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Self-regulated Learning Profiles among Engineering Students: A case study

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Abstract
This study addresses a gap in self-regulated learning (SRL) research within Malaysian engineering education. Using the Motivated Strategies for Learning Questionnaire (MSLQ) and Cumulative Grade Point Average (CGPA) data from 320 students (yielding a 63.37% response rate), this study examined SRL profile differences between higher/lower achievers and males/females. Higher achievers demonstrated significantly greater self-efficacy and metacognitive self-regulation. Females reported higher overall SRL than males. Crucially, SRL significantly predicted 53.7% of the CGPA variance. Regression analysis identified self-efficacy (β = .252), metacognitive self-regulation (β = .567), and test anxiety (β =- .113) as key predictors. Future research should explore SRL development factors and intervention efficacy in this population.

Keywords: self-regulated; academic achievement; self-efficacy; MSLQ

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1.0 Introduction

Research shows academic performance depends on cognitive intelligence and non-cognitive traits like self-regulated learning (SRL). However, findings conflict; some support its critical role (Acosta-Gonzaga & Ramirez-Arellano, 2021), others find no correlation (e.g., self-efficacy) (Colomeischi & Carstiuc, 2018), and some even report adverse effects (Çetin, 2017). SRL research in engineering, especially in Malaysian contexts, remains scarce. While Kosnin (2007) found a significant link between SRL and achievement in Malaysian engineering students 14 years ago, producing lifelong learners is now an accreditation imperative (BEM, 2020); however, contemporary studies are lacking. Engineering students face significant challenges (Astin, 1993), often leading to attrition or delayed graduation, creating a paradox where previously successful students struggle (Scheidt et al., 2018). SRL is a potential explanatory factor. Admitted students possess comparable cognitive ability, yet outcomes diverge, suggesting unmeasured non-cognitive factors like malleable SRL are key determinants of success (Robbins et al., 2004).

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Student success is critical for individuals (enabling upward mobility, especially for disadvantaged students), institutions (impacting reputation and enrolment, Caviglia-Harris & Maier, 2020), and the nation. Consequently, predicting academic performance, a key success proxy influenced by multifaceted factors, remains a major research focus, centering on predictive factors and algorithms (Veenstra et al., 2009). However, Malaysia critically lacks comprehensive tools for analyzing student progress (Shahiri et al., 2015), partly due to insufficient systematic research on leveraging educational data and a specific gap in understanding non-cognitive factors, such as self-regulated learning (SRL), for engineering students' achievement.

This research urgently addresses this gap. Its primary objective is to investigate the hypothesis that SRL significantly influences academic performance. Furthermore, while prior research suggests gender differences in SRL adoption, with females often exhibiting stronger goal-setting, planning, and environmental management (Zimmerman & Martinez-Pons, 1990) and outperforming males in time management and effort (Bidjerano, 2005), findings remain inconsistent. Crucially, Bidjerano (2005) highlights the need for further study on the role of gender in SRL. Therefore, this research will investigate gender differences in SRL adoption among engineering students. This research attempts to answer the following research questions:

RQ1: Are there any SRL differences between the high and low-performing engineering students?
RQ2: Are there any SRL differences between male and female engineering students?
RQ3: Is there a statistically significant correlation between engineering students' self-regulated learning and academic achievement?

The remainder of this article is divided into four sections. The following section reviews related works, highlighting research gaps and positing factors that influence students' academic performance. Section 3 outlines the methodology of our approach to answering all three research questions, including the participants and context, while Section 4 presents the findings and discussion of our research work. Section 5 concludes with key findings, highlights the limitations of the proposed approach, and suggests future directions for research expansion.

2.0 Literature Review

Tertiary learning, though latent, traditionally emphasizes cognitive factors for assessing performance and skills. However, initiatives addressing the psychosocial demands of engineering education, particularly in Malaysia, are scarce, heightening interest in non-cognitive factors like SRL (Ahmed et al., 2022; Morris et al., 2019). SRL involves students' self-generated thoughts, feelings, and actions to achieve academic goals, directing their knowledge acquisition through planning, execution, and self-evaluation (Rozi et al., 2025; Zimmerman & Martinez-Pons, 1990). Grounded in Albert Bandura's Social Cognitive Theory, SRL reflects the triadic interaction of personal, behavioral, and environmental factors influencing self-regulation (Alexander et al., 2017).

