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Learning Strategies as an Enabler of Study Success

Paimin, A. N.[1]*, Hadgraft, R. G.[2], Prpic, J. K.[3] and Alias, M.[1]

[1]*Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia*

[2]*Faculty of Engineering and Information Technology, University of Technology Sydney New South Wales, Australia, 2007*

[3]*Engineering Learning Unit, The University of Melbourne Parkville, Australia, 3010*

ABSTRACT

Engineering students enrol in engineering without a clear understanding of how they can achieve success in the field. The current study explores study strategies of engineering undergraduates across two geographical locations, Malaysia and Australia. Qualitative data were collected using semi-structured interviews, in which 16 final-year engineering undergraduates volunteered to participate. Data were analysed using a thematic coding approach and the NVivo software was used to assist with the coding process. The results suggested that engineering students at universities in both locations used very similar learning strategies to achieve different success outcomes such as to fulfil assessment criteria, to achieve a personal goal or success, to endure with challenges, to overcome challenges, to survive after failure and to keep persisting in the programme. Integrating knowledge, visualising engineering applications, optimising the use of learning materials and mastering engineering skills are examples of strategies that were frequently used by the students. The level of importance of each strategy is context dependent.

Keywords: Engineering students, learning strategy, study success

INTRODUCTION

Among the cognitive functioning in learning i.e. thinking, learning styles and learning strategies, the one that will be given attention in this study is learning styles or learning strategy. Strategy in general refers to a plan of action designed to achieve a long-term goal or overall aim ("Strategy", 2010). In a learning context, learning strategy implies

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E-mail addresses:
nazura@uthm.edu.my (Paimin, A. N.),
roger.hadgraft@uts.edu.au (Hadgraft,R. G.),
kaya.prpic@unimelb.edu.au (Prpic, J. K.),
maizam@uthm.edu.my (Alias, M.)
* Corresponding author

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actions made by the learner "to make learning easier, faster, more enjoyable, more self-directed, more effective, and more transferable to new situations" (Oxford, 2001, p. 167).

Why do engineering students need to establish a study strategy? Weinstein, Acee and Jung (2007) highlighted that students should possess three important elements of strategy namely, study skills, will and self-regulation to become effective learners. Other researchers have also actively discussed the role of strategies in learning. This includes the use of strategy in problem solving (Mayer,1998), control and regulation of learning (Pintrich, 1999), determination of the direction of learning and organisation of learning activities (Weinstein et al., 2007), engagement and motivation (Khamisah, Mohd Firdaus, Nik Rusdi, & Ruhizan, 2007) and study performance (Duff, 2004; Yip, 2009). The focus of this investigation into strategy is consistent with the positive view of these researchers that students used diverse strategies for learning and this helps improve learning performance. In engineering, there is evidence that learning activities that involve students' active participation, such as problem-based learning (PBL), constructivist learning and blended learning can help enhance effective learning compared with traditional ways of learning (King, 2008; Litzinger, Lattuca, Hadgraft, & Newstetter, 2011).

Learning Strategy

Boulton-Lewis, Marton, Lewis and Wilss (2004) introduced three levels of learning strategy: focusing-rehearsal strategy, organisation-memory strategy and elaboration-monitoring strategy. Focusing-rehearsal strategy involves learners' interaction with information-gathering activities, such as viewing pictures and skimming through text. This action is followed by the reading and writing process. Organisation-memory strategy explains the way learners arrange and construct information, followed by an affirmative plan to remember the information. Elaboration-monitoring strategy involves an in-depth interaction with information, followed by additional learning activities to relate, discuss, synthesise and analyse. These strategies can be linked to Blooms' classification (1956) of cognitive development taxonomies.

