© Universiti Tun Hussein Onn Malaysia Publisher's Office

JTET

http://penerbit.uthm.edu.my/ojs/index.php/jtet
ISSN 2229-8932 e-ISSN 2600-7932

Journal of Technical Education and Training

Prediction of Academic Performance Based on Learning Orientation: A Mixed Method Study in Malaysia and Australia

Aini Nazura Paimin[1*], J. Kaya Prpic[2], Roger G. Hadgraft[3], Fatin Najwa Mohd Nusa[4]

[1]Faculty of Technical and Vocational Education,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

[2]The University of Melbourne,
Victoria, 3010, AUSTRALIA

[3]University of Technology Sydney,
New South Wales, 2007, AUSTRALIA

[4]Malaysia Institute of Transport (MITRANS),
Universiti Teknologi MARA (UiTM), Shah Alam, Selangor, 40450, MALAYSIA

*Corresponding Author

DOI: https://doi.org/10.30880/jtet.2023.15.01.025
Received 3 February 2023; Accepted 17 March 2023; Available online 31 March 2023

Abstract: The issue of high dropout rates in higher education, including in engineering, has led to some researchers focusing their research on understanding the relationship between students' learning approaches and academic performance The current study adds to the current literature in this area to deepen our understanding of the role of learning orientation in the study success of engineering students. While technology-based learning approaches are becoming more popular, students nowadays are expected to be more independent and autonomous in learning. This study applied a concurrent mixed method design to get the breadth and in-depth information about learning strategies involved in the learning processes of engineering students. A revised version of the R-SPQ-2F learning orientation instrument was used to explore the learning strategies of 135 and 132 final-year engineering students at an institution in Malaysia and Australia respectively. The quantitative data were analysed using SPSS version 22 to inform the most important learning strategies used. The findings are further explained using data from semi-structured interviews which were conducted with similar participants. The information gained from both studies contributes to a deeper understanding of factors contributing to the study success of the engineering students at the two universities. The finding provides answers and reasoning to the differences in the learning strategies of students in both learning contexts and suggests strategies for universities to help improve students' learning experiences in engineering programs. Special attention is highlighted to the inclusion of the conative element that is always neglected in much research for further consideration by researchers who conduct similar research.

Keywords: Academic achievement, conation, interest, learning orientation, learning strategy

Corresponding author: nazura@uthm.edu.my

1. Introduction

Why is ensuring success in engineering so important? The government have spent large amounts of money and effort to sustain engineering education programs. In Malaysia, the development of knowledge workers in this area has consistently become part of our national education development plan, which aims to increase the supply of professional skilled workers in engineering. The critical shortage of engineers in Australia has been consistently raised over recent years and become worsened since the COVID-19 pandemic (Bell & Mortimer, 2022). The increase in vacancies was reported in several areas such as civil, industrial, mechanical, and ICT (Bell & Mortimer, 2022) and the results might reflect the trend in the low numbers of completion rates with only approximately 25 per cent of students graduated on time in the program (Bell et al., 2022). In Malaysia, researchers also concerning on attrition issues in engineering (Mohamed Yunus, 2020) since graduating in engineering with good overall academic performance can potentially increase students' chances to get a good job after graduation. Therefore, focusing on improving their performance is highly desired since universities are federally funded, the local universities are financed, and lecturers are allocated based on the number of undergraduate students enrolled in the course. Consequently, the decrease in the number of undergraduate students affects the financial support given to the university. Other financial stakeholders who are also affected include scholarship providers and parents.

A higher attrition rate in engineering does not necessarily mean that more attention, effort and investment are required from stakeholders. Rather, these findings give us a sign that despite the various efforts made to facilitate learning we do not fully understand how the student is experiencing learning, how they are dealing with challenges, what factors influence their success, and why some students can be successful while others drop out from the program. These concerns have resulted in the focus of research over the past 15 years on understanding students' attrition, demotivation, and drop-out rates in engineering programs. There is some agreement about the factors contributing to attrition such as loss of interest, university engagement and poor performance (Andrews et al., 2021; Han & Ellis, 2020a), all of which are relate to their orientations in studying. In contrast, there is still much debate about factors contributing to success. Despite much research conducted and models introduced to understand success, mixed results are generated, making it difficult to develop firm conclusions about the factors influencing study success in engineering.