Core SRL components critical for academic performance include (1) metacognitive strategies for organizing and adapting cognition, (2) management of learning efforts, and (3) cognitive methods for knowledge acquisition (Pintrich et al., 1991). Self-regulated learners are metacognitively, motivationally, and behaviorally active, taking personal responsibility rather than relying on external prompts (Zimmerman, 1990). While SRL correlates significantly with academic performance (e.g., GPA) in diverse samples (Keyser & Viljoen, 2015; Valle et al., 2008), particularly constructs like self-efficacy and metacognition, meta-analyses reveal conflicting evidence. Robbins et al. (2004) identified self-efficacy and motivation as key predictors of GPA, yet Fenollar et al. (2007) found no direct impact of self-efficacy or achievement goals. However, Credé et al. (2008) confirmed robust links between study skills/attitudes and performance.

Given these inconsistencies and the lack of recent Malaysian engineering studies, despite Kosnin's (2007) finding linking higher CGPA to stronger SRL a decade ago, this research investigates SRL's impact on engineering students in a contemporary Malaysian public university. This is urgent; graduates must transcend rote learning, embodying lifelong learning and initiative crucial for work. Engineering graduates are also expected to have the initiative to pursue lifelong learning, which would prove critical in the working environment. It is important to cultivate SRL to produce autonomous learners who can initiate their learning, assess their knowledge attainment, and be motivated to improvise and adapt to achieve academic success. The roles of students and educators should shift from those described by Boekaerts (1997), where students are passive receivers of information disseminated by educators and merely replicate the materials made available to them. Battista et al. (2023) reinforce this need by demonstrating that effective learning occurs when educators adopt facilitative behaviors that promote interaction, autonomy, and active student engagement.

3.0 Methodology

The central premise underlying this research is that SRL is an independent variable that affects the dependent variable, specifically, engineering students' CGPA. Based on the research questions posed in the Introduction, the following null hypotheses are formulated:

Null hypothesis 1 (RQ1): There are no significant differences in SRL between the two academic performance groups of high and low achievers.
Null hypothesis 2 (RQ2): There are no significant differences in SRL between male and female engineering students.
Null hypothesis 3 (RQ3): SRL does not significantly predict engineering students' academic performance.

3.1 Participant and Context

Data collection proceeded after institutional ethical approval and digital informed consent. Final-year students from four engineering faculties, Electrical, Civil, Chemical, and Mechanical, from a public university in Selangor, Malaysia, were invited to participate in this study. Out of 505 invitations sent, 320 students from all four faculties consented to answer the online survey, corresponding to a

63.37% response rate. The online sample size calculator (Raosoft, 2021) determined a minimum sample size of 219 for a 95% confidence level and 5% confidence interval; hence, 320 respondents met the requirement. The survey consists of two parts: the first is demographic, and the second comprises the MSLQ survey questions. Of the final 320 respondents, 133 were females (41.56%), and 187 were males (58.44%). Since this university specifically caters to *Bumiputera* (indigenous), no other race besides *Bumiputera* is involved in this study. Prior to analysis, cases with incomplete MSLQ responses were listwise deleted to maintain data integrity.

3.2 Procedure

Final-semester engineering students across four faculties were recruited via email four weeks before the March 2020 final exams. Participation was voluntary and consequence-free. Data collection occurred over three weeks. Academic achievement was measured using the final-semester Cumulative Grade Point Average (CGPA) sourced from official academic repositories. Respondents were stratified into high-achievers (CGPA > 3.3) and low-achievers using a median split, yielding two equal groups (n = 160 each). While acknowledging the potential for sample size reduction within each group, this approach ensures statistically robust comparisons through balanced group sizes (Kosnin, 2007).