Previous research implied that learning strategy is context dependent (Litzinger et al., 2011). The diversity in the strategies used can depend on the ways the learning system is structured, including the learning activity, the assessment criteria, the curriculum and the learning environment. In certain institutions, the environment is not properly structured to support meaningful learning (Cano & Cardelle-Elawar, 2008). For example, students may have limited access to learning facilities. Therefore, students feel that it is hard to actively participate in learning. On the other hand, a positive learning environment, such as is created when teachers supply motivational words, can encourage active participation in learning in a way that students may establish strategies to cope with the learning

situation (Lashari, Alias, Akasah, & Kesot, 2013). According to Schmeck and Geisler-Brenstein (1989), students will not only establish a strategy for learning, they will also modify their strategy to match the learning instruction and situation to enable them to actively take part in the learning process. Schmeck and Geisler-Brenstein (1989) suggested that students should be aware of their preferred teaching and learning style so that they can consider a better strategy that better matches their learning style.

There is considerable agreement that learning strategy is often established towards achieving good grades or maintaining performance. There is empirical evidence for a relationship between learning strategy and study performance (Ferla, Valcke, & Schuyten, 2008; Paimin, Hadgraft, Prpic, & Alias, 2011; Yip, 2009). For example, Yip's (2009) study suggested that learning strategy affects the study performance of Chinese university students, with will and self-regulation contributing to high academic success more than skill. The study provided strong support for the importance of learning strategy as one of the success factors in higher education study. In engineering, a study conducted among first-year Hong Kong university students reported a high use of memorising and achievement strategies. However, none of these strategies correlated significantly with the academic performance of the students. The selection of first-year students as a study sample is most likely inappropriate, given that the students are still in the transition phase from a high-school learning environment to the university setting. They may require at least three years to develop a consistent learning strategy (Niles, 1995). Research shows that students tend to use a particular learning strategy that they have found to 'work well' to achieve their desired goal (Baeten, Kyndt, Struyven, & Dochy, 2010).

A review of the literature on learning strategy suggests that it is a critical learning element, one that should be possessed by higher education students (Boulton-Lewis et al., 2004; Cano & Cardelle-Elawar, 2008). Yet, what we know about strategy is mainly based upon empirical studies that investigate relationships between study strategies with other factors such as interest and performance. Studies that are available in this area have been conducted among Business and Arts students (Duff, 2004). There is a dearth of studies that explore learning strategy used among higher education students, particularly in engineering education. Therefore, we still lack information on the types of learning strategy that are beneficial for engineering students to be successful in their courses. The ubiquitous development of information technologies, which has been largely applied in the context of engineering learning, has opened up challenges for students to become independent learners since they have access to information worldwide.

There is evidence suggesting the importance of first-year undergraduate engineering students establishing their own learning strategy to enable them to survive in the courses (Zeegers, 2001). It is

expected that one of the major challenges for engineering students would be to recognise the required strategy or skills when they enter university, and this could be the reason for the consistently higher percentage of attrition from engineering in the first year of study (Godfrey, Aubrey, & King, 2010). The first-year stage is crucial for students as they are exposed to a new university system and faced with expectations that are different from those they had in high school. During the learning process, students are expected to have mastery over the integration of engineering skills such as computer skills, hands-on skills and being good at mathematics. Also, students must be able to learn complex derivation, perform analyses, demonstrate simulation and use problem solving effectively. Due to the learning complexities, students are expected to adopt different learning strategies as they are experience learning. This highlights the importance of focussing this study on final-year engineering undergraduates in order to identify learning strategies that are vital in the context of engineering education.

The limited research among engineering students in this area and the lack of consistency in the findings of studies on learning strategies highlighted the need for a study to be conducted among engineering students. This study was embarked on to identify learning strategies used by engineering students in their effort to persist and succeed in engineering programmes.

METHODOLOGY

This study was conducted at Universiti Tun Hussein Onn Malaysia (UTHM) and the University of Melbourne, Australia. Invitations through email and distribution of flyers in the final-year engineering classes were some of the strategies used to obtain participants for this study. Sixteen participants (eight participants from each institution) volunteered to share their success story. The participants included seven males and nine females; all scored at least a second class lower (12.5% of the total respondents) in their graduation achievement (second class lower at UTHM is almost equivalent to level H2B Honours at the University of Melbourne). A one-to-one interview session was arranged, in which students were required to answer a set of semi-structured interview questions. The participants were asked about strategies they used in striving towards achieving success in studying.

