which data was gathered from 945 participating engineering students in Thailand. The results of confirmatory factor analysis revealed that all three of the competing models fitted the data quite well, as all standardized factor loadings of these models were statistically significant. It appeared that two-factor and second-order factor models yielded a better overall fit to the data in comparison to one-factor model. These results confirmed that the original MSLQ is a reliable and valid measurement instrument, particularly the second-order factor model, which was the best model.

Keywords: motivated strategies for learning questionnaire (MSLQ), learning strategies, confirmatory factor analysis, validation, competing models

INTRODUCTION

In the complex adaptive systems of engineering education (Noor, 2013) and adoption of online learning in HEIs across the globe (Palvia et al., 2018), students are required to take active learning (López-Fernández, Ezquerro, Rodríguez, Porter, & Lapuerta, 2019) and become more self-regulated learners (Araka, Maina, Gitonga, & Oboko, 2020; Nelson, Shell, Husman, Fishman, & Soh, 2015). Students who are highly self-motivated and self-directed, they tend to perform more successfully in HEIs (Artino & Stephens, 2009; Garcia-Ros, Perez-Gonzalez, Cavas-Martinez, & Tomas, 2018; Martin & Sorhaindo, 2019). According to the general constructivist perspective of learning (Alt, 2015), motivation and learning strategies were defined as self-regulated learning (SRL) methods which are an actively process possessed by students to improve their learning by "set goals for their learning and then attempt to monitor, regulate, and control their

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cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment" (Pintrich, 2000; Wolters, Pintrich, & Karabenick, 2005).

Instruments that can provide students with the ability to monitor their motivation and learning have been devised and implemented. One of the most widely used questionnaires for assessing students learning behaviors in HEIs is the MLSQ (Duncan & McKeachie, 2005; Pintrich, Smith, Garcia, & Mckeachie, 1993). As a self-reported measure of SRL strategies, MSLQ can be used as a tool to predict academic achievement (Kizilcec, Pérez-Sanagustín, & Maldonado, 2017), it may be used to identify students at risk (Credé & Phillips, 2011). The MSLQ consists of fifteen different components, some of the constructs might be deemed difficult to measure when used in different disciplines and cultures (Credé & Phillips, 2011). Thus, it is necessary to decide before using the questionnaire whether construct validity should be investigated to define the measuring quality. Although various international researchers have increasingly tested the validation of the MSLQ involved with one, two or three-factor models in STEM student (Chechi, Bhalla, & Chakraborty, 2019; Jackson, 2018; Ng, Wang, & Liu, 2017; Ramirez-Echeverry, García-Carrillo, & Dussan, 2016), few attempts have been made to examine its use for second-order CFA (Jackson, 2018; Karadeniz, Büyüköztürk, Akgün, Çakmak, & Demirel, 2008), especially for engineering and at Thai HEIs. Despite having been utilized for over 30 years (Pintrich, Smith, Garcia, & McKeachie, 1991), there are several concerns about the psychometric properties of the scale (Chechi et al., 2019; Cho & Summers, 2012; Credé & Phillips, 2011; Holland et al., 2018; Ramirez-Echeverry et al., 2016; Rotgans & Schmidt, 2010). Therefore, appropriate validation is required for MSLQ to provide useful information for research planning.

MSLQ consists of two main sections (motivation and learning strategies) (Pintrich et al., 1993), which is a second-order construct. In section A, the academic motivation dimension measures students' goal and value beliefs for courses, ability to succeed in courses, and anxiety about tests in courses. In section B, the learning strategies dimension assesses students' use of different cognitive and metacognitive strategies (Duncan & McKeachie, 2005). It has been applied in different contexts and translated into several languages (Duncan & McKeachie, 2005). The instrument as a second-order model has many advantages over a first-order factor model, such as: (a) the relative significance of each factor on overall MSLQ can be investigated (Kwan & Walker, 2003); (b) a second-order model can test whether the pattern has a relation between the higher factor and first-order factor (Chen, Sousa, & West, 2005); (c) when the model has multiple factors or indicators, second-order factor analysis can be used to address each of these problems (Marsh & Hocevar, 1998). Therefore, this study aims to expand previous research to: (1) investigate the dimensionality of MSLQ at the general level; (2) specifically examine as well as compare the validation of the three competing models when applied to engineering students in Thailand. The results obtained in this work could be used as a guideline for the application of MSLQ to students in other academic programs.