2. Literature Review

Researchers on learning orientation has focused their study on understanding how study perceptions influence behaviour of learners (e.g., Aboobaker & KA, 2021; Al-Qirim et al., 2018) . Students' Approaches to Learning (SAL) research uses a more holistic approach in attempting to understand student motivation to learn, and is usually focused at the general curriculum level when compared to other studies on learning motivation which focus on exploring learning at the course level. In the current study, the SAL approach was selected because it has the capability to provide useful information in understanding student motivation and learning at a general curriculum level thus can be applied to better understand success factors of students in engineering.

There are three major approaches to study SAL. One line of research has taken a broader perspective on understanding individual differences in approaching learning (Aboobaker & KA, 2021; Dika & Martin, 2018; Duff & Mckinstry, 2007) and relates the learning orientation with the cognitive development. Other line of research has concentrated on investigating the SAL factors which contribute to students' academic success and meaningful study experiences (Drew & Watkins, 1998; Han & Ellis, 2020b). There is also a large volume of research published which focuses on understanding patterns of approach and the relationship with cognitive processing activities and other aspects of learning (e.g., Aboobaker & KA, 2021). Knowing the differences in students' learning is especially important because it helps explain the influence of typical orientation on the way students approach learning and the effectiveness of learning and performance.

Vermunt (1998, p.151) described learning orientations as "the whole domain of personal goals, intentions, motives, expectations, attitudes, worries and doubts of students in doing courses or studies". The primary researchers on learning orientations applied phenomenological studies using qualitative interviews to identify the variety of way students approach learning. The researchers categorised learning approaches into deep and surface approaches based on information gathered from interviews (Marton & Saljo, 1976; Watkins & Hattie, 1980). Various self-report instruments were developed, and SAL models were extended based on this original idea of SAL. Biggs et al., (2001) had proposed another category of learning approach, the strategic approach, or what Entwistle and Ramsden (1982) described in his model as achieving approach. Entwistle and Ramsden (1982) used a classification to that of Marton and Saljo (1976), and further split the deep and surface categories into motive and strategy to form other sub-classifications: deep strategy, deep motive, surface strategy, surface motive, achieving strategy and achieving motive.

The more recent research in SAL uses three categories of learning orientation namely deep approach, achieving approach, and surface approach. Deep approach learners are those who are intrinsically motivated and prefer meaningful learning experiences. Such learners tend to approach learning by exploring knowledge in depth, understanding the meaning of new knowledge, and relating a new idea with previous knowledge (Duff, 2004; Duff & Mckinstry, 2007; Felder & Brent, 2005). Achieving approach learners always determine ways to excel or achieve the highest grade, for example, by using previous exam papers to predict questions (Entwistle & Ramsden, 1982; Felder & Brent, 2005). For that purpose, they show reasonable effort in study, manage their time well, organise learning resources well, and are selective in choosing learning materials. On the other hand, learners who are categorised under the surface learning approach often rely on memorising and put less effort into exploring new knowledge (Duff, 2004; Duff & Mckinstry, 2007; Felder & Brent, 2005). They may be too dependent on learning materials provided by lecturers and prefer "spoon feeding".

There are some evidences to prove that the different study approaches determine the diversity of quality in learning experiences (Han & Ellis, 2020b; Waugh, 1999; Woods et al., 2000). For example, deep approach learning (composed of deep strategy and deep motive) links to a deep learning outcome, and produces a committed, well-structured, and self-independent learner rather than an extrinsically-dependent learner. Burnett and Dart (2000) reported that students who are less committed to learning have a high probability of not continuing their studies; approximately 32% of the study samples were engineering students. This model proposed that students who possess deep strategy and deep motive have the potential to become a self-independent and performance-oriented learner. Therefore, one suggested hypothesis in the current study was that engineering students who approach deep and achieving approach learning could have greater potential to succeed and persist in engineering whereas students who possess surface approach learning are those who are less motivated in learning; therefore, could have the potential to drop out from the system.

