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An Application of the Theory of Reasoned Action: Assessing Success Factors of Engineering Students*

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Student attrition in engineering is of concern. This study investigated motivational factors necessary to succeed in engineering. The Theory of Reasoned Action (TRA) model was used to guide the suggested paths from learning strategy, interest, and intention to academic performance. Participants were 135 Malaysian and 132 Australian engineering undergraduates who had completed the Study Process Questionnaire (R-SPQ-2F) scale and the Learner Autonomy Profile (LAP-SF) scale. The correlation coefficient analysis showed strong interrelationships between learning strategy, interest and intention. The findings of the structural equation modelling (SEM) revealed unexpected but interesting findings between the two countries. Two different pathways were established for the Malaysian and Australian data suggesting that the TRA model is best suited to the Australian learning context. The findings of this study could help identify a suitable model for explaining success factors in engineering.

Keywords: cognitive; affective; conative; academic performance; Theory of Reasoned Action; success

1. Introduction

Why is ensuring success in engineering so important? First and foremost, many countries have spent large amounts of money and effort to support engineering education. In several countries such as Malaysia and the United States, the development of knowledge workers in this area has become part of their national education development plan, which aims to increase the supply of skilled human resource in engineering [1, 2]. This problem has also caused societies to lose potential engineers who can support the future workforce in local industries. For example, in Australia, the critical shortage of engineers has been raised several times over recent years [3, 4]. The local universities in Malaysia are federally funded, and lecturers are allocated based on the number of undergraduate students enrolled in courses. The decrease in the number of undergraduate students consequently affects the financial support given to the universities. This problem could also affect financial stakeholders such as scholarship providers and parents.

While the reasons of attrition are clear, we still have inadequate information about factors influencing success in engineering programs. Research on attrition in engineering has consistently cited poor performance, decreased confidence and loss of interest in engineering as among the primary factors that influence students' decision to leave engineering programs [5–7]. In contrast, there is much debate about factors contributing to success. Several models of success were considered to be implemented in engineering education [8]. Despite a lot of research conducted and models introduced to understand success, there are mixed results generated from the research, making it difficult to develop firm conclusions about which model can be used to explain study success in engineering.

Students are different in the aspect of "mind" development. An individual mindset is theorised to be representative of the combined effects of the cognitive, affective and conative domains [9, 10]. In the current study, these three factors are hypothesised as the main factors contributing to the dissimilarity of engineering students in their learning process which consequently impacts on persistence and success in engineering. Studies of these mental elements (i.e., cognitive, affective or conative factors, or a mixture of these elements) provide support to the importance of the "mind" factors in ensuring success and persistence in engineering [8, 11, 12]. For example, it has been shown that engineering students who used deep cognitive strategies (e.g., meaningful understanding) in approaching a topic, achieved greater success than students who adopted surface cognitive strategies (e.g., memorising) [12]. Students are also different in their affective attributes (e.g., feeling, valuing or emotion) [13]. A lot of research has been conducted in this area to investigate cognitive and affective learning factors [8, 12]; however, very little effort has been made to include the other important domain, the conative [14]. To begin the exploration, this study focused on investigating the relationships between cognitive, affective and conative domains in order to identify learning factors that could influence student perfor-

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mance in the context of engineering education and how these factors are related.

Given that retaining students in engineering would have huge implications in fulfilling national workforce demands for Malaysia and Australia, it is crucial to understand factors that can lead to students' success in both countries. A better understanding of the success factors for different learning contexts is useful for universities, especially in dealing with the current world scenario where inter-country mobility of students is widespread.

2. Understanding learning strategy, interest and intention

The three aforementioned mind factors, the cognitive, affective and conative, will be discussed individually in this section in the form of learning strategy, interest, and intention, respectively.

2.1 Learning strategy

There are several terminologies used to describe cognitive function in learning such as a cognitive process, ability, skill, strategy and learning style [16]. This study focused on learning strategy, which is defined as a plan of action made by learners to enhance understanding and engage them in the learning process. Studies of learning strategy have been largely focused on a specific aspect of strategy, namely, cognitive processing strategy [17, 18]. Previous studies suggested that learning strategy (i.e., self-regulation, and skill) affects the study performance of Chinese university students, with self-regulation contributing to high academic success more than the skill factor [19]. Several other studies have attempted to relate learning strategy to study success however there is a lack of consistency in the findings, highlighting the need for a more in-depth analysis of the effect of learning strategies on academic performance.