3.3 Instrument

The Motivated Strategies for Learning Questionnaire (MSLQ) assessed students' self-regulated learning (Pintrich et al., 1991). Students scored themselves on a seven-point Likert scale ranging from 'not at all true of me' to 'very true of me'. The MSLQ is divided into two sections: motivation and learning strategies. The motivation scale comprises six subscales (intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy, and test anxiety). The learning strategies include nine subscales (rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, and help-seeking).

3.4 Data Analysis

IBM SPSS v28 was used to analyze the collected data. Cronbach's alpha was used to determine the reliability of the MSLQ items, an indicator of the internal consistency of items in a survey instrument, representing its internal validity. A comparison of means between two independent groups, high-achievers and low-achievers, and male and female, was conducted using the independent t-test. Multiple linear regression (MLR) was performed to assess the correlation between students' self-regulated learning and their academic performance.

4.0 Findings and Discussion

Before performing descriptive and inferential statistics on the collected data, the reliability and validity of the distribution of responses to each MSLQ motivation and learning strategies sub-scale were determined. Cronbach's alpha values range from 0.7 to 0.92, indicating that each MSLQ sub-scale has high internal reliability (exceeding the recommended α of 0.7).

4.1 RQ1: Are there any SRL differences between the high and low-performing engineering students?

To answer RQ1, the differences in the mean scores of the MSLQ sub-scales for motivation and learning strategies across the two independent groups were investigated, resulting in the values presented in Tables 1 and 2.

Table 1. Descriptive statistics and an independent t-test for the MSLQ motivation scale between the high and low achievers

Motivation	Mean (SD) High	Mean (SD) Low	Mean difference	t
Intrinsic Goal Orientation	5.288 (1.234)	4.394 (1.572)	.893	5.658*
Extrinsic Goal Orientation	5.595 (1.247)	4.847 (1.555)	.748	4.749*
Task Value	5.541 (1.096)	4.895 (1.333)	.6458	4.734*
Control of Learning Beliefs	5.431 (1.238)	4.578 (1.72)	.853	5.093*
Self-Efficacy	5.468 (0.944)	3.507 (1.479)	1.961	14.138*
Test anxiety	4.325 (1.229)	4.193 (1.364)	.132	.913

** Correlation is significant at the 0.05 level (2-tailed)*

For the MSLQ Motivation scale, all but one p-value of Levene's test for equality of variance is less than 0.05. Therefore, we reject the null hypothesis of Levene's test and conclude that the variance in the motivational construct of high-performing students is significantly different from that of low-performing students, except for test anxiety. Therefore, only test anxiety is analyzed using values with equal variances assumed, while the rest use values with unequal variances not assumed. There was a significant difference in the means of motivational constructs between high and low-performing students. For example, in terms of self-efficacy, $t(270.235) = 14.138$, $p < .001$, with a mean difference of 1.961, indicates that high-performing students have a higher belief in their ability to perform any necessary task to achieve good academic performance compared to their low-performing peers.

Table 2. Independent t-test for the MSLQ Learning Strategies scale between the high and low achieving engineering students

Learning Strategies	Mean (SD) High	Mean (SD) Low	Mean difference	t
Rehearsal	*5.159 (1.182)*	*4.334 (1.509)*	*.825*	*5.443**
Elaboration	5.172 (1.214)	4.303 (1.620)	.868	5.428*

Organization	5.222 (1.237)	4.361 (1.525)	.860	5.546*
Critical thinking	5.020 (1.184)	4.080 (1.583)	.940	6.014*
Metacognitive self-regulation	5.541 (.842)	3.014 (.893)	2.527	26.050*
Time study environment	5.089 (1.184)	4.399 (1.309)	.689	4.945*
Effort regulation	5.453 (1.025)	3.533 (1.232)	1.92	15.163*
Peer Learning	5.194 (1.254)	4.323 (1.584)	.870	5.453*
Help-seeking	5.314 (1.043)	4.019 (1.224)	1.295	10.191*

** Correlation is significant at the 0.05 level (2-tailed)*

Levene's Test showed non-significant p-values ($p > .05$) for metacognitive self-regulation, time, and study environment, indicating equal variance between high- and low-performing students. Independent t-tests across learning strategies yielded significant mean differences ($p < .001$), with the largest gap in metacognitive self-regulation, where high performers scored 2.527 points higher than low performers.

