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Learning in a Traditional or Contemporary Environment: A Student Perspective

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ABSTRACT

CONTEXT

The constant call for transformation of engineering education has driven many institutions to evolve towards a contemporary real-world problem-based learning (RWPBL) approach from Traditional Learning (TL). The contemporary approach is deemed to meet the learners' needs and better equip future engineers to contribute to the world's sustainable development.

PURPOSE OR GOAL

While RWPBL is widely adopted and acclaimed by many institutions and educators, it is essential to explore the students' perceptions of these different approaches. This paper examines engineering students' perceived learning preferences and perceived effectiveness of learning in TL and RWPBL environments.

APPROACH OR METHODOLOGY/METHODS

A mixed study with questionnaires and one focused-group interview was conducted to collect data from 68 students who had completed at least one TL unit and one RWPBL unit in a Bachelor of Engineering (Hons) degree program. The student experiences and perceptions in both learning environments were examined based on five learning criteria. The study also explores the students' preferred learning methods.

ACTUAL OR ANTICIPATED OUTCOMES

The study identified perceived advantages in both RWPBL and TL. Students attributed RWPBL to the discovery of new ideas and teamwork skills development, but also appreciate the benefits of TL in contributing to theoretical learning. The academic staff are perceived to play the ultimate role in making each approach effective.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The study concludes that both RWPBL and TL have a place to play in engineering education. Students understand and appreciate the different advantages provided by each approach as well as the shortcomings presented in both approaches. The students place more emphasis on the ability of their educator in facilitating effective learning than a particular approach or setting.

KEYWORDS

Problem-based learning, contemporary learning, engineering education.

Background and Introduction

The call for change in engineering education has been echoing for years, driven by evolving societal needs and technological advancements (Aslaksen, 2017). The evolvement of engineering education is deemed necessary due to its intertwined relationship with the constantly evolving technology and society (Chehrehgosha, 2023). As society and technologies evolved, so must the engineering education to produce graduates and future engineering workforce that are equipped with the up-to-date knowledge and skills to not only work in a world of increasing social, economic and environmental complexity but also to deliver sustainable engineering solutions that contribute to the sustainable development goals (Wrobel & Lyden, 2022) and lead the world to a sustainable future (UNESCO, 2021).

The call for change in engineering education is also viewed unavoidable due to the changing learning behaviour among the younger generations, which is argued to have shifted the learners' confidence and perceived effective learning strategies away from the traditional theoretical-based learning to a more contemporary technology-integrated and real-world problem-solving focused learning approach (Baruh, 2012). In this regard, technology-integration could make the learning environment friendlier to young students who are already computer and technology savvy, while the incorporation of real-world problem-based learning approach could enable students not only to practice complex problem solving but also to associate their learning with the world that they live in (Nehara, Sibabda, & Magenuka, 2024). This transformation to a contemporary approach is argued to suit the learning needs of the young learners and make engineering courses appear more relevant and attractive to new learners (Froyd, Wankat, & Smith, 2012).

The calls for shift of engineering education from traditional to contemporary can be clearly observed in both global and domestical engineering education in Australia. Over the years, various changes had been observed in global engineering education. For example, in documenting the five major shifts of engineering education in the past 100 years in America, Froyd et al (2012), describes gradual shift from a theoretical engineering science and mathematical modelling-based to an engineering design emphasis and later to cross-disciplinary and problem-solving emphasis and information and communication as well as technology integrated education. Lindsay, Hadgraft, Boyle, and Ulseth (2023) observed the curriculum in leading universities in Singapore and China shift towards more socially and real-world relevant tasks with project-based learning playing a key role in building students' practice skills and multidisciplinary problem-solving skills.

In Australia, the Australian Council of Engineering Deans (ACED) are proactive in advancing engineering education to keep pace with technology evolvement and societal change. In their recent 'Engineering Futures 2035' report, they recommend engineering education should focus not only on technical rigor but also to adopt a contemporary approach to incorporate the real-world engineering practices and cross-disciplinary elements in the curriculum design (Australian Council of Engineering Deans, 2021). This real-world problem-based learning (RWPBL) is argued to motivate students' learning through discovery of new ideas and enhancing their conceptual understanding through practising their theoretical understanding through studying and solving real-world problems (Wei, Chang, & Lin, 2023). The incorporation of cross-curricular elements, on the other hand, is argued to equip future engineers with not only technical proficiency but also other important skills such as emotional intelligence and interpersonal skill which are considered necessary to work effectively in a multidisciplinary team (Australian Council of Engineering Deans, 2021).

