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Virtual work integrated learning (VWIL) implementation for improving student professional development in a remote learning environment

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ABSTRACT

CONTEXT

To become an accredited engineer, Engineers Australia requires students to engage with professional practice outside of their educational institution. Unfortunately, disruptions caused by the Covid-19 pandemic have made it difficult for students to secure industrial placement and develop the required professional competencies, resulting in delayed graduations. The significant number of students impacted by pandemic restrictions has necessitated new approaches to integrating authentic learning practices into engineering courses to provide students with industry exposure. Among these approaches, VWIL activities have proved to be one of the most robust in a remote learning environment and while still achieving course learning outcomes.

PURPOSE OR GOAL

The purpose of this paper is to share learnings based on VWIL activity integration to improve engagement, student professional development and student experience study. The learnings include the development of the teaching and learning activities which constructive aligns with assessments in the course as well as reinforce threshold concepts taught in the courses.

APPROACH OR METHODOLOGY/METHODS

A 360° virtual site tour was developed to continue to support student professional development by providing industry exposure in an online learning environment. This VWIL activity was integrated into level 3 chemical engineering discipline-specific courses as part of tutorials that focus on relevant threshold concepts for the program. An anonymous survey was conducted with questions based on student’s reflection of using the VWIL activity.

ACTUAL OR ANTICIPATED OUTCOMES

The study will provide an understanding of how VWIL can be used to supplement student professional development. Virtual site visits and WIL teaching and learning activities will enable equitable learning for the cohort whether the students are geographically local or studying remotely. Lastly, the study has an opportunity to provide insights into best practices for integrating industry learning activities into tertiary engineering courses.

CONCLUSIONS

It was concluded that desktop site tours are a useful learning tool for chemical engineering students, with over 90% of students being satisfied with the module’s implementation. They can be easily integrated into tertiary study, and student feedback indicates the resource is useful for enhancing understanding of course and discipline outcomes. It is suggested for future iterations that virtual site tour modules include additional supplementary engineering material or prompts to increase student engagement with it.

KEYWORDS

Authentic learning, virtual work integrated learning, professional development.

Introduction

To become an accredited engineer, Engineers Australia (EA) provides a list of professional competencies that students must develop during their tertiary study (EA AC, 2018). These skills range from the mathematics and sciences that underpin engineering theory, to professional and personal skills such as effective team membership, communication, and accountability (EA, 2021). To develop these skills, Engineers Australia recognised that 'exposure to practice' must become an imperative part of engineering education curricula (Bradley, 2008).

It is consequently a mandatory requirement for students in accredited engineering programs to have engaged with professional practice outside of their educational institution prior to graduation (EA AC, 2018), which is primarily completed in the form of an internship. Student participation in internships have been identified by Bilsland et al. (2020) as helping to bridge the gap between education and practice by providing the opportunity to be actively involved in their own learning (Seifan et al., 2019). Observation, interaction, and performance of engineering practices ease the transition between education and employment, and due to the less predictable nature of real-life events in an operating environment, students learn how to respond swiftly to unexpected occurrences (Bilsland et al., 2020). Communication with operators, contractors, and other staff during an internship also assists students in developing important professional skills (Lee, 2008).

In addition to internship experiences, site visits and interaction with industry integrated into courses throughout the program also provide students with authentic learning practices and connect them to their professional identity. The challenge for students in securing relevant discipline specific internship or course-work programs gaining industry site access even prior COVID-19 pandemic is well known. In a survey conducted by Male and King (2019) of 215 final year engineering students across 11 Australian institutions, 29 percent had not competed 12 weeks of industrial training and consequently could not graduate from their tertiary degrees despite nearing completion of their studies. These issues have been further exacerbated by the recent COVID-19 pandemic, which has meant that newer generations of engineering students are more likely to lack industry learning experiences (Aucejo et al., 2020) or gain site access through their coursework program. The transition to online learning has contributed to decreased student skills engagement, participation engagement and performance engagement (Wu & Teets, 2021), making it difficult for students to develop the required professional skills listed in the EA Stage 1 Competency Standards. Engineering student internships and job offers are also more likely to be cancelled (Asgari et al., 2021), decreasing the number of opportunities available for individuals to meet EA's industrial training requirement. Thus, a focus on improving student professional development through exposure to industry practices in a remote environment is necessitated.