4.2 RQ2: Are there any SRL differences between male and female engineering students?

We used an independent t-test to compare the motivation and learning strategies scale of MSLQ across male and female engineering students, addressing the second research question.

Table 3. Independent t-test for the MSLQ motivation scale between the male and female engineering students

Motivation	Mean (SD) Female	Mean (SD) Male	Mean difference	t
Intrinsic Goal Orientation	5.073 (1.316)	4.675 (1.569)	.398	2.461*
Extrinsic Goal Orientation	5.632 (1.258)	4.929 (1.519)	.702	4.511*
Task Value	5.457 (1.187)	5.047 (1.287)	.410	2.902*
Control of Learning Beliefs	5.342 (1.374)	4.765 (1.635)	.577	3.421*
Self-Efficacy	4.899 (1.356)	4.195 (1.666)	.703	4.155*
Test anxiety	4.645 (1.211)	3.984 (1.291)	.661	4.632*

** Correlation is significant at the 0.05 level (2-tailed)*

All the p-values for the independent t-test are less than .05, indicating a significant difference between male and female engineering students in their motivation sub-scale. Female students score higher than their male counterparts in each aspect of the motivation sub-scale. Table 3 also highlights that female engineering students have higher test anxiety than their male peers. However, this does not appear to affect their academic performance, as their CGPA was comparable to that of their male peers.

Table 4. Independent t-test for the Learning Strategies scale between the male and female engineering students

Learning Strategies	Mean (SD) Female	Mean (SD) Male	Mean difference	t
Rehearsal	5.156 (1.273)	4.456 (1.443)	.700	*4.490
Elaboration	5.031 (1.365)	4.529 (1.549)	.503	*3.004
Organization	5.177 (1.343)	4.517 (1.467)	.659	*4.102
Critical thinking	4.830 (1.337)	4.3508 (1.535)	.479	*2.902
Metacognitive self-regulation	4.7093 (1.505)	3.971 (1.483)	.739	*4.365
Time and study environment	5.118 (1.215)	4.478 (1.284)	.640	*4.497
Effort regulation	4.870 (1.482)	4.225 (1.431)	.646	*3.920
Peer Learning	5.130 (1.410)	4.494 (1.495)	.637	*3.843
Help-seeking	4.981 (1.222)	4.443 (1.323)	.539	*3.704

** Correlation is significant at the 0.05 level (2-tailed)*

In Table 4, the independent samples t-test revealed a significant difference (all $p < .05$) between male and female engineering students for all learning strategies scales. The mean difference in the table indicates that female engineering students are more likely to adopt learning strategies in their pursuit of knowledge.

4.3 RQ3: Is there a statistically significant correlation between engineering students' self-regulated learning and academic achievement?

Multiple linear regression was used to assess how MSLQ sub-scales (independent variables) collectively and individually predict academic performance (dependent variable), addressing RQ3. Given SRL's multidimensional structure, this multivariate approach was necessary, as it surpassed the capacity of Pearson correlation to evaluate combined effects. Results are presented in Tables 5 and 6.

Table 5. Multiple Regression Analysis for independent variables and academic performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.747[a]	.558	.537	0.296

a. Predictors: (Constant), Help-seeking, Test anxiety, Metacognitive self-regulation, Time study environment, Effort regulation, Self-Efficacy, Critical thinking, Extrinsic Goal Orientation, Peer Learning, Control of Learning Beliefs, Rehearsal, Intrinsic Goal Orientation, Task Value, Organization, Elaboration

b. Dependent Variable: CGPA

As displayed in Table 5, the Multiple Regression Analysis for independent variables (SRL) and academic performance (CGPA) yielded an adjusted R-squared value of .537, indicating that 53.7% of the variation in academic performance could be attributed to the independent variables. In contrast, the remaining 46.3% is contributed by other predictors not included in this study.