METHOD

Participants

The participants were undergraduate engineering students from a university in Thailand. The 1,276 questionnaires were distributed through traditional mail at university dormitories. A total of 946 questionnaires were collected, only one was incomplete. Therefore, the number of participants used in this analysis was 945 engineering students, comprised of 638 (67.51%) freshmen and 307 (32.49%) sophomores. Regarding gender, 408 (43.17%) were female and 537 (56.83%) male.

Measures

The MSLQ consisted of 2 factors, namely: (1) Academic Motivation Factor, it was measured by 6 indicators (31 items); (2) Learning Strategies Factor, which was measured by 9 indicators (see Table 1). For item measurement level, each item was rated on a 5-point Likert scale (1-5). To assess internal consistency reliability, Cronbach's alpha coefficient (α) was employed (Cronbach, 1951) and ranged from .41 to .80 (Table 1). Although reliability for some indicators was low, this study retained them because Cronbach's alpha is extremely sensitive for number of items (Pelham, 2013) and necessary but not sufficient condition for measuring homogeneity or unidimensionality of the scale (Cortina, 1993; Green, Lissitz, & Mulaik, 1977). Furthermore, this questionnaire represents the components of student's motivation (Pintrich et al., 1991), as well as the MSLQ measures for many different constructs, so it is necessary to keep the indicators as short as possible (Artino, 2005).

Procedures

The data were collected using multistage sampling method across three hierarchical levels in the university, first stage at the school level, second at the department level, and ultimately at the stage of the GPA group by distributing randomly across all groups. The author sent an official letter to the Student Registration Department to request list of students with their GPA, all living in the university's dormitory. Questionnaires were directly delivered to all participants at the dormitory by three research assistants. Participants were requested to return questionnaires in the mailbox at each dormitory. All students' information was kept confidential, and participation was voluntary.

Table 1
Descriptive statistics by indicators of MSLQ

Factors/Indicators	Items	alpha	Min.	Max.	*M*	*SD*	*SK*	*KU*
1. Academic Motivation Factor	31	.81						
1.1 Intrinsic Goal Orientation	4	.57	1.50	5.00	3.64	0.53	0.04	0.03
1.2 Extrinsic Goal Orientation	4	.51	1.50	5.00	3.70	0.60	-0.17	-0.20
1.3 Task Value	6	.74	2.00	5.00	3.76	0.50	-0.01	0.00
1.4 Control Beliefs about Learning	4	.46	1.50	5.00	3.69	0.54	-0.10	0.01
1.5 Self-efficacy for Learning and Performance	8	.80	1.63	4.88	3.18	0.50	0.26	0.54
1.6 Test Anxiety (reversed)	5	.67	1.00	4.80	2.52	0.64	0.14	-0.07
2. Learning Strategies Factor	50	.90						
2.1 Rehearsal	4	.50	1.50	5.00	3.27	0.53	0.04	0.27
2.2 Elaboration	6	.74	1.17	5.00	3.33	0.51	0.11	0.72
2.3 Organization	4	.61	1.00	5.00	3.32	0.61	-0.01	0.24
2.4 Critical Thinking	5	.65	1.40	5.00	3.26	0.50	0.16	0.65
2.5 Metacognitive Self-Regulation	12	.65	1.75	4.42	3.20	0.38	0.06	0.56
2.6 Time and Study Environment	8	.57	1.50	4.75	3.21	0.46	-0.02	0.64
2.7 Effort Regulation	4	.41	1.25	5.00	3.21	0.55	-0.01	0.47
2.8 Peer Learning	3	.47	1.00	5.00	3.01	0.60	-0.03	0.47
2.9 Help Seeking	4	.44	1.00	5.00	3.22	0.59	-0.26	0.75

