A Path Analysis of Model of Performance for Malaysian and Australian Engineering Undergraduates

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Abstract: While most studies have focused on attrition issues, engineering educators still have a lack of understanding of factors that can contribute to students' success in engineering. The main purpose of this research has been to quantitatively examine the relationships between strategy, interest, intention and academic performance within the Theory of Reasoned Action (TRA). Participants were 135 Malaysian and 132 Australian engineering undergraduates who completed the Study Process Questionnaire (R-SPQ-2F) scale and Learner Autonomy Profile (LAP-SF) scale. The correlation coefficient analysis shows strong interrelationships between learning strategy, interest and intention. However findings of structural equation modelling (SEM) analysis revealed unexpected but interesting findings. Two different path models were established for the Malaysian and Australian data with suggesting that intention is influenced by strategy only via the establishment of interest, which is consistence with the theory used.

Keywords: learning strategy, interest, intention, academic performance, success

1. Introduction

Over the past years, there has been a dramatic increase in the researches on attrition and retention problem in engineering especially in Australia thus reflects the concerns of the engineering society of the problem (Engineers Australia, 2012; Godfrey, Aubrey, & King, 2010; Kaspura, 2011; King, 2008; Lloyd, 2008). Godfrey (2010) highlighted several concerns around the issue such as:

- Attrition rates found to be higher in engineering than in other science disciplines (e.g: medicine and veterinary science), but lower than art-stream courses.
- There is a reduce numbers of migration into than out of engineering from other degrees
- There is higher attrition rate among local than international students.
- On average, attrition and failure rates are higher for male students than for female students (male are dominant in the course which is about 15% higher than female)
- The retention rate is about 85% per year, which has led to 52% active enrolment or eligible to graduate after four years.

The utmost concern is that the higher dropout rate from engineering has caused a slow increment in the numbers of engineers produced by local universities each year (Kaspura, 2011; Lloyd, 2008) which could also impact on the critical national shortage of engineers in Australia. (Engineers Australia, 2012)

Interestingly, while the attrition issue is of concern in Australia, it is less discussed among Malaysian researchers. This does not mean that the attrition problem does not occur in Malaysia. The problem is less concerned because Malaysia has recorded an increase in almost 50% of the total engineering workers (in Civil, Electrical and Mechanical only) in every five years. By 2010, local work force in engineering grew from 26 158 in 2000 to 100 957 in 2010, an increase of about 386% in ten years.

There is an evidence that Australian students who chose to enrol in engineering because of personal interest are more likely to persist in the course (Godfrey et al., 2010). While interest is believed as important to ensure retention (Besterfield-Sacre, Atman, & J.Shuman, 1997; Godfrey et al., 2010), the Malaysian scenario seems to be appealing. Alias & Abu Bakar (2010) study has showed an evidence that the Malaysian students are not only driven by "pure intrinsic motivation" such as interest. They have also chosen engineering because of job guaranty, teacher's suggestion and parents' desire.

Students enter university with a set of background characteristic that shaped their beliefs, values, ethics and behaviour. Students from different culture are also varying in their approaches to learning (Kember, 2000). Thus, it is important to conduct a cross-cultural study to better understand how the cultural phenomena affect different attributes and learning behaviour of students. It is hypothesised that there are differences in the driven factors that lead to students' success in both locations.

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2. Literature Review

The current study explores the way engineering undergraduates approaches learning and how its influence on their success. The differences in learning approaches will be discussed throughout this study by three separate but related learning domains namely cognitive, affective and conative. It is assumed that students may have different beliefs about learning, hence different learning strategies. They may have different attitudes, which impact on interest. They may have different levels of conative capacity, which impacts on intention to learn.

2.1 Learning Strategy

There are research evidences suggesting that students' used different learning strategies to achieve success (Cano and Cardelle-Elawar, 2008; Duff, 2004; Duff, Boyle, Dunleavy, and Ferguson, 2004; French, Immekus, and Oakes, 2005; Zhang and Watkins, 2011; Zwanenberg and Wilkinson, 2000). Strategy in general refers to a plan of action designed to achieve a goal ("Oxford University Press," 2012). It can be established as a result of cognitive process activities and interaction with learning environment. In a learning context, learning strategy implies actions made by learner "to make learning easier, faster, more enjoyable, more self-directed, more effective and more transferrable to new situations." (Oxford, 1990, p.8).