One strategy for improving student engagement with industry is virtual work integrated learning (VWIL); compared to other authentic learning methods such as authentic assessment, and service learning, it is far more robust to online learning environments. The use of VWIL also provides a more level playing field for students studying remotely. Although it is not useful in assisting in student professional development on its own, it can be easily used as a supplementary material into course assessments and is consequently extremely adaptable to changing learning outcomes (Kumar et al., 2021). However, the usefulness of using VWIL activities to enhance student understanding of engineering learning and discipline outcomes by providing exposure to industrial practices has not been thoroughly explored in literature.

There are multiple types of VWIL implementation, namely virtual reality head-mounted displays (HMD), virtual interactive desktop models (VIDM), and desktop site tours (DST) (Kumar et al., 2021). These all vary in their level of interactivity and the scope for deeper learning offered. Compared to HMD and VIDM, DST have the lowest level of interactive activity and their guided nature is not conducive to deeper learning or exploration. Thus, for this method to succeed, it should be paired with guided activities or assessments to prompt participants to conduct further research about the features shown. This increases the scope of this implementation's use cases, allowing it to be tailored to address deficiencies in student education and professional development. Learning content can be developed faster and continuously updated between teaching periods based on student feedback (Kumar et al., 2021), allowing teaching activities to reach higher levels of Bloom's Taxonomy (Bell & Fogler, 1996). Despite its flexibility and ease of implementation, DST usage is not commonly found in engineering education literature. It is these benefits however that have informed the decision to focus on this model for this study.

This study therefore aims to (i) integrate the usage of a DST module into a tertiary engineering course to supplement learning activities, (ii) to evaluate the usefulness of this module in enhancing student understanding of course and discipline outcomes, and (iii) to evaluate the enthusiasm of students in participating in VWIL activities.

Methodology

Human Research Ethics

The ethical approval was granted by Human Research Ethics Advisory Panel at our institution.

Desktop Site Tour Creation

A DST was created for a brewery site in Sydney using 360-degree video and an interactive, web-based 3D menu using Three JS. The DST was filmed and created in conjunction with Vantage Interactive, who specialise in immersive experiences for education. This contained several short videos detailing information about each of the major units of operation from raw material plant, production (brewing and maturation) through to finishing plant (bottling and packaging). The content includes process flow inputs and outputs, reactions occurring, and examples of important process control parameters. The videos were filmed with a 360° camera to allow students to explore the surroundings and scale of each unit. The DST can be accessed via: https://vantageinteractive.com.au/UNSW/SCE/virtual_tour/Tooheys/.

Research Methods

Semi-qualitative methods were used to investigate the usefulness of using desktop site tours as a learning resource. To evaluate the DST's usefulness and understand student perception of the module, a questionnaire was developed for students to complete after interacting with the DST. These statements were developed based on the Online WIL Placements and Projects Guide (Kaider et al., 2020) and the Guide to Effective Assessment Design (Boud et al., 2020), and are listed in Table 1. The sample of this pilot study comprised of third-year chemical engineering students enrolled in a process plant design course. Around 20% (n = 12) of the students participated in the survey. Qualitative observations of student interactions with the tool were also made during the tutorial time.

Table 1: Student survey statements

No.	Statement
1	I was satisfied with the virtual tour as a learning resource
2	The virtual tour was an innovative learning resource, demonstrating a new creative use of technology
3	The virtual tour was interesting and kept my attention as a learning activity
4	The virtual tour enabled me to understand how course theory applies to real life scenarios
5	This platform enhanced my understanding of this course
6	This platform enhanced my understanding of my enrolled program discipline

Usefulness Survey

Students spent an hour in a process plant design tutorial observing the fermentation and maturation processes in the DST. Afterwards, they were tasked with completing a basic process control table (PCT) and process and instrumentation diagram (P&ID) of the vessel, before providing a basic description of the controls associated with it. The theory associated with the design tutorial was provided in preceding lectures. Students were then asked to indicate their level of agreement (1 = strongly disagree, 4 = strongly agree) with six statements (Table 1) to assess the usefulness of the DST as a learning resource. The students could also optionally provide written feedback explaining their agreement to each statement.

Data Analysis

Data was analysed in Qualtrics Experience Management and MATLAB R2022a for graphical analysis.

Results and Discussion

Table 2 displays the descriptive statistics (average and standard deviation) of student responses to the survey statements in Table 1 regarding the DST module's usefulness in enhancing their understanding and their enthusiasm to using this learning tool.