Statistical Analysis

Descriptive statistics were conducted to assess the normality of distribution and identify outliers. The Pearson correlation coefficient (r) was a measure of the relationship between pairs of indicators. CFA was performed to evaluate the goodness-of-fit for the three competing models of MSLQ, and was conducted in Mplus 8.3 using maximum likelihood (ML) estimation. In order to test the validation of the model, various fit indices were employed, e.g. chi-square per degree of freedom ($\chi 2/df$), comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA) including 90% confidence intervals (90% CI), and the standardized root mean squared residual (SRMR). Further evaluation of the construct validity includes convergent and discriminant validities of the measurements. Three criteria should be considered to estimate the amount of convergent validity among indicators (Fornell & Larcker, 1981): (a) the size of standardized factor loading; (b) the value of the average variance extracted (AVE); (c) the construct reliability (CR). The comparison of two competing models, chi-square test of differences ($\Delta\chi 2$) and Akaike information criterion (AIC) are criteria for selecting among nested models (Kline, 2011).

FINDINGS

Descriptive Statistics and Data Screening

In Table 1, the mean scores of indicators for the academic motivation factor were mostly in the good range (M = 3.64 to 3.76). Meanwhile, the mean scores of 9 indicators on the learning strategies factor ranged between 3.01 and 3.33, showing a moderate range. This indicated an overall positive response to the indicators. The absolute value of skewness (*SK*) is less than 3 and the absolute value of kurtosis (*KU*) is less than 10, the data set can be approximated by univariate normal distribution (Garson, 2012). These results suggest that multivariate normality can be assumed and the data set is appropriate for CFA (Kline, 2011).

Almost all of the correlation coefficients demonstrated that there was a relationship between two indicators ($p < .01$), except for Test Anxiety and three indicators including Elaboration, Metacognitive Self-Regulation, and Peer Learning. The values of Kaiser-Meyer-Olkin (*KMO* = .90) and Bartlett's Test of Sphericity ($p = .00$) supported the use of factor analysis as an appropriate procedure (Hair, Black, Babin, & Anderson, 2014; Munro, 2005).

Confirmatory Factor Analysis: Comparison of the Three Competing Models

CFA was used to assess the goodness of fit of a null model and three competing models. In general, the comparison of nested CFA models: a null model was computed first that tested all indicators were uncorrelated (there are no latent variables) (Teo, 2010). Second, a single, one-factor first-order model (Model A) was computed to test whether the 15 indicators could all be loaded on one general latent factor, MSLQ. Third, the relationship between two-factors first-order model (Model B) was computed to test whether the academic motivation factor was related to the learning strategies factor. For each factor, there was a relationship among one latent factor and its indicators. Finally, a second-order factor model (Model C) was computed to assess whether the two-factors could be used to produce an overall MSLQ factor.

Fit indices for the four models are shown in Table 2. The null model had a very large Chi-square, indicating that all indicators were uncorrelated. Moreover, the Chi-square test of goodness of fit suggested that the three proposed models fit the data reasonably well. The other fit indices namely: CFI, TLI, RMSEA, and SRMR, which also confirmed that all three of the hypothesized models were consistent with observed data well, providing support for these models.

Table 2
Summary of fit indices for null model and three competing models of MSLQ

Model	$\chi 2$	$\Delta\chi 2$	*df*	*p*	$\chi 2/df$	CFI	AIC	TLI	RMSEA	SRMR	AVE	CR
Null Model	5701.463		105	.000	54.300							
Model A: One Factor Model	50.152		47	.350	1.067	.999	16761.504	.999	.008 (90% CI = .000, .023)	.017	.32	.85
Model B: Two Factor Model	49.089	$\Delta\chi^2_{B\text{-}A}$ = -1.063	46	.350	1.067	.999	16762.441	.999	0.008 (90% CI = .000, .024)	.016	.45	.91
Model C: Second-Order Factor Model	49.086	$\Delta\chi^2_{C\text{-}B}$ = -0.003 $\Delta\chi^2_{C\text{-}A}$ = -1.066	46	.050	1.067	.999	16762.438	.999	0.008 (90% CI = .000, .024)	.016	.45	.91