A self-report instrument of Study Process Questionnaire (SPQ) was developed by Entwistle and Ramsden, (1982), to measure students' general orientation in approaching learning. The SPQ is a 42–item questionnaire, consisting of deep, surface, and achieving approach measures. A longitudinal and cross-disciplinary study was conducted among higher education students in Australia to test the reliability and validity of this instrument at course specific level and at general program level (i.e., throughout studies until graduation). Findings revealed that there were huge differences between the learning approach of Arts, Education, and Science students. For example, the Arts and Science students had the same deep approach scores in their first-year study, but the pattern diverged sharply as they progressed in their studies. The Art students' scores fluctuated in the first three years of study but increased sharply in the final year. Inversely, Science students' scores on deep approach declined towards the minimum level in the third year maintaining low level scores in the final year. The high workload towards the end of the Science program may have caused students to change the way they approached learning. Findings of this study demonstrated that students approached learning in various ways, and suggested that they may act and react differently according to program requirements. Entwistle and Ramsden, (1982) further established two hypotheses considering the findings of the study: (i) students who are driven by certain motivations will establish a particular learning strategy that is congruent with the motivation, and (ii) the combination of the motivation and strategy approaches is more effective to predict performance.

Aboobaker and Zakkariya (2021)'s suggestion implies that diversity in the students' learning approach might be influenced by a number of factors including extrinsic motivational elements and may possibly be contextually and culturally dependent. Creswell and Creswell (2018) speculated that students use different approaches to learning dependent on the curriculum used. It is indeed possible that the way students approach learning depends on how the curriculum is designed. A study conducted in Malaysia among engineering students at four faculties revealed that majority of the students applied deep learning approach and their approaches to learning were neither faculty nor gender dependent (Hussin et al., 2017). Researcher suggested several contextual factors that influencing student perception and their approaches to learning in engineering. These included learning environment (i.e., laboratory, lecture and classroom setting), problem solving activities (i.e., tutorial sheets, assignment questions and work examples), social aspects of learning (i.e., discussion activities in lectures, and informal group work in tutorials and assignments), perception of staff (i.e., approachable, enthusiastic and teaching approach), student motivation (i.e., interest, assessment, engagement and task perception), subject demand (i.e., independent reading, prior learning, perceived difficulty and work experience), mode of learning (i.e., face to face, online and hybrid learning) (Al-Kumaim et al., 2021; Nagahi et al., 2020; Tudor et al., 2010). When considering curricula used in engineering, this assumption is seen as relevant. One of the most common reasons for the drop out from engineering was differing expectations about the curriculum (Godfrey et al., 2010). Students claimed that they had difficulties in understanding the curriculum. It was expected that some students failed to develop learning strategies best suited with the engineering curriculum which led to a loss of interest to continue the journey. Students tend to adopt surface approaches if they feel that the course is unstructured, or they are overloaded with work and assignments, or poor feedback is given in class (Tudor et al., 2010). Students are more engaged and adopt a deep approach in class if they value the learning activities or academic tasks and see them as important.

It is also possible that students establish learning strategies that are in line with the learning activities or assessment criteria introduced in class. Final year engineering students are expected to have a stable dispositional learning orientation and to have become familiar with the learning activities designed, especially if similar learning approaches are throughout the program. It is a challenge for some first-year engineering students to get a sense of familiarity with all the common engineering processes. Therefore, an important aspect of research perhaps is not to investigate how the contextual settings or cultural influences might impact on strategy development or the approaches used. Instead, a study focusing on understand strategies adopted by the engineering student to familiarise themselves with the curriculum, how the contextual settings help developed their interest, and how these learning experiences might influence their success in engineering needs to be undertaken. It is often in educational settings that we determine what we believe is important for our students instead of understanding what benefits them from their own perspectives.

The review of the literature so far reveals that there are central agreements that the learning orientation of students is observable and measurable. However, the reviewed studies were less coherent, as the information about student differences in learning were scattered and provided no firm conclusions about the important learning orientations that engineering students should possess to enable them to succeed in the program. Paimin et al., (2017) stressed that it is crucial to understand student perceptions in engineering if researchers intend to understand the factors that contribute to success, retention, and dropout rates in engineering.