Table 2: Statistical description of student responses to DST for Process Plant Design course.

Statement	Average	Standard Deviation
1	3.3	0.5
2	3.6	0.7
3	3.9	0.8
4	3.2	0.4
5	3.3	0.5
6	3.4	0.5

The average score for each statement was above 3, with low standard deviations across all responses. As a score of 3 (75%) indicates agreement, overall, student responses to the use of the DST were positive. Figure 1, which displays the percentage breakdown of student responses to the survey statements, furthers these findings as all statements have a high percentage of agreement. Particularly, 100% of students agreed or strongly agreed that they were satisfied with the DST as a learning resource (statement 1), that it helped them understand the application of theory to real life scenarios (statement 4), and that it helped to enhance their understanding of the process plant design course (statement 5). For the other statements, there remained a high level of agreement, with 92% of students agreeing that the resource was innovative (statement 2) and helped to enhance their discipline understanding (statement 6), and 83% agreeing that they felt it kept their attention (statement 3). None of the students strongly disagreed with any of the statements, indicating that they positively responded to the use of the DST in their coursework.

General student feedback shows that students were enthusiastic about using the site tour in their coursework. One student mentioned that

> "*it was exciting to learn the coursework before seeing the site, I genuinely felt like I had the knowledge to be able to contribute to industry*",

with another stating that

> *"it's great to be able to see an actual process unit and all the equipment that we're discussing in seminars being used in real life"*.

Another student noted that

> *"the enthusiasm of the presenters made me enthusiastic about the tour"*,

highlighting the importance that tour guides have on maintaining student attention.