Further information, such as parameter estimates, factor loadings, residual variances and values of R^2 obtained in the analysis of the three competing CFA models were utilized to describe the relationship between each factor and their indicators in the first-order model, as well as between each factor and the MSLQ factor in the second-order model. All indicators of these loaded models were statistically significant at $p < .05$ onto their respective latent factors (see Figures 1, 2, and 3). As seen by Model A in Figure 1, the value of standardized factor loadings ranged from -.118 to .831, with AVE = .32 and CR = .85. Model B in Figure 2 shows that the standardized factor loadings ranged from -.206 to .965, with AVE = .45 and CR = .91. Model C in Figure 3 shows that the standardized first-order factor loadings ranged from -.206 to .972, with AVE = .45 and CR = .91. It should be mentioned that AVE and CR, as well as most of the values of the factor loadings of learning strategy and academic motivation factors, of model C are approximately the same as model B, which reflects composite reliability and homogeneous correlation pattern of both models (Bacon, Sauer, & Young, 1995).

For the academic motivation factor in Model A and Model B the highest loadings were found for “Self-efficacy for Learning and Performance”, “Task Value”, and “Intrinsic Goal Orientation”, whereas the lowest loadings were found for “Test Anxiety”, and “Control Beliefs about Learning”. Furthermore, learning strategies factor in Model A and B the highest loadings were found for “Metacognitive Self-Regulation”, “Elaboration”, and “Critical Thinking”, whereas the lowest loading was found for indicator “Help Seeking” only. The higher factor loading, the better relevance existed in defining the factor’s dimensionality. A negative value indicated an inverse impact on the factor. However, although the value of AVE is less than .5 and some of the factor loadings are less than |.5|, this suggests that these same indicators have low convergent reliability for a construct (Fornell & Larcker, 1981). All factor loadings differed reliably from zero ($p < .05$) and the other indicators had moderate to strong standardized loadings, including CR, which exceeded .7. As such, the results of this study can be commented that further research needs verification or adaptation of “Test Anxiety”, “Help Seeking”, and “Control Beliefs” indicators. Because factor loadings of these indicators are too low (< .5) in their factors, these are not sufficiently construct reliabilities.

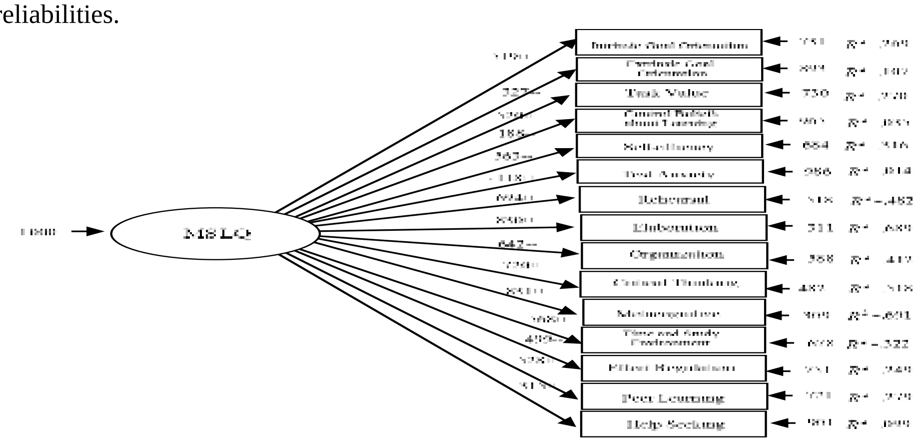

Figure 1
Model A: First-order one factor model (* $p < .05$, ** $p < .01$).