The issues of high dropout rates in higher education, including in engineering, has led to some researchers focusing their research on investigating the relationship between learning approaches and academic performance. Findings of these studies have yielded useful information regarding the relationships, which were presented as both the magnitude of relationship (either positively or negatively correlated) and the strength of relationship (low, medium, or high). Although there is a common agreement that students' learning orientations are linked to their study performance (Duff, 2004; Rodríguez & Cano, 2006; Tynjälä et al., 2005; Zeegers, 2001), findings of these studies indicate mixed results. Some of the studies found that only a deep approach to learning (deep strategy and deep motive) can predict study performance (Drew & Watkins, 1998; Duff & Mckinstry, 2007). For example, Duff and Mckinstry (2007) found that deep approach leaning significantly predicted study performance of science students at an Australian university, while students who left the program had a greater tendency towards surface learning. in their study of Drew and Watkins, (1998) university students who enrolled in Nursing, Radiography and Language and Communication courses found no direct and significant relationship between locus of control, self-concept, surface approach learning and academic performance. Even though much research have been conducted to identify the most dominant study approaches of engineering student students, still there are lack of information to confirm the relationship between students' approaches in learning and their academic performance which require further investigation. Furthermore, their intention to apply certain strategies in studying is also not well-explained.

3. Methodology

A concurrent mixed method designed (Creswell & Creswell, 2018) was applied in this study combining data from the quantitative and qualitative studies. The quantitative study used the R-SPQ-2F instrument to investigate the learning strategies possessed by final year engineering students. Samples involves 135 and 132 final year engineering undergraduates who studying civil, electrical and mechanical engineering at UTHM and the University of Melbourne respectively, were recruited for the quantitative study. According to Chuan (2006), a minimum of 85 samples are required to perform Pearson Correlation Analysis. Several criteria that have been given emphasis and attention during this study were, (i) confirming reliability of the construct, (ii) investigating the relationships between deep learning strategies and academic performance (as measures by cumulative grade point average) and, (iii) to understand the underlying factors that forms the development of learning strategies.

Only five items from the deep approach scale (deep strategy) were presented in the current study to focus the measure into intrinsic motivational factors only. These five items will be further discussed in relation to the qualitative findings. The coefficient of Cronbach alpha was used as a measure to evaluate the internal consistency of the R-SPQ-2F scale. The deep strategy scales of the SPQ-2F have reliability estimates of $\alpha = 0.77$. The α values obtained are comparable with most reliability testing for the SPQ-2F instrument which were normally ranged between 0.6 to 0.7 (Hair et al., 2019). The value of 0.7 or more was considered sufficient (Pallant, 2016) to confirm the inter-item consistency. Since there are only five items for representing constructs of deep learning strategy, a slightly less Cronbach alpha value for these constructs was accepted (Pallant, 2016). The Statistical Package for the Social Sciences (SPSS) version 22 was used for analysing the empirical data. The Pearson product-moment correlation coefficient analysis was carried out to determine the degree of interrelatedness (strength) and direction of the relationship between learning strategy and academic performance. The strength value was measured according to Hair et al. (2019) guideline: from $r=0.10$ to 0.29 indicates small, from $r=0.30$ to 0.49 indicates medium and from $r=0.50$ to 1.0 indicates large.

A semi-structured interviews were conducted among 18 of the participants (9 Malaysian and 9 Australian students respectively) in the same semester period to ensure trustworthiness of the data. Students who answered the questionnaire were further invited to join the one-to-one interview sessions. A thematic coding technique were employed involving several steps such as: (i) becoming familiar with the data, (ii) generating initial codes, (iii) searching for themes, (iv) reviewing themes, (v) defining and naming themes and, (vi) producing the report (Seidman, 2013). Findings of the qualitative analysis was used in conjunction with the findings of the qualitative study, for the purpose of supporting and validating the findings. In certain cases, participants were given an opportunity during the interview to explain or elaborate any answers provided in the questionnaire especially when the story of their learning experiences did not match with the information given. This method enabled the researcher to get clarification for any uncertain answers that merged in both data sources thus, can ensure credibility and accuracy of the findings.

4. Results and Discussions

The quantitative study investigated five elements of deep approach strategies of R-SPQ-2F instrument of Biggs et al., (2001). Students are expected to achieve greater success if they studies in a meaningful way (i.e., do sufficient work to summarise topics, self-testing to get meaningful understanding, spend time relating new ideas to various knowledge and seek for more information about topics, and having a vigorous interaction with suggested reading in class), as proposed by [32]. The correlation coefficient findings revealed that deep approach strategy was significantly correlated with the study performance of the Malaysian participants only ($r_{MY} = 0.27$; $p < 0.01$) as demonstrated in Table 1. A study conducted in the Asian learning context also revealed similar findings which proved a significant relationship between deep learning approach with higher education students' academic achievement (Chotitham et al., 2014). This can be a sign that the way students approach learning is context dependent. Findings of the qualitative study could provide support to this notion.