In response to the call, many universities have reported making innovative changes in their engineering courses and experienced success in their new venture, especially in the adoption of the contemporary RWPBL approach. For example, O'Connor, Power, Blom, and Tanner (2024) found that RWPBL improved students' motivation and enjoyment in their learning; Naveh, Bakun-Mazor, Tavo, and Shelef (2022) asserted the effectiveness of RWPBL in developing students' professional and employability skills; and Warnock and Mohammadi-Aragh (2015) discovered improved critical thinking and problem-solving skills among students.

With the anticipation of attaining similar success, the School of Engineering at University of Tasmania (UTAS-Eng) made relevant changes in their engineering programmes by increasing the proportion of project-based and cross-disciplinary curriculum. Following a major curriculum redesign process in 2016-2017, a new engineering course commenced in 2018 featured a sequence of design units in the first two years of the degree alongside more traditional technical units. These design units enabled students to work on cross-specialisation projects of increasing complexity while developing the relevant professional skills including project management, teamworking and communication skills. The ongoing evolvement of UTAS-Eng is done carefully and perpetually. While anticipating the positive outcomes reported in many studies about RWPBL, the school remains vigilant about the concerns raised in these studies, which include concerns about students being anxious about the lack of clarity around learning objectives and the applicable timeline in a RWPBL environment (O'Connor et al., 2024); and most importantly, the students' lack of confidence in attaining a wider subject knowledge due to the narrow content focus in the RWPBL approach, which is commonly perceived to have a limited focus on selected topics (Naveh et al., 2022; Warnock & Mohammadi-Aragh, 2015).

It is thus the purpose of this study to explore the students' experience and perception about the RWPBL approach, especially when compared with the traditional learning (TL) approach which is reported to still serve as an effective mode of learning (Coe, Aloisi, Higgins, & Major, 2014). In particular, this study seeks to improve the understanding of students' learning experience in both RWPBL and TL approaches. How do they perceive the effectiveness of the different learning approaches in contributing to their learning experience and learning outcomes? What approach do they perceive to be effective in achieving their intended educational goal? The students' views are important not only in validating the transformation process but also in informing the future development of the learning and teaching within the school. The study outcomes could also provide insightful information to engineering educators and institutions at large, about how engineering learners prefer to be educated and trained.

Methodological approaches

This study was funded by an internal grant at the University of Tasmania and was approved by the Human Research Ethics Committees (HRECs) Australia. A mixed method approach consisting of survey and structured group interview was adopted to collect data from students who had completed at least one TL and one RWPBL unit in the Bachelor of Engineering with Honours degree program. The survey was developed based on the outcomes of a literature review with objective to explore students' learning experience and perception about the effectiveness of each learning approach as well as their preferred learning method. A Likert-scale was used in the survey and was administered to 68 student respondents, in which, respondents were asked to indicate the extent to which they agreed or disagreed with each item.

The design of the semi-structured grouped interview was informed by the survey data and was carried out with the 8 respondents who volunteered from the survey pool. The structured group interview was conducted with the intention to follow-up on the responses collected from the survey. The interview questions were developed based on the outcomes of the literature review and survey with the objective to elicit more detailed responses about the students' experience and perceptions of the different learning approaches. The interview data serves to provide further understanding about the survey responses and as a significant triangulation of the data collected through the survey. The aim and objective of the study was explained in detail to all participants and all participants provided consent. A briefing about the structure of the TL and RWPBL approach was also given to all participants by the Research Assistant who was assigned to conduct the survey and group interview to avoid participants' confusion and misinterpretation.

Data Analysis and Results

Students' learning experience

The students' learning experience were first assessed through analysing data collected through Likert-scale based on two criteria: Engagement and Motivation and Feeling Challenged. The data shows that, 85% of respondents found RWPBL to be engaging and motivating and 79% of respondents considered RWPBL approach to be challenging. In comparison, 68% of respondents found TL to be engaging and motivating while 60% of respondents found it challenging. This data suggests students found RWPBL more engaging and motivating and provided a more challenging learning experience. It is worth noting TL recorded a lower approvement rate but with the rates for Engagement and Motivation at 68%, and Feeling Challenged at 60%, suggests students' showed a significant appreciation of TL, which warrants a further examination on both RWPBL and TL approaches.