The close connection between learning strategy established by students and the learning objectives set in class seems to suggest that students tend to established different learning strategies that can be matched with in class activities and learning goals. Evidences found in previous research which implies that students used different learning strategy in different subjects but they tend to use a particular learning strategy that they found "work well" to achieve their learning goal (Diseth and Martinsen, 2003). It is also expected that the way the assessment criteria is structured also be part of the reasons to the various learning strategy used by students. Additionally, the diverse in learning strategy among students may also depend on the ways lecturers facilitate learning in class.

A review of the literature on learning strategy suggests that it is a critical learning element which should be possessed by higher-education students (Boulton-Lewis, 2004). Yet, what we know about strategy is mainly based upon empirical studies that investigate how the factor can predict interest (U Schiefele, 1991) and academic performance (Cano and Cardelle-Elawar, 2008; French *et al.*, 2005; Zhang and Watkins, 2011). Even so, there is a dearth studies that relate learning strategy with study success in higher-education studies with more studies in this area were focused on cognitive processing strategy or learning orientation (Biggs, 1987; Cukras, 2006; Duff and Mckinstry, 2007; Entwistle and Ramsden, 1982; Schiefele, 1991). The reason is because in most of the research, such learning strategies were proven to have the most significant effect with study performance (Biggs, 1987; Drew and Watkins, 1998; Entwistle and Ramsden, 1982; Zeegers, 2001). However, the lack of consistency in the findings highlights the need for a more in-depth study on this area.

2.2 Interest

Interest is one of the affective attributes that has become the focus in this research. Research on interest has also attracted attention from other social psychologists who have explored how it affects a person's psychological status and motivation to learn (Deci, 1992; Dewey, 1913; Hidi and Renninger, 2006). Interest also plays an important role in influencing students behaviour and study performance (Dewey, 1913; Harackiewicz *et al.*, 1997; Harackiewicz, Barron, Tauer, and Elliot, 2002; Lent *et al.*, 2008;Ulrich Schiefele, Krapp, and Winteler, 1992). These researchers have mainly focused their investigation on two different areas that are: (i) the impact of learning environment to students' intrinsic interest and (ii) the impact of students' interest in learning activities and academic success.

As mentioned before, interest is a critical aspect that can influence on individual's psychology and learning performance. Several available literatures suggested that interest plays important roles in influencing i) cognitive strategy (Wolters & Pintrich, 1998) ii) self-regulation (Zimmerman, 2002) iii) conceptual change (Andre & Windschitl, 2008; Kang, Scharmann, Kang, & Noh, 2010) and, iv) performance (Harackiewicz et al., 2002; Kupermintz, 2002). The cognitive strategy, self-regulation and conceptual change are three vital elements that important to engage students in class activities (Cano and Cardelle-Elawar, 2008; Sinatra and Paul R. Pintrich, 2008; Wolters and Pintrich, 1998). As a result, with the engagement can eventually link interest to effort and commitment. Therefore, it is not surprising if students who possess deep interest in learning are likely to persist longer, understand better and score higher than students who approach learning without interest. Furthermore, it is not impossible to say that interest also plays a crucial role in the context of engineering learning because the complexity of engineering studies requires a dedicated, determined and internally motivated student to succeed in the course.

Brainard and Carlin's (1997) research found that a student, who has a high interest to pursue engineering decided to drop out after several years due to loss of interest, low self-confidence and failure to adapt to the new system (university). Therefore, there is an urge need for lecturers to help students maintaining their interest. Realising the importance of understanding students' interest towards science learning, (Renninger, 2007) explicitly discussed the role of interest in informal science learning. Since learning practices between science and engineering are very similar, the explanations may provide researchers a clearer insight into the connection between interest and learning outcomes in an engineering context.

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2.3 Intention

Intention is an attribute of conation. Conation is such a strength from within that differentiates the way a person making sense of the success and failure. Conation is not a new concept but a common understanding of the conation has been slowly emerged because variety concepts have been used to reflect the conation domain functions. Classical psychologists referred conation as "the will" (e.g.: Bain, 1875), which refers to the spontaneity of movement and an element that medium the link between feeling and action; and desire (Bain, 1975). In the current century the conation concept is also applied to an effort to change (Bertrand Russell, 2008) or a striving in achieving the goal sets (Gerdes & Stromwall, 2008). Although differences of opinion still exist, there appears to be some agreement that conation refers to "intention", which is the most commonly and recent term that used among psychology, education, medical, social and human science scholars.