Table 1 - Descriptive statistics for deep learning strategy construct and items, for Malaysia and Australia data

	Mean, *M*		**Std. Deviation, σ**		**Cor. Coef., r with Academic performance**	
	MY	**AU**	**MY**	**AU**	**MY (N-135)**	**AU (N=132)**
Deep Strategic scale	3.72	3.14	0.59	0.65	0.27*	0.140
Self-testing	3.84	3.27	0.82	1.06		
Vigorous interaction	3.59	2.65	0.85	1.14		
Form a conclusion	3.98	3.85	0.76	0.87		
Spend extra time	3.39	2.83	0.91	1.07		
Relates ideas	3.82	3.12	0.82	0.89		

* Significant at the 0.01 level (2-tailed)

Surprisingly, findings of the qualitative study revealed that engineering students at both learning contexts recognised the importance of establishing deep learning strategies to ensure successful in engineering, however, the medium strength of relationship could be because they are highly depending on external support to ensure effective strategies rather than intrinsically motivated (deep strategy). Example of interview responses that match the survey questions are as shown in **Table 2.**

Table 2 - Comparison of quantitative measures and examples of related strategy behaviours from qualitative interviews

Strategy Component (questionnaire)	**Learning Strategy (interview)**
Self-testing to get meaningful understanding **I test myself on important topics until I understand them completely.**	• Lots of practice in drawing • Get seniors notes with answers and practice doing the calculations until get the understanding • Do calculation part in group projects to practice • Practicing a lot on solving tutorial problems • Do the calculation part in group projects as a practice for exam • Read through all materials and concentrate on tutorial questions and past exams
Vigorous interaction with suggested content **I make a point of looking at most of the suggested reading that goes with the lectures.**	• Use subject syllabus as a guideline, mark topics that have been covered and read next topic beforehand • Use the same book as suggested in the subject syllabus • Use own short-notes/note taking in class • Use seniors notes/any available resources • Use past exam/test papers • Refer to library books/journals • Refer to lecture module/notes/syllabus • Use online resources (get information from websites)
Do enough work to form conclusion **I have to do enough work on a topic so that I can form my own conclusion before I am satisfied.**	• Do summary of lecture notes using colour, coordinate, • use coding for referencing • Do topics summary using mind mapping or short note • Refer to lots of resources to gain an understanding • Do lots of reading to enable understanding • Studying in group to combines ideas about topics • Ask lecturer or tutor to get a firm answer • Imagining real object/application helps understand the processes

	• Do past year exam/test papers to challenge knowledge/gain confidence
Spend extra time to obtain more information/integrate knowledge about interesting topics **I find most new topics interesting and often spend extra time trying to obtain more information about them.** **I spend a lot of my free time finding out more about interesting topics that have been discussed in different classes.**	• Integrating of practical knowledge, visualisation and the underlying theory enabling it to be applied to other related tasks • Seeing a real object helps understand how things work (by watching television /searching on Internet/watching YouTube (e.g. Discovery channel)/ • Seeing demonstration in labs/do observation at site work

Finding of the qualitative study also discovered several deep learning strategies perceived to be important for the engineering students such as visualisation of the applications, maximise use of learning material, and mastery of engineering skills and practices are examples of common strategies used by participants in the context studied. Some of the strategy behaviours can explain strategy measures in the quantitative and the cluster of strategy proposed for the qualitative study are comparable with strategies explained by Weinstein et al. (2007).

When being asked about strategies perceived to be important for students to be successful in the program, there are some evidences found that there was a mismatch in the intention of using the strategies as demonstrated in **Table 3**. It is notable that the deep strategy measure of the R-SPQ-2F instrument is a multi-dimension domain. The item 3 for example, measures cognitive strategy (self-testing) in relation to intention attribute of conation (the intention to get an understanding). It may be argued that relating the strategy with intention is a reasonable way to identify attributed causes of the behaviour, whether intrinsically or extrinsically driven. However, this comparison demonstrated an interesting point given that students use such a similar strategy but for different reasons or intentions. In two of the given interview cases, the intention to use such strategy for the Australian participants were found to be extrinsically driven, that is to score and pass an exam. This finding provides some evidence into why students who use a similar strategy did not achieve an equivalent learning outcome,, which potentially link to their intention in studying. Interestingly, Paimin, (2014) study found significant relationship between intention and study performance of Australian students, but insignificant results for the Malaysian students. The explanation in Table 3 might provide some supports to the quantitative findings which explain the differences in their intention of using a particular learning strategy based on study context.