Research has suggested that it is important for engineering undergraduates to establish their own learning strategy in the first year of studies to enable them to succeed in the program [18]. During the learning process, students are expected to have mastery in integrating diverse engineering skills such as computer skills, practical skills, and analytical mathematical skills. Apart from mastering these skills, students must learn complex derivations, perform analyses, demonstrate simulations and use problem-solving skills, effectively. However, it is highly challenging for fresh undergraduates to recognise the required strategy or skills in different learning situations. Therefore, students are expected to adopt different learning strategies, as they experience each specific learning event, in order to succeed.

2.2 Interest

Interest represents the affective domain of valuing, a dynamic feeling that can be inculcated or induced naturally. Interest is generated when an individual experiences one of these three situations: (i) increased knowledge (ii) positive emotions and, (iii) increased reference value [20]. For example, a lecturer who has the ability to deliver a good lecture and to interact with students in the class could engage students' attention and increase their interest in the topic. This is likely due to the positive feelings that are generated through the experiences. Students can also feel interested in learning topics if the course content meets their early expectations about the course. Interest can be observed through a student's attitude and behaviour such as paying attention, concentrating or making extensive efforts [21–23], but problems often arise with the observation when it is difficult to know whether such behaviours are associated with interest that are intrinsically generated (intrinsic interest) or some other motivational factors [24].

Research on interest has attracted attention among social psychologists, who have explored how it affects a person's psychological status and motivation to learn [23, 25]. These researchers have mainly focused their investigations on two different areas that are: (i) the impact of the learning environment on students' intrinsic interest and (ii) the impact of students' interest on learning activities and academic success. Recent evidence suggests that interest plays an important role in influencing self-regulation [26] and study performance [22, 27] which highlight its importance in promoting academic success.

2.3 Intention

Intention represents the conative domain of psychology. The conative domain is not a new domain, but the common understanding of this domain has been slow to emerge. There are several terms used to describe the conative attributes making it difficult to keep track of research in this area. Classical psychologists refer to conation as "the will" which refers to the spontaneity of movement and an element that mediates the link between feeling, action and desire [29]. Later, the conation concept is also used to explain a desire or an act of striving towards achieving goals set [30, 31]. However, the most frequent term used by psychology, education, medical, and social science scholars is intention [15, 30–32].

Conation is claimed as a crucial factor in engaging students in a learning process [12, 28]. Researchers in this area believe conation is the most important domain because it is the strength from within that differentiates the way students make sense of their learning experiences, including success and failure [11, 33]. Conation has been proposed as the most important factor to influence performance, to the extent that, it is the key controller of behaviour where effort, will and intention is placed, and a decision is made to perform a behaviour [34]. Students who possess cognitive ability, affective value and psychomotor skills act differently corresponding to their desire, will, effort, energy, commitment and self-determination [35]. Indeed, they act dissimilarly because of their conative differences. Based on the discussion, there appears to be some centralised agreement that conation refers to intention. Therefore, the term intention is used throughout this paper to refer to conation.

2.4 Theory of Reasoned Action Model: Conceptual framework

The Theory of Reasoned Action (TRA) model [15] was adapted to align the pathway from cognition, through affect (interest) and conation (intention) to performance as demonstrated in Fig. 1.

Researchers have proposed that the cognitive, affective and conative domains are part of "mind activities" that complement each other [9, 10, 15]. The TRA model provided a more detailed explanation about the relationships. The model suggests how beliefs impact behaviours via a cascade of steps. Beliefs can influence an individual's attitude and intention and, the combination of the three factors can influence a learner's behaviour. Integration of the cognitive, affective, and conative domains is predicted to generate greater intrinsic motivation. In the current study, motivation factors within the three domains were explored in a slightly different form as shown in Fig. 1. Learning strategy, interest and intention, are presented as causal factors that influence student performance.

It is believed that students react differently to achieve success. They may have different beliefs about important strategies to achieve better performance. For example, some students may believe that it is important to study in a group, while other students believe that it is enough to read any suggested notes given by the lecturer in class. These students will develop interests depending on learning outcomes, whether they experience increased knowledge, positive feelings or higher functional value. The interest level determines the levels of conative capacity or intention to learn. They may have a greater desire; thus they put more effort in learning. A combination of these learning activities is hypothesised to lead to better performance. Indeed, the stronger the beliefs and interest to learn, (it is assumed) the greater the determination to achieve success.