Intention is also predicted to play a crucial role in engaging students in learning process but the lack of conation research has led to unfirm conclusion since there is no strong evidence to support such claims. Intention is the starting point of all to which students must possess a desire or will to learn before generates their effort and energy to commit with learning process (Riggs & Gholar, 2009). Intention in the current study involves four conative aspects of learning behaviour namely desire, resourcefulness, initiative and persistence which have been discussed by Confessore and Park (2004). The factors were found to be significantly correlated with students' performance in higher education study (Lowe, 2009). Although many researchers have expected that intention is the most crucial factor to ensure study success, only a limited amount of research has been carried out to prove the claim.

2.4 Conceptual Framework of the Study

Based on the literature studies, a framework of study is developed based on the gaps identified which aims to enhance deeper understanding of factors that influencing on students' success in engineering. The theory of Reasoned Action (TRA) behaviour is used as guideline to link the direction of the path between the variables (as illustrates in Fig.1). The theory is widely used in social psychology research. The theory proposed causative relationship between beliefs, attitude and intention to represent cognitive, affective and conative as predictors of behaviour. In the model, beliefs represents cognitive domain, a knowledge based domain that also connected with opinion and thought; attitude represents affective, a domain that involves feelings towards a situation, issue, event or object; and intention represents conative, a domain that relates to behavioural intention and an action to perform behaviour (Fishbein, 1975).

It is assumed that, students may have different beliefs about learning, hence different learning strategies. For example some students believe that it is important to understand the fundamentals of the related topic prior to completing the assignment, while other students believe that it is enough to read any suggested notes given by the lecturer in class. Both of these students will develop different learning strategies based on their beliefs. They may have different attitudes, which impact on learning interests. For example, some students feel that the topic is more interesting once they understand the concept (interest), while other students feel disappointed when facing difficulties in conceptualising the topic. These situations in turn can influence both learning strategies (Ferla, Valcke, & Schuyten, 2008; Niles, 1995; Vermunt & Vermetten, 2004) and intention to learn. Students will establish a new or more effective learning strategy or begin to develop an action plan as to how the learning goal can be accomplished.

And, they may have different levels of conative capacity, which impacts on intention to learn. Different persons react differently based on their degree of beliefs, motivation and desire to accomplish the learning goals. For example, if students find it is difficult to complete the assignment, some of them will use initiative to try several other alternatives (e.g.; seeking help from tutors) until the assignment is adequately answered. Some students will choose not to do anything until they get the answers from friends. It is easy to see how beliefs impact on learning behaviours via a cascade of steps. Indeed, the stronger the beliefs and motivation to learn, (presumably) the greater the determination to realise the learning goals. Literature studies shows that the interrelationship between learning strategy, interest and intention and academic performance had not been thoroughly investigated. A preliminary study is needed to investigate the interplay role of the three variables in determining students' success in engineering.

The academic performance is measured by Cumulative Grade Point Average (CGPA) for the Malaysian or average marks for the Australian. The TRA can be used to predict performance of any independent act, provided that the intention must not be changed prior to performing behaviour and the intention measure must not in relation with the performance measures (Fishbein, 1975; Fishbein, 1980).

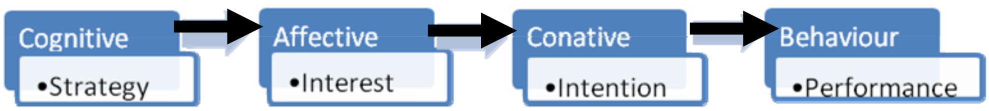

Fig. 1: Adapted model from Fishbein and Ajzen's (1975) Theory of Reasoned Action model of behaviour.

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3. Methodology

3.1 Research Participants

Questionnaires were collected from 132 final year undergraduate students at the University of Melbourne, Australia and 135 final year undergraduate students at the Universiti Tun Hussein Onn Malaysia. The participants were enrolled in Mechanical, Electrical or Civil engineering programs at both universities. The participants are assumed to be successful in the engineering study since they have already completed 80% of the course. The same participants were invited to share their learning experiences throughout the course through interview.