Data presented in this paper were part of the mixed method design research, where quantitative and qualitative data (from a questionnaire and interviews) were simultaneously collected to understand factors influencing learning success in engineering. Only the qualitative data are presented in this paper. Two activities were designed during the interview to encourage participants to stay engaged with the session. The first activity required the participants to plot their level of academic achievement

throughout the years of study and share learning strategies used to maintain their results or ensure better performance. The second activity required the participants to rank several key words about strategy in a colour-coded zoning card (labelled from most important to less important). The key words were selected based on information on study strategies obtained from the literature. The participants were encouraged to add any other strategies that were not in the list. The activities appeared to be highly effective in facilitating the interview, and students could recall up to five years of their success stories. As hoped, the participants were actively engaged with the activity and expressed their feelings naturally and openly on the topics of selection. The interview data were analysed using a thematic coding approach. Data were coded into several themes using the NVivo software.

RESULTS AND DISCUSSION

The designed activities for the data collection uncovered nine learning strategies to get meaningful understanding of topics i.e. visualising engineering applications, maximising the use of learning materials (e.g. online learning resources, lecture notes), understanding basic engineering concepts, mastering engineering skills (e.g. computer skills, hands-on skills), asking an expert (e.g. lecturer/technician), studying with friends, focussing on tests and exams, selecting important topics to learn and managing study time (see Figure 1).

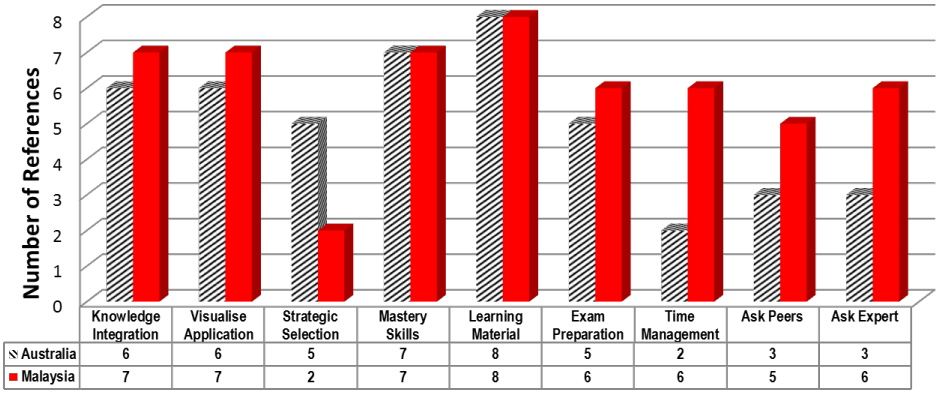

Figure 1. Categories of learning strategies of the engineering students

The four most common strategies highlighted by the participants were mastery of engineering skills, maximising the use of learning materials, visualising application and meaningful understanding of topics (knowledge integration). These strategies were established for various reasons such as to achieve a personal goal or success, to fulfil assessment criteria (to pass tests or to complete assignments), to endure challenges (e.g. falling sick), to overcome challenges (e.g. having no interest in the subject), to

survive after failure and to keep persisting in the programme.

The learning strategies used by the participants are similar to the strategies proposed by Weinstein, Jung and Acee (2010), except for 'mastery of engineering skills' and 'ask/study with peers'. Mastering engineering skills and knowledge is crucial in engineering as undergraduate students are expected to develop several attributes and professional competencies in engineering. An example of this response, a comment made by a Malaysian participant, is as follows:

> For example like Excel. It is notably important, especially for reporting (computer skills). We need to perform analysis, if we do not have that skill we need to learn from others (ask peers)... to have such computer skills makes every single task become a lot easier.