The TRA model was used in this study because the model is considered a basic guideline for the understanding of intrinsic factors in human behaviour. The outcomes of this study will facilitate the understanding of the linkages and provide a useful argument of whether the TRA applies in this case, or whether a new theory is required. Research work to date mainly focuses on the cognitive and affective domains of learning, and consequently there is little understanding on how the conative domain complements the other two domains in the learning process. In addition, there are limited works that examine the cognitive, affective, and conative factors together in a single study. Therefore, we have little information about the interconnection between the three factors, especially in an engineering learning context. The roles of the three learning factors are worth investigating as this may contribute to explaining the differences in students' success in engineering programs. Furthermore, although much research has been conducted on learning strategy and interest [12, 36–38], there is little research on intention and no research has been found where learning strategy, interest and intention are considered in a single study.

The main purpose of this study was to seek a better understanding of the relationships between the intrinsic factors of cognition, affection, conation, and study performance. The combination of cognitive, affective and conative domains is expected to determine the greater academic performance of engineering undergraduates. More specifically, the following research questions will be examined:

(i) What are the relationships between learning strategies, interest, intention and academic performance of engineering students in the Australian and Malaysian learning contexts?
(ii) To what extent does learning strategy, interest and intention directly or indirectly influence student performance in engineering?

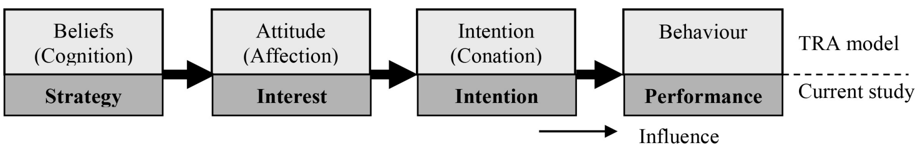

Fig. 1. Adapted framework based on the theory of reasoned action (TRA) model.

Academic performance was measured in this study, using cumulative grade point average (CGPA) for the Malaysian students and average marks for the Australian students. The findings from this study will inform researchers about the strength of relationships between the selected factors and the effects on student performance. It is important to note here that the current study is not a purely comparative study; rather the focus is to understand success factors of students in the engineering programs.

3. Methodology

The current study is classified as a non-experimental predictive study [39]. The predictor variables were learning strategy, interest and intention, and the outcome variable was academic performance. This study employed a quantitative approach of gathering information with the aim of achieving the objectives of this research. By using the selected approach, the results of this study could represent a larger population of students.

3.1 Participants

This study was conducted at two universities, Universiti Tun Hussein Onn Malaysia (UTHM) and the University of Melbourne (UoM), Australia. Accordingly, success factors of students at UTHM and UoM are expected to be different due to substantial differences in the culture, the focus of each university (technical university versus research focus university) and some aspects of the engineering programs (i.e., subjects taken, years of study), mode of program (single degree program versus double degree program), and performance indicators (cumulative grade point average versus marks average). Selecting students from the two learning contexts provided an opportunity to investigate learning differences between a Western and an Asian learning context.

This study was conducted among groups of 'completers' who managed to survive throughout the engineering program. Students from three programs: Civil and Environmental engineering, Electrical and Electronic engineering, and Mechanical and Manufacturing engineering programs were invited to participate in this study. A total of 267 participants consented to participate, consisting of 135 Malaysian and 132 Australian students.

The sample size was deemed adequate for performing most statistical analyses used in this study. For example, for a medium effect size of 0.30, a power of 0.80, and a significant value of 0.05, a range of 85 to 116 participants is necessary to perform the Pearson correlation analysis and the Multiple Regression analysis [40] while a size of 100 to 400 is recommended for performing a Structural Equation Modelling (SEM) analysis [41]. Based on the suggested sample size, the size used for this study was considered adequate to perform the aforementioned data analyses.

3.2 Instruments

The revised version of the learning orientation instrument (R-SPQ-2F) scale [42] was used to measure *learning strategy* and *interest.* The strategy and interest scales had five items each and participants were asked to answer on a Likert-type frequency scale, from 1 (never) to 5 (always). This study used a 66-item Learner Autonomy Profile-Short Form (LAP-SF) [30] to assess *intention*. The instrument measures four conative constructs: desire, resourcefulness, initiative and persistence. Participants indicated their responses on a 10-point scale, ranging from 1 (will never perform the behaviour) to 10 (will always perform the behaviour).

Reliability analysis was performed to measure internal consistency of the selected measures. In response to the pilot test, the strategy and interest constructs had reliability estimates of $\alpha = 0.77$ and $\alpha = 0.70$, respectively. The α values obtained were comparable with most reliability testings for the SPQ-2F instrument which were in the range of 0.6 to 0.7 [43]. A high internal consistency was also derived for the intention construct with an alpha value of 0.96. The reliability estimates obtained indicated that the values were within the accepted range therefore, the entire items were retained for both instruments.