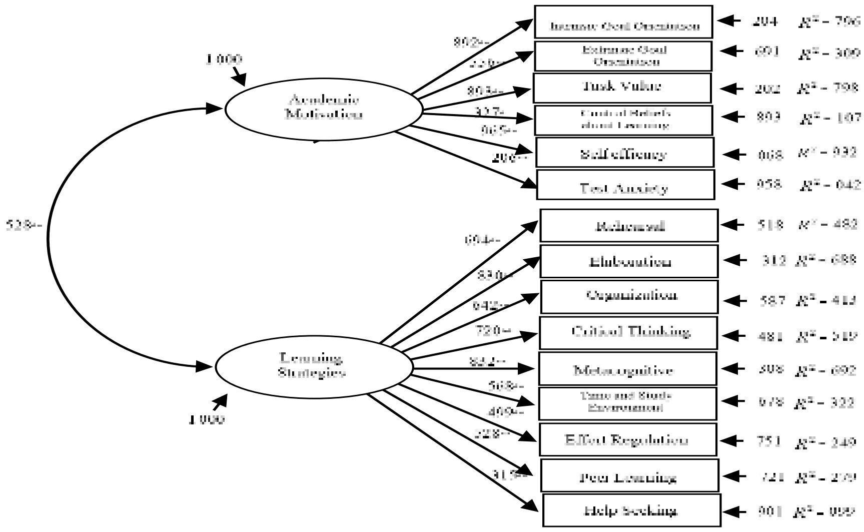

Figure 2
Model B: First-order two factor model (* $p < .05$, ** $p < .01$).

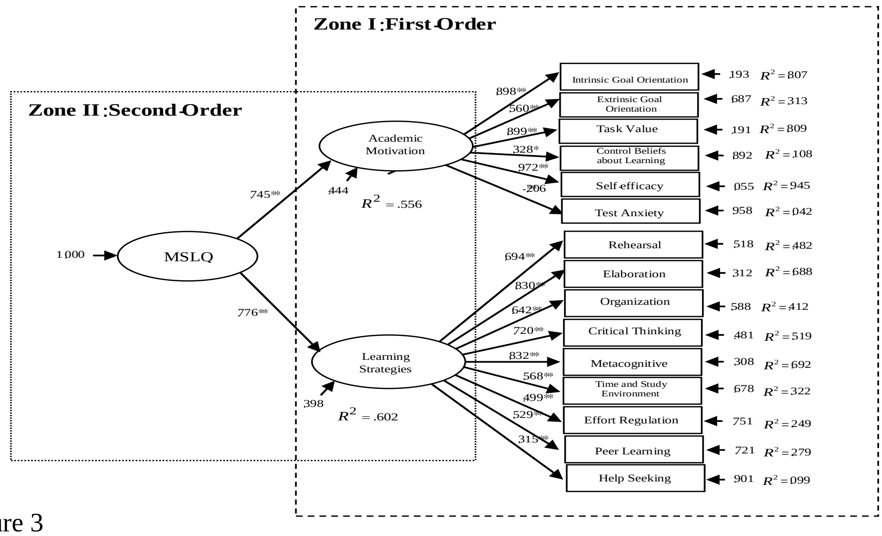

Figure 3
Model C: Second-order CFA model (* $p < .05$, ** $p < .01$).

The squared multiple correlations (R^2) are shown in Figures 1, 2, and 3, describing how much variance the factors account for in the indicators or the reliability of the measurements. For Model A, the R^2 illustrated that modest amounts of variance were accounted for in almost all indicators except for the "Elaboration" and "Metacognitive Self-Regulation". In Models B and C, large amounts of variance ($R^2 > .6$) were accounted for in the "Intrinsic Goal Orientation", "Task Value", "Self-Efficacy for

Learning and Performance", "Elaboration", and "Metacognitive Self-Regulation". The large R^2 values suggested that the indicators were strongly related to their factors. The average R^2 of all indicators for each model indicated that an average of 32%, 44.8%, and 45.1% (of Model A, B, and C, respectively) of total variance in the indicators was accounted for by the latent factors.

Finally, based on these results, it was clear that the one-factor (Model A), two-factor (Model B), and second-order factor models (Model C), generated good fit indices. Therefore, the delta chi-square ($\Delta\chi^2$) tests of differences and AIC indexes were used to assess which of the three competing models provided a better fit to the data. Lower values of $\Delta\chi^2$ and AIC are generally associated with better model fit in comparing nested models. The $\Delta\chi^2$ tested between the one-factor model (Model A) and two-factor model (Model B) indicated that the two-factor model had a significantly better fit than the one-factor model. The $\Delta\chi^2$ tested between the two-factor model (Model B) and the second-order factor model (Model C) indicated that the second-order factor model (Model C) had a significantly better fit than the two-factor model. The values of AIC indexes were slightly different between the three models.

Although the second-order factor model (Model C) is a better fit than the two-factor model (Model B), the chi-square test of differences between models seemed to show an insignificant difference. The AIC also had a small difference (ΔAIC = .003). Therefore, the results suggest that the two-factor model (Figure 2) and the second-order factor model (Figure 3) were acceptable and the strongly-supported model of their scale is more than the one-factor (Figure 1).