The dispersed and equal appreciation for TL and RWPBL was confirmed during the group-interview. Four out of eight interviewees claimed RWPBL was a better learning approach for them when compared to TL. The typical reasons for RWPBL being perceived as more favourable include: more interesting, practical and professionally relevant. A typical response from one of the interviewees:

> *I become more engaged in a design-based classroom. Design-based classes can acquire knowledge from practice rather than just from textbooks, so that the acquired knowledge can be better applied to future work and life.*

Three out of the eight interviewees preferred TL and one interviewee took a neutral stance between both approaches. The typical reasons of approving TL as a preferred approach included systematic learning, time-efficient and topic-focused. The following response featured the typical response from these interviewees:

> *I'm more inclined to traditional form of class, in this form of class can be more direct access to the knowledge of the course, the professor has a more complete teaching system to teach us knowledge.*

As the discussion went further, a different opinion was formed within the group which eventually drove the group to reach a consensus that the preferred learning approach depends on the subjects or units. The consensus view can be represented by the following response concluded by one of the interviewees:

> *It comes down to the subject, like with math-base and theory base subjects, I think lecture based traditional classroom is (the) best and more engaging especially if it is also backed up with a lot of online resources. Whereas in the design project or a hands-on subject like welding or making a circuit, is not so well taught in a traditional classroom.*

One interviewee also pointed out that TL and RWPBL were co-related and needed to co-exist to make learning efficient. This idea also received consented agreement from the group. The following quote captured the idea:

> *Practical (RWPBL) and traditional learnings needed to be treated as two parts of a whole, as opposed to individual existence. This could be done better by having the design units come after the theory.*

Students' perception

The students' perception and preference were assessed through data collected using a Likert-scale based on three criteria: Discovery of New Ideas, Theoretical Learning, Professional and Teamwork Skills. A higher agreement rate was recorded in the areas of Discovery of New Ideas and Professional & Teamwork Skills in a RWPBL approach as compared to TL approach, in which, 94% of respondents perceived RWPBL as effective approach in discovering new ideas and 90% of respondents perceived it to be effective in acquiring professional and teamwork skills. The students' high regard of RWPBL in developing new ideas and professional and teamwork skills is further explored during the group interview. Interviewees found RWPBL effective in developing new engineering ideas and developing professional and teamwork skills due to the unit teaching activities which emphasised brainstorming, problem-solving, team-based project and groupwork. The interviewees also perceived that teamwork skills could only be learned most effectively through practical training or in a project-based environment. The respondents' belief is evidenced in the following quotation:

> *In terms of teamwork and group projects I don't think that could be taught so well in a lecture. It can be explained but I feel people go into those lectures walk out not having really listened. Whereas if you are put in a designed group it forces you to engage and to develop those skills and it's like you can't just be taught team work like reading a book about teamwork.*

A higher agreement rate was recorded in the areas of Theoretical Learning for TL approach when compared to the RWPBL approach, in which, 87% of respondents perceived that TL is more effective in theoretical learning. The high approval rate for TL to contribute to theoretical learning agreed with the responses collected during interview. The interviewees explained the reason for TL being effective in theoretical learning was mainly due to the units that conducted through TL approach having a high focus on building conceptual understanding of established theories. In this regard, TL was perceived to be the most appropriate way that these units could be taught. The following quotation captured this idea:

> *Academic subjects such as Maths, English, Sciences, a traditional environment is the best, with lectures and tutorials. In this form of class can be more direct access to the knowledge of the course, the professor has a more complete teaching system to teach us (the relevant) knowledge.*

Although RWPBL recorded a lower agreement rate, an 85% approval rate suggests that students also perceived it is also an effective approach in theoretical learning. The students believed that a practical task helped to provide purpose and motivation in learning theories that are relevant to completing the task. Thus, it would drive stronger interest among students in learning the relevant theories. This view is evident in the interview response below:

> *I prefer learning in a problem-based environment because such learning environment allows us to know what we lack from the needs, when we can't solve a problem, we will learn and understand relevant knowledge in targeted and purposeful way. Studying in a purposeful situation will make me feel that learning is more efficient.*

Learning experience and perception

The correlation between students' learning experience and perceptions was further explored. Spearman's correlation was conducted to evaluate the relationship between Engagement & Motivation and Feeling Challenged against Discovery of New Ideas, Professional & Teamwork Skills, and Theoretical Learning in a RWPBL and TL environment individually. A significant positive relationship was only found between Engagement & Motivation and Discovery of New Ideas, $r_s(66) = .28$, $p = 0.021$; between Engagement & Motivation and Professional & Teamwork Skills $r_s(66) = .26$, $p = 0.030$ and between Engagement & Motivation and Theoretical Learning $r_s(66) = .27$, $p = 0.029$.