The attributes that represent the three domains have not been clearly established in the literature where multiple conceptualisations of the cognitive, affective and conative functions have emerged. For example, interest has been classified as the conative attribute [44] but has also been described as the affective attribute in other research [22, 25, 45]. Furthermore, available instruments tend to mix the attributes in one measure making it difficult to clearly differentiate the learning attributes of the individual domains. Confirmatory Factor Analysis (CFA) was performed prior to conducting the SEM analysis to confirm clear distinctions between the selected domains.

3.3 Results

The relationships between learning strategy, interest and intention were established and their roles in predicting success were explored.

3.3.1 Relationship between variables

The Pearson product moment correlation method was used and the results are shown in Table 1. The interpretation of the strength of the relationship

Table 1. Correlation coefficient (r)

	Strategy		**Interest**		**Intention**	
	MY	**AU**	**MY**	**AU**	**MY**	**AU**
Strategy	1	1				
Interest	0.777**	0.697**	1	1		
Intention	0.547**	0.395**	0.591**	0.430**	1	1
Performance	0.270**	0.140	0.137	0.212**	0.157	0.252**

Significant value (*p*), ***p* < 0.01; **p* < 0.05.

among variables was calculated [40]. The findings indicate strong and positive correlations between Strategy and Interest (r_{MY} = 0.777; r_{AU} = 0.679), Strategy and Intention (r_{MY} = 0.547; r_{AU} = 0.395), and, Interest and Intention (r_{MY} = 0.591; r_{AU} = 0.430) for both country groups (all significant at *p* value less than 0.01).

Despite the high correlation found between strategy, interest and intention, the correlation findings between the three learning factors and performance revealed unexpected outcomes. Only strategy has a statistically significant correlation with performance (CGPA) for the Malaysian students while interest and intention have a statistically significant and positive correlation with performance (average marks) for the Australian students. In other words, Malaysian students with deep learning strategies achieve greater success, whereas Australian students who possess higher interest and conative commitment have greater success. These findings suggest that only certain learning domains appear to be important to students' success in each study location. These factors are different between the two countries as shown in Table 1.

3.3.2 Predicting success: Exploring the roles of strategy, interest and intention

The SEM method was used to analyse the data as it is an effective method to: (i) explain relationships between indicator items and the related construct; (ii) determine the goodness of fit between the hypothesized model and the sample data; and (iii) inform cause and effect relationship between the investigated variables [46–48]. The SEM analysis procedures involved two stages of model development [41]: (i) development and analysis of the measurement model using confirmatory factor analysis (CFA); and (ii) development and analysis of the structural equation model (SEM model). It is proposed that learning strategy, interest and, intention influence academic performance. The analysis was conducted separately on the Malaysian and Australian data because the performance measures were dissimilar. The SEM analysis is sensitive to sample size, normality and outliers [41]. Prior to the analysis, the data was checked for technical errors, and pre-analysis assumptions testing were performed to ensure that required assumptions were fulfilled.

During the analysis, any insignificant path was eliminated from the model, retaining only significant path in the modified structural model [48]. The goodness-of-fit values of the Malaysian model (see Fig. 2) were recorded as $\chi 2/df = 1.52$, GFI = 0.80, TLI = 0.93, CFI = 0.93 and RMSEA = 0.062. Despite achieving a good model fit, the path from Intention to CGPA was insignificant (β = –0.06, p > 0.05). The only direct path to performance was observed from Strategy (β = 0.25, p < 0.05), which supported the correlation analysis (Table 1). The other significant paths were established from Interest to Strategy (β = 0.98, p < 0.01) and from Intention to Interest (β = 0.71, p < 0.01). This finding suggests that the TRA model cannot be used to explain the study performance of the Malaysian participants.

The same procedure was used in modelling the Australian data. Elimination of insignificant paths in a sequential order (beginning from the lowest

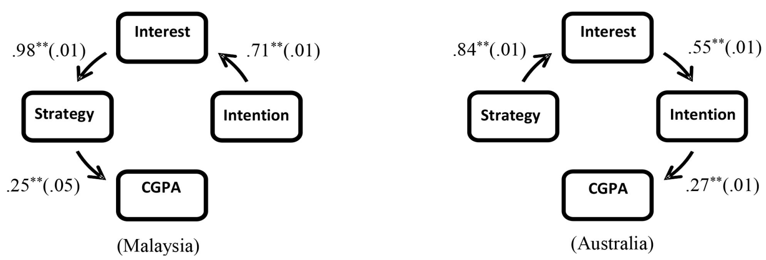

Fig. 2. Path analysis of the performance model for Malaysia and Australia Note: Numbers in the middle of two constructs represent standardised regression weights (β) and significant value (*p*), ***p* < 0.01, **p* < 0.05.

standard regression weight) had consequently yielded goodness-of-fit indices for the Australian model (Fig. 2). The outcome values were: $\chi 2/df = 1.49$, GFI = 0.82, TLI = 0.90, CFI = 0.92 and RMSEA = 0.061. The entire paths were statistically significant at $p < 0.01$. These paths reflected the impact of Strategy on Interest ($\beta = 0.84$, $p < 0.01$); Interest on Intention ($\beta = 0.55$, $p < 0.01$); and Intention on CGPA ($\beta = 0.27$, $p < 0.01$).