The sample size used in the current study meets Hair (2010) and Kline (2005) recommendation value to perform Structural Equation Modelling (SEM) analysis, which can be ranged from 100 to 400 samples. Based on the suggested values, the sample size used in this study is relatively small but sufficient to perform the SEM analysis.

3.2 Instruments

Two different instruments were used in the current study. S*trategy* and *interest* were measured using the latest version of the learning orientation instrument (R-SPQ-2F) scale (Biggs, Kember and Leung, 2001) while *intention* was measured using a short form version of the Learner Autonomy Profile (LAP-SF) scale (Confessore & Park, 2004). The R-SPQ-2F scale was an adaptation of the initial learning orientation instrument which was based on Biggs' proposal (Biggs, 1987) on how people approach learning. According to Biggs (1987) there are three ways a student may choose to approach their course namely, a surface approach, deep approach or the achieving (strategic) approach. In the latest version of the R-SPQ-2F, only the surface approach and the deep approach items were maintained while the achieving approach items were removed. With the purpose of measuring the internal driving factors that influence students' learning intention, only the deep strategic and deep interest scales were used to measure both learning factors in this study while the surface approach items were excluded as they are usually linked to an external driving factor (Biggs, Kember and Leung, 2001 ; Fowler, 2003) such as goal achievement.

The deep strategic and deep interest scales have five items each with reliability estimates of α = .77 and α = .70 respectively based on the Cronbach Alpha method. A high internal consistency was also derived for the intention scale with Cronbach alpha of 0.96. None of the instruments indicate measures of alpha Cronbach values below than 0.7; therefore, the entire items were retained in the instruments. Participants were ask to answer on a Likert-type frequency scale, from 1 (never) to 5 (always).

4. Results

Results of the Pearson correlation coefficient analyses are shown in Table 1. The interpretation of the strength of the relationship among variables is made with reference to Cohen (1988) and Cohen, Cohen, West, & Aiken, (2003). Despite of high correlation found among strategy, interest and intention, correlation coefficient findings between the three learning factors and academic performance revealed unexpected findings. Only strategy has statistically significant correlation with academic performance (CGPA) for Malaysian samples while interest and intention have a statistically significant and positive correlation with academic performance (average marks) of Australian samples. The results are summarised in Table 1.

Table 1 Correlation coefficient analysis of variables

	Strategy		Interest		Intention		CGPA	
	MY	AU	*MY*	*AU*	*MY*	*AU*	*MY*	*AU*
Strategy	1	1						
Interest	$.777^{**}$	$.697^{**}$	1	1				
Intention	$.547^{**}$	$.395^{**}$	$.591^{**}$	$.430^{**}$	1	1		
CGPA	$.270^{**}$	.140	.137	$.212^{**}$	.157	$.252^{**}$	1	1

The Malaysian Model of Performance

The hypothesised structural (comprehensive) model of performance for Malaysian data was evaluated using the SEM analysis. Consideration of parameter modifications was made based on recommended value for better fit model in the modification indices (MI). Testing of the structural model of performance revealed that the solution is not admissible. Elimination of the insignificant path between Interest and CGPA (the lowest regression weight value) eventually has solving the problem. The goodness-of-fit values were recorded as Chi-square per degree of freedom (χ^2/df)=1.52, GFI=.80, TLI=.93, CFI=.93 and RMSEA=.062. Despite of achieving a good model fit, the path from Intention to CGPA was insignificant (β=-.06, p>.05). Meanwhile, the only direct path to performance has been observed from Strategy (β=.29, p<.05). This finding reflects that the TRA model cannot be used to explain performance of the Malaysian participants.

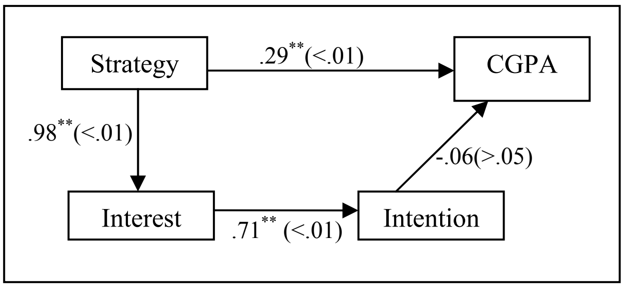

Fig.2: Path analysis of the TRA model based on Malaysian data.