Table 3 - Examples of strategy measure in the R-SPQ-2F and the interpretation of findings from interviews

An example of deep strategy component of R-SPQ-2F	***Interpretation***
Item 3: *I test myself on important topics until I understand them completely.*	This item asked about using a self-testing strategy with **the intention to understand the topics.**
Interview findings: *i) ...if we are hardworking enough and do a lot of practice, I believe we can easily <u>gain an understanding</u> (Malaysian student 6)* *ii) I am not just looking at the answers, but I also learn and try to do the calculation <u>until I understand</u> how they did the calculation. (Malaysian student 2)* *iii) I always do all the tutorial problems because I need as much practice as I can get...my housemate done that subject and I got tutorial solutions. The only assessment for these subjects is the exam at the end of semester, so <u>it is sort of thing that we are looking</u> (Australian student 8)* *iv) I just do, just read through all materials and concentrate on tutorial questions and past exams cause lecturers tend to go of the same things for exam topics so if you can do all tutorials questions and you can do past*	Two participants reflected that they do lots of self-practice in order **to get a meaningful understanding (intention)** of the topics. Meanwhile, the other two participants reflected that they use of a similar strategy **to score or pass in exam (intention).**

exams you usually can get more than enough to pass exams (Australian student 7)	

The deep approach strategies of the R-SPQ-2F also covers aspects related to meaningful understanding that relates to interest whereas in reality, some of the interview participants acknowledged that they applied any strategies that they think might be best "work" at the time. It was also observed that some participants discussed their strategy without relating the strategy to their interest feelings. The impression conveyed was that some of the participants may have less conscious attitude concerning interest but has greater intention towards achieving their desired goal. The design of engineering curricula, which heavily emphasise on collaboration in group projects and applied sciences in practice (implementing theories and principles to understand practice), is expected to have contributed to the less than complete strategies that should be possessed by engineering students. Moreover, engineering curriculum also covers multiple areas of knowledge and skills. There were examples that engineering students whose intention are towards professional development tend to develop interest in a specialise area that is far beyond the content in their syllabus and the strategy used was directed towards this interest and intention. This is expected to be one of the reasons why some of the deep strategy measures did not significantly predict success of the Australian students even though students agreed that such a strategy applied to them (Paimin, 2014). Therefore, it should be notable here that fostering deep approach strategies among engineering students may be less than ideal for some learning contexts in solving problem related to poor performance. Nevertheless, the selected deep approach strategies in the quantitative study are still important. Students should also put initiative to foster intrinsic interest and intention to persist regardless of the study location. Intention has been proved to be important as a striving mode behind the establishment of learning strategies among the students.

5. Conclusion

This research provides an insight towards a possible integration between learning strategy and other motivational factors to influence engineering students' academic performance at two different learning context, Malaysia and Australia. This section summarises the overall findings gathered from the mixed method study. The quantitative finding demonstrated that there was a relationship between learning strategy and academic performance of the Malaysian students whereas the Australian students requires to integrate their learning strategies with other motivational elements to ensure greater academic success. Findings of this qualitative study have made it clear that the quantitative findings measure a small area of strategy only. The qualitative findings also revealed that the inclusion of interest and intention factors is important to consider to better understand factors determining success in engineering. Intention plays different role depending on learning situation but deemed as crucial as a striving mode towards success. Future research needs to consider the role played by external factors such as lecturers, family and friends and detailed observation of their learning experiences could enabling the extension information of factors influencing success in engineering.

Acknowledgement

The researchers would like to express gratitude to the Malaysia Ministry of Higher Education (MOHE) and Research Fund Q023 from Research Management Centre, UTHM who provided the financial support for this research and its publication. Deep appreciations also dedicated to anyone who directly or indirectly involved in this study.