These statistics testing outcomes suggest that the students' engagement and motivation in the RWPBL approach is related to their anticipation in acquiring conceptual understanding and discovering new ideas through a problem-based learning environment. The statistics also suggest students' expectations to work in group in the RWPBL environment and thus the association between the acquisition of professional and teamwork skills in a RWPBL environment. This outcome is consistent with the outcome analysed through the data collected from the survey and group-interview. The expectation was apparent during the discussion about the learning outcomes in a RWPBL environment. The typical responses are demonstrated in the following quotations from the following interviewee:

> *(In a RWPBL environment) you learn how to interact with other people, how to work in team, and be a leader but know when not to take over, and interact with different personalities, to plan things*

well and make a project from start to finish without relying on other people as well; really teamwork. That is important for our 21st Century jobs and the skills you develop.

However, the Spearman's correlation test to evaluate the relationship between Feeling Challenged against Discovery of New Ideas, Professional & Teamwork Skills, and Theoretical Learning in RWPBL approach returned a not significant outcome for Discovery of New Ideas, $r_s(66) = .23$, $p = 0.061$; for Professional & Teamwork Skills $r_s(66) = .13$, $p = 0.289$ and for Theoretical Learning $r_s(66) = .11$, $p = 0.370$. This outcome suggests a dissociation between the challenge students experienced through working on problem-based task and their anticipation in learning new knowledge and skills. The following quotation from an interviewee offers an interesting view:

I would say that the problem based is more challenging and engaging, whether it makes me learn more maybe not but it definitely engages me more.

The non-significant correlation between the students' learning experience and their perception or anticipation in discovering ideas and developing professional and teamwork skills in a TL environment aligns with the data collected through the group interview, in which students associate the units taught in a TL environment will focus on theoretical teaching and conceptual understanding, which are not related to discovering new ideas and acquiring of professional and teamwork skills. A non-significant and negative correlation between students' learning experience and Theoretical Learning in a TL environment comes as a surprise, but a high neutral rate of 44% suggests a discrepancy, and possible are for future investigation.

Preferred learning approach

The students' preferred learning approach was assessed through data collected through the multiple-choice survey questions based on four learning methods: Independent Learning, Collaborative Learning, Traditional Classroom Teaching and Online Learning. While 69% of surveyed students perceived independent learning to be favourable, 81% preferred Collaborative Learning. The preferred learning approach was further explored during the group interview.

The discussion in the group interview was consistent with the survey and showed the interviewees recognised the benefit of independent learning but leaned more towards collaborative learning which they perceived to be more engaging, interesting and supportive. The interviewee comments also reflected that the preference is subject relevant. The quotation below demonstrates a typical response provided by interviewees:

we can go in a group session and get lots done and it is beneficial, but I also like to sit down with my computer with the questions up and zone out with myself a lot, but once again it depends on the subject.

The data shows a higher preference for Traditional Classroom Teaching, with a 82% preference rate, in comparison to Online Learning which received only a 56% preference rate. The interview data suggests that students' higher preference in the traditional classroom teaching is attributed to better accessibility to teaching staff, especially in terms of getting focused guidance and this supports a perception of "more efficient learning". The following quotation demonstrates the idea:

I go to every lecture and be there in person to support my learning. I do spend a lot of time studying the provided materials like textbooks and anything from the online resources and I really like the guidance that the lecturers provide. I like to be "pushed" in the right direction and being told if you do X, Y and Z questions, or which part of the textbook to look at. I don't like to waste my time, when I have tests and exams coming up, I would rather focus on things that are relevant.

The interviewees were asked to make a final remark about their preferred learning approach as a conclusion to the group-interview. The discussion was consistent with data collected through the survey and interview. While students found RWPBL to be more interesting and engaging, they also found TL necessary for specific units that were "theory and calculation focused". The discussion also teased out the problems with RWPBL, in which, RWPBL was regarded 'time-consuming' with lots of ambiguities which left students uncertain if the "learning requirements" was met despite the work done which aligns with the concerns raised in literature. The idea was evidenced in the following quotations captured during the interview:

> *It does bother me if we are not given a clear idea what we meant to be achieving, because we are usually not given a very clear idea; we are just tumbling around database especially when we are in a team. It is a bit hard to design something when you are not quite sure, when you do not know what the outcome will be, and what it would look like or how heavily it will weigh, things like that.*

The group discussion further led to role of lecturers and unit coordinators, in which, it was a consensus agreement that teaching staff and unit coordinators play the ultimate role in contributing to the effectiveness of different learning approach. The following quotation represents the interviewees sentiment:

> *we like to talk about how hard subjects are, and what's good and bad about them, really the lecturer is key to whether we want to attend the lectures to understand the content and to have the motivation to actually do it. Of course, some lecturers know their subjects well but a lot of the time may not be as engaging as others. So I think it is more important for the lecturers to know how to teach their content efficiently.*

Discussion & Conclusion

Discussion

This study found that engineering students have a positive view of both TL and RWPBL and appreciate the benefits of both approaches in contributing to their learning. The RWPBL approach was found to be more engaging and motivating due to its' problem-based feature, which contributes to the discovery of new ideas through researching, brainstorming and problem solving. The students were also found to have associated RWPBL to teamwork and group projects, which resulted to their confidence in the RWPBL approach as a more relevant approach in developing professional and teamwork skills. This finding is consistent with literature that promote transformation in engineering curriculum for better learning experience such as Eidenskog, Leifler, Sefyrin, Johnson, and Asplund (2023) and Hernàndez-Sabaté et al. (2024).

While RWPBL was found to be a more favourable choice, students were also concerned about the ambiguity with learning objectives and outcomes in a RWPBL environment. This finding aligns with the literature. The persistent concern does not distract from the benefits of RWPBL but does serve as a good reminder to educators, especially in ensuring the design and implementation of RWPBL activities aligns with desired learning outcomes.

This study also demonstrated a high level of appreciation towards the TL approach. Traditional learning was perceived to be more effective for theoretical learning and considered to be more a more time-effective learning approach due to its' capability in enabling a focused discussion and direct interaction with teaching staff in a classroom environment. This finding is consistent with Coe et al. (2014) which suggested not to overlook the benefits of the TL approach, which facilitates clear instructions and efficient class time usage.

Students found that the effectiveness of each approach to be subject dependent. The students perceived that technical units and teamwork project could be learned efficiently in a RWPBL environment, but engineering science and mathematics focused units could only be learned effectively in a TL environment. This finding is consistent with the Australian Council of Engineering Deans (2021) recommendation to accommodate both RWPBL and TL and to strike a balance between the two approaches. The students' presupposition of theoretical and mathematics focused subjects could only be learned effectively with TL approach indicated not only a perception but also a learning behaviour which was influenced by previous school experience where theoretical subjects like science and mathematics were taught in a TL environment (Ardeleanu, 2019; Coe et al., 2014). This raises a question- should TL continue to play a significant role in some subjects to make the transition less abrupt for students commencing higher education?

The students also perceived the effectiveness of a learning approach is dependent on the capability and performance of the teaching staff. Students asserted that teaching staff play the ultimate role in making a certain learning approach effective to enable students to maximise the use of the relevant learning approach to attain the best learning outcomes and experience. This finding is also consistent with Australian Council of Engineering Deans (2021) which recommended for teaching staff members to be constantly trained and updated with pedagogical and professional knowledge. Well-equipped teaching staff could also address the ambiguous situations and disadvantages students identified in a particular learning approach, for example, less engaging learning in TL and learning objective being ambiguous in RWPBL.

Conclusion

This study concludes that students consider both RWPBL and TL have a role to play in engineering education, and are not mutually exclusive. This is a view shared by engineering students who appreciate the benefits of the contemporary RWPBL and yet value the merit of the TL approach. It is promising to see students persistently regarded the contemporary RWPBL approach as a more engaging and motivating way to learn, however, their lurking concern about the effectiveness of RWPBL in facilitating a holistic engineering learning should not be overlooked. This is a valid concern which warrants a closer examination to ensure the effectiveness of RWPBL in engineering education.

The students' reception of a particular approach can be significantly influenced by their previous schooling experience. While appreciating the novelty and benefits of a contemporary approach, they also gravitate towards the TL approach which is familiar to them since earlier school years. More importantly, the students place strong reliance on their educators in attaining successful education. They believe the effectiveness of a learning approach relies not only on a specific setting but more essentially the person preparing and controlling the setting. They also judge the effectiveness of a particular setting based on how readily their educator can be accessed for support and guidance. This serves as a reminder for educators to always maintain close contact with their students. This also alludes to the necessity in ensuring the educators are equipped with the relevant knowledge and skills to not only use the most appropriate approach for the appropriate unit/subjects, but also to engage the students in the approach that they select to use for their teaching. This efficacy is important not only for engineering education to educate the students with the relevant knowledge and skills but also for it to continue to play a sustainable role in the education world.

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