Note: Numbers in the middle of two constructs and between construct and indicator item represent standardised regression weights (β) and significant value (*p*), ***p*<.01;**p*<.05.

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The Australian Model of Performance

The same procedure was used in estimating model of performance for the Australians. Elimination of the insignificant paths in a sequence order (begin from the lowest standard regression weight) has consequently yielded a better model fit. The goodness-of-fit indices for the Australian model of performance (see Fig.3) was $\chi 2/df$ = 1.49, GFI= .82, TLI= .90, CFI=.92 and RMSEA=.061. The entire paths were statistically significant at *p* value less than .01. These paths reflected the impact of Strategy on Interest (β =.84, p<.01); Interest on Intention (β =.55, p<.01); and Intention on CGPA (β =.27, p<.01).

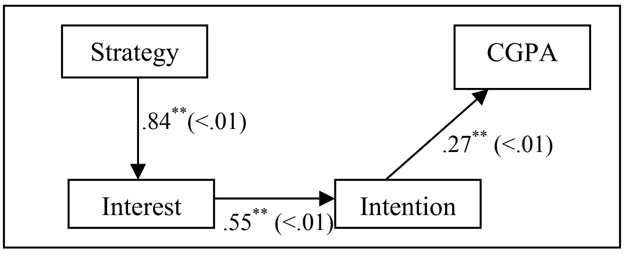

Fig.3: Path analysis of the TRA model based on Australian data.

Note: Numbers in the middle of two constructs and between construct and indicator item represent standardised regression weights (β) and significant value (*p*), ***p*<.01;**p*<.05.

5. Discussion

Findings of the quantitative study offer new insight into the effects of learning strategy, interest and intention on academic performance of engineering undergraduates in Malaysia and Australia. Results of the correlation coefficient analysis demonstrate high correlations between Strategy, Interest and Intention for both, the Malaysian and Australian data, thereby highlighting the importance of intention to integrate with strategy and interest in the engineering learning process. These findings were consistent with Riggs and Gholar's (2009) point of view that the cognitive (represented by learning strategy), affective (represented by interest) and conative (represented by intention) domains are closely interconnected and interdependent. The strong correlations between the three elements are also consistent with the relationship that suggested by Bain in (1875), which further explained as the Trilogy of Mind concept by Hilgard (1980).

Findings of the Structural Equation Model (SEM) analysis revealed several interesting findings. The evaluation of the model of performance for Malaysian and Australian samples eventually produced two best-fit models of performance for the Malaysian and Australian samples. The path analysis findings provide another interesting finding which revealed that the causative combination of strategy, interest and intention can predict study success only for the Australian learning context. In other words, it can be said that the paths as guided by the Fishbein's (1975) TRA model was only explains model of performance for the Australians but not for the Malaysians.

Clearly, this finding provides some empirical validation of the TRA model (Fishbein and Ajzen, 1975) which suggests that the cognitive factors (represented by beliefs) not directly influence the conative capacity (represented by intention), unless mediated by the affective attribute (represented by attitude). Specifically, in this study, meaningful understanding strategy did not affect intentional behaviour, unless mediated by the effect of interest.

While interest is increasingly seen to be important in an individual success in study (Dewey, 1913; Harackiewicz *et al.*, 2002; Hidi and Renninger, 2006; Kang, Scharmann, Kang, and Noh, 2010; Renninger, 2007), the current study found no significant relationship between interest and academic performance for both national groups. The small numbers of items used to measure the interest factors may not extensively explains factors that are related to interest about learning engineering topics. In addition, interest is also a part of the affective domain attributes which is always linked to external motivation factors (Riggs and Gholar, 2009). With not including the external motivation factors in this study, may cause the missing relationship between the interest measures and study success of the students.

6. Summary

Based on the general findings, we learn that one way to help Malaysian students achieve success is by making them aware of the needs to have a deep and meaningful understanding on engineering topics that they learn. On the other hand, the Australian students should be placed in a situation that encourages development of the four intention attributes namely desire, resourcefulness, initiative and persistence. The most important implication to emerge from the entire analyses is that none of the three learning factors should be neglected in the effort to help students to achieve success. Indeed, integration of the factors could play an important role in developing students' personal qualities and attributes that help strengthen their effort, confidence, commitment and potential to succeed in engineering study. This claim is supported by the strong correlation between the strategy, interest and intention.

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