References

Aboobaker, N., & Zakkariya, K. A. (2021). Digital learning orientation and innovative behavior in the higher education sector: effects of organizational learning culture and readiness for change. *International Journal of Educational Management*, *35*(5), 1030–1047. https://doi.org/10.1108/IJEM-09-2019-0345

Al-Kumaim, N. H., Alhazmi, A. K., Mohammed, F., Gazem, N. A., Shabbir, M. S., & Fazea, Y. (2021). Exploring the impact of the covid-19 pandemic on university students' learning life: An integrated conceptual motivational model for sustainable and healthy online learning. *Sustainability (Switzerland)*, *13*(5), 1–21. https://doi.org/10.3390/su13052546

Al-Qirim, N., Tarhini, A., Rouibah, K., Mohamd, S., Yammahi, A. R., & Yammahi, M. A. (2018). Learning orientations of IT higher education students in UAE University. *Education and Information Technologies*, *23*(1), 129–142. https://doi.org/10.1007/s10639-017-9589-y

Andrews, M. E., Patrick, A. D., & Borrego, M. (2021). Engineering students' attitudinal beliefs by gender and student division: A methodological comparison of changes over time. *International Journal of STEM Education*, *8*(1). https://doi.org/10.1186/s40594-020-00269-6

Bell, M., Briggs, P., Romanis, J., & MacMaster, J. (2022). *Strengthening the engineering workforce in Australia* (Issue August).

Bell, M., & Mortimer, T. (2022). *Australian Engineering Employment Vacancies* (Issue January). https://www.engineersaustralia.org.au/sites/default/files/2022-02/Australian-Engineering-Employment-Vacancies-July-December-2021.pdf

Biggs, J. B. (1979). Individual Differences in Study Processes and the Quality of Learning Outcomes. *Higher Education*, *8*(4), 381–394. http://www.springerlink.com/index/GKL3851251273676.pdf

Biggs, J. B. (1987). *Student Approaches to Learning and Studying*. Brown Prior Anderson Pty. Ltd.

Biggs, J., Kember, D., & Leung, D. Y. P. (2001). The Revised Two-Factor Study Process Questionnaire: R-SPQ-2F. *British Journal of Educational*, *71*, 133–149.

Burnett, P. C., & Dart, B. C. (2000). The Study Process Questionnaire: A Construct Validation Study. *Assessment & Evaluation in Higher Education*, *25*(1). http://www.tandfonline.com/doi/abs/10.1080/713611415

Chotitham, S., Wongwanich, S., & Wiratchai, N. (2014). Deep Learning and its Effects on Achievement. *Procedia - Social and Behavioral Sciences*, *116*(May 2015), 3313–3316. https://doi.org/10.1016/j.sbspro.2014.01.754

Chuan, C. L. (2006). Sample Size Estimation using Krejcie and Morgan and Cohen Stastical Power Analysis: A Comparison. *Jurnal Penyelidikan IPBL*, *7*, 78–86.

Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, quantitative and mixed methods approaches* (5th ed.). SAGE Publications.

Dika, S. L., & Martin, J. P. (2018). Bridge to Persistence: Interactions With Educators as Social Capital for Latina/o Engineering Majors. *Journal of Hispanic Higher Education*, *17*(3), 202–215.

Drew, P. Y., & Watkins, D. (1998). Affective Variables, Learning Approaches and Academic Achievement: A Causal Modelling Investigation with Hong Kong Tertiary Students. *British Journal of Educational Psychology*, *68*(2), 173–188. http://doi.wiley.com/10.1111/j.2044-8279.1998.tb01282.x

Duff, A. (2004). Understanding Academic Performance and Progression of First-Year Accounting and Business Economics Undergraduates: The Role of Approaches to Learning and Prior Academic Achievement. *Accounting Education*, *13*(4), 409–430. https://doi.org/10.1080/0963928042000306800

Duff, A., & Mckinstry, S. (2007). Students ' approaches to learning. *Issues in Accounting Education*, *22*(2), 183–214.

Entwistle, N. J., & Ramsden, P. (1982). *Understanding Student Learning*.