Table 6. ANOVA Analysis of independent variables and academic performance

	Sum Of Squares	df	Mean Square	F	Sig.
Regression	*33.597*	*15*	*2.240*	*25.616*	*<.001*[b]
Residual	*26.581*	*304*	*.087*		
Total	*60.178*	*319*			

a. Dependent Variable: CGPA

b. Predictors: (Constant), Help-seeking, Test anxiety, Metacognitive self-regulation, Time study environment, Effort regulation, Self-Efficacy, Critical thinking, Extrinsic Goal Orientation, Peer Learning, Control of Learning Beliefs, Rehearsal, Intrinsic Goal Orientation, Task Value, Organization, Elaboration

Referring to Table 6, it can be stated that the result in Table 5 is statistically significant at the $p < .001$ level. Therefore, the results suggest a linear relationship between the MSLQ motivation and learning strategies scale and academic performance. Out of all the MSLQ motivation and learning strategies sub-scales, only three were found to be significant ($p < .05$) in predicting academic performance: self-efficacy ($\beta = .252$), test anxiety ($\beta = -.113$), and metacognitive self-regulation ($\beta = .567$). Self-efficacy and metacognitive self-regulation have a positive relationship with academic performance. The negative coefficient for test anxiety indicates an inverse relationship between test anxiety and academic performance, i.e., students who are more apprehensive when assessments are involved tend to achieve a lower CGPA than students with less apprehension towards the test.

5.0 Discussion

The findings reveal that SRL serves as a meaningful differentiator among engineering students, both in terms of performance and gender. This aligns with recent scholarship highlighting how motivation, cognition, and metacognition jointly shape learning outcomes in higher education (Acosta-Gonzaga & Ramirez-Arellano, 2021). Evidence from Tables 1 and 2 shows that high achievers significantly outperform low performers in terms of motivation and learning strategies. These students exhibit stronger tendencies toward goal-setting, planning, self-monitoring, and evaluation, all hallmarks of self-directed learners as emphasized by Hyppönen et al. (2019). Gender-related patterns further underscore SRL variability. Results from Tables 3 and 4 align with earlier findings by Baldan Babayigit & Guven (2020) and Zimmerman (1990), yet diverge from those of Zhao et al. (2014), suggesting that gender effects may be context-specific rather than universal. Regression analyses provide additional nuance, identifying SRL components most closely linked to achievement. Self-efficacy and metacognitive self-regulation emerge as positive predictors of academic success, consistent with Rozi et al. (2025) and Robbins et al. (2004). Conversely, the negative coefficient for test anxiety confirms its detrimental impact on performance (Ahmad et al., 2022). Taken together, these results highlight the imperative for engineering programmes to cultivate students' metacognitive regulation, foster self-efficacy, and reduce harmful anxiety. Strengthening these dimensions of SRL has a profound impact on enhancing academic achievement and preparing students to succeed in demanding educational environments.

6.0 Conclusion& Recommendations

This study establishes a critical link between SRL proficiency and academic achievement in engineering students, demonstrating clear performance-based distinctions across genders. Consistent with social-cognitive theory, self-efficacy, metacognitive self-regulation, and test anxiety emerged as the strongest SRL predictors. These findings mandate that educators proactively integrate SRL developments, specifically cultivating strategic learning, confidence, and emotional regulation into the curriculum. The utility of the MSLQ provides advisors with a reliable tool for early identification and intervention with at-risk students. However, the study's reliance on a cross-sectional design and a homogenous cohort limits causal inference and generalizability. Future research must employ a longitudinal design and diverse samples to advance the understanding of SRL's dynamic influence on academic trajectories.

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Paper Contribution to the Related Field of Study

This study bridges a critical gap in SRL research by providing robust empirical evidence from an understudied non-Western context, Malaysian engineering education. It establishes distinct SRL profiles linked to academic achievement and gender, validating the cross-cultural relevance of key SRL constructs. It offers educators actionable pathways to cultivate metacognitive skills and self-efficacy by confirming the reliability of a primary SRL instrument (MSLQ) locally.

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