4. Discussion

It is common knowledge that cognition (i.e., knowledge, learning strategy) and affection (i.e., interest, enjoyment) are two important elements in student learning. Conation is suggested as another important element that should be possessed by higher education students to survive and thrive in a highly independent learning environment [14, 35]. The results of this study provide two important findings on the relationship between cognitive, affective and conative learning factors and the validity of the TRA model. Firstly, irrespective of study location, student intention was found to be highly correlated with learning strategy and interest. This finding provides evidence to the possibilities of integrating the conative learning factor with the cognitive and affective factors in engineering learning. These findings are consistent with previous research [14, 35]. It gives a sign that the ways students approach learning nowadays are not merely cognitively driven, but also conatively driven (i.e., students are striving towards desired goals, are resourceful in learning, have initiative to improve learning and persist towards achieving their goals [30]). Such a transformation is expected to become even more important with the growing practice of interactive teaching and learning activities across disciplines including engineering where social networking and e-learning are prevalent. In such a learning setting, a student needs to be an independent learner and should be able to decide his/her own learning direction.

Secondly, the findings of the SEM analysis provides interesting information to support the proposed relationships between the three elements [10, 15] and study performance. The findings indicated that the path as defined by the TRA model only applies to the engineering students in the Australian learning context. This finding is not surprising considering that the theoretical foundation used for this study departed from the Western perspective and it compared Asian (Eastern) with Western participants. The Australian model of success suggests that learning strategy did not affect intention, unless mediated by the effect of interest. Interest also mediates the relationship between intention and strategy for the Malaysian predictive model of success, although in the opposite direction.

While interest is suggested as important in influencing student success, the current study found an indirect relationship between interest and academic performance for both national groups. This result may be explained by the fact that mere interest without other successful characteristic behaviours (i.e., learning strategy or intention) would have little influence on student performance. In addition, interest is also a part of the affective domain attributes which are linked to external motivation factors [24]. The exclusion of the external motivation factors in this study may have caused the missing relationships. Furthermore, the use of other success measures (rather than average marks) may also have influenced the results.

The lack of support for the TRA model in the Malaysian context can be explained from the perspective of culture. In the Malaysian learning context, students' decision to study engineering is highly influenced by teachers, parents and friends [50]. Therefore, students may need to develop interest and more strategies throughout the learning process in order to continuously engage in the learning process and achieve success. Students' potential to achieve better academic performance can be enhanced by having a good learning strategy. The significant path from intention to learning strategy for the Malaysian model provides an explanation to a previous study [49] that interaction between conative and affective factors may cause changes to students' cognition in a scientific learning context. Students may establish a new or more effective learning strategy to achieve an intended learning outcome or learning goals. The findings of this study also provide evidence to support another study, which showed that students who learn science topics with great interest are likely to establish a meaningful understanding (deep learning strategy) [20].

The findings of this study have demonstrated that the TRA model [15] is less useful in the Asian learning context. These findings add value to the cross cultural literature to propose that researchers in Malaysia should be more cautious in applying any instruments or models developed based on Western paradigms. On top of the model outcomes, we should still respect differences in personal characteristics and the nature of the individual regardless of cultural context and learning environment.

5. Conclusion

The study sets out to determine predictors of success in engineering programs. The collected data supports the conclusion that learning strategy, interest and intention are closely correlated and the integration of the three factors plays a significant role in predicting engineering success. Based on the general findings, we learned that none of the three learning factors should be neglected in the effort to help students achieve success. One way to help Malaysian students achieve success is by making them aware of the need to establish strategies in learning. On the other hand, Australian students should be placed in a situation that encourages the development of intentions (i.e., desire, resourcefulness, initiative and persistence). This conclusion, thereby, highlights the importance of intention to integrate with strategy and interest in the engineering learning process, to ensure study success. Future papers will explore the model outcomes based on interviews conducted with the same participants, to enhance meaningful understanding of these findings.

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