Felder, R. M., & Brent, R. (2005). Understanding Student Differences. *Journal of Engineering Education*, *94*(1), 57–72. http://eprints.me.psu.ac.th/ILS/info/Understanding_Differences.pdf

Godfrey, E., Aubrey, T., & King, R. (2010). Who Leaves and Who Stays ? Retention and Attrition in Engineering Education. *Journal of Engineering Education*, *5*(2), 26–40.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). Multivariate Data Analysis. In *Cengage* (8th ed.). Cengage. http://wiki.biomine.skelleftea.se/wiki/images/3/37/Multivariate_data_analysis_wiki.doc

Han, F., & Ellis, R. (2020a). Combining Self-Reported and Observational Measures to Assess University Student Academic Performance in Blended Course Designs. *Australasian Journal of Educational Technology*, *36*(6), 1–14. https://doi.org/10.14742/AJET.6369

Han, F., & Ellis, R. (2020b). Personalised learning networks in the university blended learning. *Comunicar*, *28*(62), 19–30. https://doi.org/10.3916/C62-2020-02

Hussin, F., Hamed, S., & Jam, S. M. (2017). Approaches to learning of engineering students: Deep or surface. *International Academic Research Journal of Social Science*, *3*(1), 122–127.

Marton, F., & Saljo, R. (1976). On Qualitative Differences in Learning-I: Outcome and Process. *British Journal of Educational Psychology*, *46*(4), 11.

Mohamed Yunus, N. H. (2020). *Conative and Extrinic Motivation: A Case Study on The Retention and Success of Engineering Students in the Malaysia Technical Universities Network*. Universiti Tun Hussein Onn Malaysia.

Nagahi, M., Jaradat, R., Davarzani, S., & Nagahisarchoghaei, M. (2020). Academic performance of engineering students. *American Society for Engineering Education*, *April 2021*. https://doi.org/10.18260/1-2--34084

Paimin, A. N. (2014). *Success factors for engineering students: Learning strategy, interest, and intention*. University of Melbourne.

Paimin, A. N., Prpic, J. K., Hadgraft, R. G., & Alias, M. (2017). Understanding Student'S Learning Experiences in

Higher Education. *INTED2017 Proceedings*, *1*(March), 6670–6676. https://doi.org/10.21125/inted.2017.1543

Pallant, J. (2016). *SPSS Survival Manual: A step by step guide to data analysis using IBM SPSS* (6th ed.). Mc Graw-Hill Education.

Ramsden, P. (1992). *Learning to Teach in Higher Education*. Routledge.

Rodríguez, L., & Cano, F. (2006). The epistemological beliefs, learning approaches and study orchestrations of university students. *Studies in Higher Education*, *31*(5), 617–636. https://doi.org/10.1080/03075070600923442

Tudor, J., Penlington, R., & McDowell, L. (2010). Perceptions and their influences on approaches to learning. *Engineering Education*, *5*(2), 69–79. https://doi.org/10.11120/ened.2010.05020069

Tynjälä, P., Salminen, R. T., Sutela, T., Nuutinen, A., & Pitkänen, S. (2005). Factors related to study success in engineering education. *European Journal of Engineering Education*, *30*(2), 221–231. https://doi.org/10.1080/03043790500087225

Vermunt, J. D. (1998). The regulation of constructive learning processes. *British Journal of Educational Psychology*, *68*, 149–171.

Watkins, D., & Hattie, J. (1980). An Investigation of the Internal Structure of the Biggs Study Process Questionnaire. *Educational and Psychological Measurement*, *40*(4), 1125–1130. https://doi.org/10.1177/001316448004000442

Waugh, R. F. (1999). Approaches to studying for students in higher education: A Rasch measurement model analysis. *British Journal of Educational Psychology*, *69*(1), 63–79. https://doi.org/10.1348/000709999157572

Weinstein, C. E., Acee, T. W., & Jung, J. (2007). Self-regulation and learning strategy. In *New directions for teaching and learning* (Issue 126, pp. 45–54). Wiley Periodicals, Inc. https://doi.org/10.1002/tl.443

Woods, D. R., Hrymak, A. N., & Wright, H. M. (2000). Approaches to learning and learning environments in problem-based versus lecture-based learning. *ASEE Annual Conference Proceedings*, *January 2000*, 959–970.

Zeegers, P. (2001). Approaches to Learning in Science: A Longitudinal Study. *The British Journal of Educational Psychology*, *71*, 115–132. http://www.ncbi.nlm.nih.gov/pubmed/11307704