CONCLUSIONS AND DISCUSSION

This study investigated the dimensionality of MSLQ for academic motivation and learning strategy factors at a general course of engineering students in Thailand. It compared the construct validity of three competing models. There were three primary findings of this study: first, testing model fit for the data and considering the difference between models; secondly, the size of factor loading; and finally, size of reliability.

Testing Model Fit the Data and Considering the Difference Between Three Competing Models

As for the first-order one-factor model (Model A), the CFA results confirmed that all fifteen indicators could be loaded on one general MSLQ measurement model. Which indicated that Thai engineering students value the cognitive, metacognitive, and resource management dimensions more than motivation dimensions, except "Help Seeking" indicator. This was consistent with previous studies of Pintrich et al. (1991), Chow and Chapman (2017), Jackson (2018), and Chechi et al. (2019), that reported it is not performing well. Further, the first-order two-factor model (Model B) showed that each measurement model of two-factors had a relationship with one latent factor and its indicators. These findings were consistent with previous studies (Karadeniz et al., 2008), which supported the measurement model of two-factors, fitting well to the culture of Thai HEIs. Finally, a second-order factor model

(Model C) was computed and demonstrated good fit as well, with estimated path coefficients from the first-order factors to second-order factors being statistically significant.

For comparisons of the three CFA models, the fit indices demonstrated that the first-order two-factor model (Model B) and the second-order factor model (Model C) had better fit than the one-factor model (Model A), unidimensional measurement model.

Comparing the **Size of Factor Loading and Structural Coefficient**

The result of standardized factor loading represents the strength of association between the latent factor and each of the indicators. In the academic motivation latent factor of Models B and C, "Self-efficacy for Learning and Performance", "Task Value", and "Intrinsic Goal Orientation" indicators are the key indicators of academic motivation factor (large positive factor loadings). These findings suggest that self-efficacy plays a causal role in academic motivation (Doménech-Betoret, Abellán-Roselló, & Gómez-Artiga, 2017; Pajares & Schunk, 2005; Zimmerman, 2000) more than other indicators, as suggested by Bandura (1977), who introduced self-efficacy as a core component in social cognitive theory. If students have high self-efficacy, they believe they can perform well to maintain high academic achievement (Alhadabi & Karpinski, 2020; Lent, Brown, & Larkin, 1986; Pajares & Schunk, 2005). This result implies that improving engineering students' self-efficacy beliefs lead to better use of cognitive strategies (Jungert & Rosander, 2010) and could significantly explain the academic performance and persistence of students in engineering (Ponton, Edmister, Ukeiley, & Seiner, 2001; Tossavainen, Rensaa, & Johansson, 2019). Furthermore, students with higher levels of "Task Value" and "Intrinsic Goal Orientation" will affect more motivated behavior (Kassim, Hancock, Hanafi, & Omar, 2004), which implies that students who value learning tasks and learning with intrinsic motivation tend to have a high motivation that guides the students' learning (Vansteenkiste, Lens, & Deci, 2006) and has an influence on learning performance (Pintrich, 1999).

On the other hand, "Test Anxiety" had a poor negative factor loading on the academic motivation factor, meaning an inverse impact on the factor. As "Test Anxiety" increases, students' academic motivation tends to decrease. This is not surprising, as high cognitive anxiety leads to debilitative feelings (Wollert, Driskell, & Quail, 2011; Zeidner & Matthews, 2005), which causes distraction and disorientation (Gall, 1985) and can decrease student motivation for learning in general (Cizek & Burg, 2006). These findings were in line with the studies done by Hilpert, Stempien, van der Hoeven Kraft, and Husman (2013) and Yen, Bakar, Roslan, Luan, and Abd Rahman (2005). However, "Test Anxiety" has been established in motivation literature (Ormrod, 2011) as a negative mood (Olafson & Ferraro, 2001). Anxiety may also lead to increased motivation to avoid negative outcomes by spending effort (Pekrun, Goetz, Titz, & Perry, 2002). Thus, "Test Anxiety" was included in the MSLQ construct to strengthen academic motivation, as well as considered as an emotional construct and not represented as motivational components (Pekrun et al., 2002).