As the engineering students looked forward to preparing themselves to be professional engineers, mastering key competency skills (e.g. communication skills, computer skills, teamwork skills) were deemed vital for ensuring that they could meet the criteria required by industry. Some students acknowledged the importance of doing practical training in industry in order to expose themselves to a 'real' engineering setting. The students reflected that they gained useful knowledge and skills and, at the same time, developed greater confidence in dealing with engineering topics.

The participants also mentioned that they created several activities with friends (ask/study with peers) for knowledge sharing, brainstorming and arguing, discussing concepts, summarising topics, sharing workload and problem solving. The students also found that studying with friends made learning easier than when studying alone as they could get instant answers and feedback and, consequently, achieve better performance. Some examples of ccomments made by the Australian participants are as follows:

> Each person makes a summary for each particular topic. The summary is like key points that are critical and must be remembered. Everyone will be like...for example, explain about the process that is involved. If any of us knows more about the topics, she will teach others.

> ...from second, third, fourth and now this year is the fifth year, we always study and do our exam papers together. We do everything. It is the biggest difference. Without it, we will be getting at least 20% less in our GPA. It is the single most incredible thing.

The participants exhibited a common understanding of the importance of having a good grasp of engineering concepts to enable better understanding of related engineering subjects and practical work. Some of the participants acknowledged that they managed to develop understanding about engineering topics when relating the topics with a real-world example of engineering. According to the participants, having sufficient learning resources and the chance to do practical work in a "real"

or "virtual" laboratory setting with access to real equipment can facilitate effective learning and understanding about topics. In certain situations where the facilities or learning resources were limited or not available, they had to develop a new strategy to ensure continuous learning.

It was noteworthy that the engineering students had applied multiple strategies that they believed were useful to contributing to their study success. Detailed observation of the interviews revealed that there was also a tendency to use similar strategies throughout their studies. This tendency could be generated based on their experiences and evaluation of the effectiveness of the strategies in achieving success. These findings support Cano and Cardelle-Elawar's study (2008), which showed that university students who possessed certain study strategies (e.g. gain a meaningful understanding of the topic learnt) performed well in their studies.

Reflection made by the participants also demonstrated that they developed several strategies to fulfil the assessment criteria. In engineering, teaching and learning activities encourage group work activities and students are expected to have some practical experience by the end of their engineering studies. The participants expressed that the heavy workload required them to establish strategies such as organising tasks, distributing the workload among team members and managing time effectively. This finding was consistent with Gow and Kember's study (1990), which demonstrated that students limited their reading and study time because of the overwhelming curriculum. Since overload of curriculum has been listed as among the contributing factors of attrition in technical programmes including engineering (Seymour, 1995), it is necessary to enlighten the students about the strategies that can be used for more effective learning.

Even though participants from both groups demonstrated the need to master engineering related knowledge and skills, they aimed to attain different skills. It was observed that the Malaysian participants, particularly the males, had the tendency to focus on mastery of hands-on skills, such as operating machines, software applications and site-work experience, while the Australians tended to focus on developing communication skills and teamwork skills. This variation may reflect the differences in the professional development criteria between the two countries.

In long-term practice, appropriate selection of learning strategies is said to generate students who are independent in learning (Zimmerman & Martinez-Pons, 1988). University students should become independent learners. They should have the ability to make their own decisions in determining the appropriateness of topics to learn, know how to select learning materials and implement study techniques that best match their preferred learning style and desired goal.

CONCLUSION

This study provided useful information on learning strategies as an enabler of study

success in engineering education. The findings revealed that learning strategies used by engineering students in the two learning contexts were similar. However, a small sample size was used for the current research, thus, the findings might reflect learning strategies used by engineering students at the two institutions only. There was also supportive evidence demonstrating the difference in intention of using the strategies by the Malaysian and Australian participants; however, this is not within the focus of this study. Much more research needs to be done to prove this assumption.

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