Based on the learning strategies latent factor of Models B and C, the standardized factor loadings of "Metacognitive Self-Regulation", "Elaboration", and "Critical Thinking" indicators yielded good loading, indicating that they were the key indicators of this factor. This suggested that students who built good habits of these indicators tended to do best on the learning strategies. Particularly, a high value of the factor loading on "Metacognitive Self-Regulation" was also consistent with learner being. Early studies have also demonstrated that metacognitive skills have been most associated with performance learning practices (Hsu, Iannone, She, Hadwin, & Yore, 2016; Young & Fry, 2008), partly independent of intelligence (Veenman, Kok, & Blöte, 2005). In contrast, "Help Seeking" was the least important indicator of the learning strategies factor. The scale of "Help Seeking" is about seeking help from peers or instructors, thus a low loading score suggested students did not take advantage of this learning resource. It was reported that avoidance of academic help seeking was less related to learning self-efficacy (Ryan & Pintrich, 1998), students tended to avoid asking for assistance because they did not know where to find help or they were insufficiently motivated to do so (Credé & Phillips, 2011). Studies also showed that students with low GPAs did not try to ask for help because of a fear of appearing dumb (Newman, 1990; Ryan & Pintrich, 1998), whereas students with performance goals avoided seeking help because of a threat to his/her self-esteem (Karabenick, 2004). Because nearly half of the participants (46.35%) in this study had GPAs of less than 2 (low GPAs), the factor loading of "Help Seeking" is the least important indicator of the learning strategy factor.

Additionally, the results of the second-order factor loading in Model C showed that the structural coefficient of learning strategies latent factor was linked to the overall MSLQ factor slightly more than the academic motivation latent factor. This result suggested that both factors play a significant role in MSLQ. That is, achieving academic success at the university level should encompass both factors, as the implementation of appropriate learning strategies and academic motivation can lead to increased academic achievement and have a crucial impact on academic outcomes as well (Schunk, 2004; Slavin, 2006; Zimmerman, 2008).

Size of Reliability

A limitation of the MSLQ in this study was the estimate of the reliability coefficient. The reliability of some of the indicators is low to moderate, which is similar to previous findings of Büyüköztürk, Akgün, Özkahveci, and Demirel (2004), Ramirez-Echeverry et al. (2016), and the meta-analysis by Holland et al. (2018). Despite the limitation, few indicators lacked reliability. However, the evaluation of construct validity for the three models supported MSLQ as a valid measurement tool in determining students' study strategies. This is theoretically related to the construct measured by the instrument (Crocker & Algina, 2006), MSLQ, as well as all indicators as crucial components of the measurement. Hence, the MSLQ could be adopted for engineering students at Thai HEIs, particularly the second-factor model, which was the best model. Furthermore, because MSLQ has multiple indicators and items, the second-order factor model could help solve problems (Marsh & Hocevar, 1998) and test the pattern of relations between the higher factor and first-order factor (Chen et al., 2005).

LIMITATIONS OF THE STUDY AND FUTURE LINE OF RESEARCH

It is should be noted that there were some limitations in this study. First, this study was conducted based on a self-assessment instrument, and it is well-known that self-report measure may be influenced by personal bias, social desirability, environment characteristics, response styles, and question items (Morgado, Meireles, Neves, Amaral, & Ferreira, 2018). Therefore, to further validate the model, collecting data from other sources, such as practitioner's assessments or peer groups' reports, is recommended. Second, because the data set used in this study was limited to undergraduate engineering students from a single institution, it may not be appropriate to generalize across other populations. Likewise, because the MSLQ is based on characteristics of HEIs, context-specific student traits and behaviors, it is possible that the measurement model may not be equivalent for members of other cultural groups or countries, races, and student backgrounds in models of student behavior, success, and persistence. Thus, for further confirmation of the scale and the multidimensionality of the MSLQ constructs, these characteristics should be considered to assess invariance across groups. Finally, this study was based on single-level CFA, future studies could apply multilevel CFA to further assess and validate the model because individuals in society could be affected by the cultural groups they belong to.

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