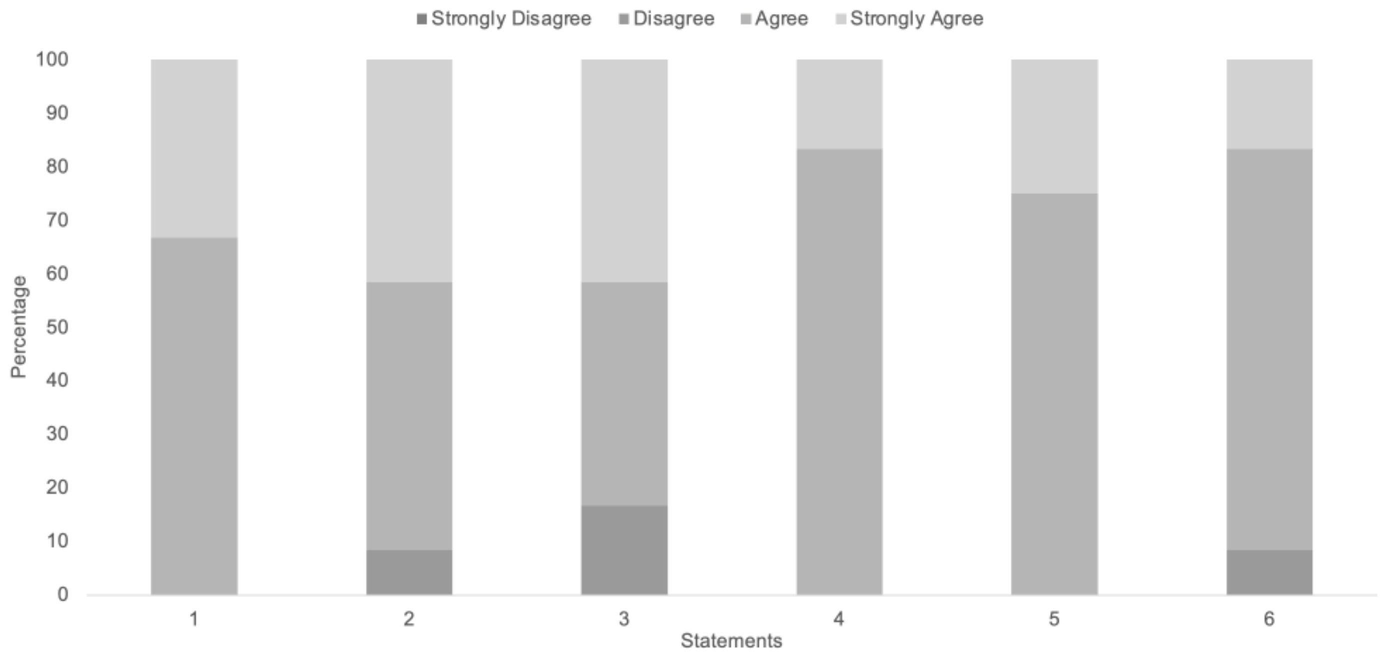

Figure 1: Student responses to survey statements

Enthusiasm of students participating in the activity

All students agreed or strongly agreed that they were satisfied with the use of the DST as a learning resource (statement number 1). Qualitative feedback, summarised in Table 3, mention that "*it was good being able to look around [the site]*", videos provided were "*vivid and clear*", and that "*it helped to grasp the scale of unit operations*". Despite this, 17% of students did not think that it kept their attention, with another 8% believing that the DST was not an innovative use of technology. Qualitative feedback for these students all mention that the module felt too

"similar to a regular video as opposed to a proper site tour".

This is likely because a DST lacks the same sensory and 3D experiences provided by that of a real site tour (Cliffe, 2017). A DST also does not provide the opportunity for students to communicate to experts on site unlike a face-to-face tour. Further, the DST lacks educational nudges, with the only prompts being the movements of the tour guides. As educational nudges and prompts are useful for keeping the attention of students to particular tour elements (Seifan et al., 2019), their absence from this DST may also have contributed to lower levels of student engagement.

Table 3: Examples of qualitative feedback for survey statements 1-3

Selection	Comment
Strongly Agree	It was good having the video and being able to look around.
	It was a great resource, allowing us to see what the equipment looked like rather than just a diagram.
Agree	While it was interactive, I didn't feel like I truly had a better understanding of the space, rather it was just more information that was being provided to us.
Disagree	I don't think the full features of a 360° video were utilised to their full extent. I think it is a good resource, "going" to a plant but there wasn't much else different from a regular video.
	It was difficult to pay attention, as it just felt like a regular video.

Usefulness in enhancing student understanding

All students agreed or strongly agreed that the DST helped to improve their understanding of course learning outcomes and the application of theory to real industrial practice. This is likely because the module was paired with tutorial activities to help connect course learnings to industrial practice. It is noted that despite positive response and comments, the qualitative feedback summarised in Table 4 displays that there were still areas that the tour could improve on regarding enhancing understanding of real-life applications of coursework. One student mentioned that it didn't assist in

> "*applying and determining how process design contributed to the equipment selected*".

Another student noted that they felt the DST only gave them a "*loose idea*" of how theory applies to real-life scenarios, suggesting that better use of supporting materials in the module could help to improve this. This would be similar to DST implementation exhibited by Norton et al. (2008) and Herritsch et al. (2011), who both incorporate relevant chemical engineering materials such as process flow diagrams and P&IDs to reinforce engineering theory applicability to industry.

8% of students disagreed that the DST module assisted in developing understanding of the chemical engineering discipline. This may be because the tutorial activities were limited in scope, only showing a specific area of one possible chemical engineering pathway. As the qualitative feedback mentions that the videos

> "*felt more like information to learn rather than something to supplement the things we had already learnt*",

it indicates that the DST implementation did not provide an overall perspective of the career students could work towards for this student.

Table 4: Examples of qualitative feedback for survey statements 4-6

Selection	Comment
Strongly Agree	Provided a good understanding of the brewing process, allowing us to apply skills we have already learnt
Agree	I felt the videos were purely instructional – it felt like more information to learn rather than something to supplement things we had already learnt.
	I think seeing a real-life example through VR when we physically can't go was good for seeing how the work we are doing is implemented.
	It gave me a better understanding of equipment size and control loops, but not so much applying and determining how process design contributed to the equipment selected.
	I understood the PCT table activity in relation to the video when we got it, but I felt it was more of a loose idea, rather than a strong supporting material to understanding theory being applied to real life scenarios.

Integration of DST into an engineering course

Observations of student interaction with the DST found that it was well received, however it was difficult to encourage students to complete the tasks as they would either get distracted with other activities, or not see a benefit in participating in the tutorial work. Out of a total 62 students in the process plant design course, only 12 participated in the research study, highlighting a lack of engagement with the designed tasks. This is likely because completing the tutorial tasks were not worth any academic merit; according to Padilla-Walker et al. (2005), providing extra academic merit encourages students to participate in voluntary research. Additionally, the use of a virtual tool is less likely to draw student engagement, with findings from Wu and Teets (2021) determining that online learning results have resulted in a decrease in student participation and engagement with coursework.

From a staff perspective, tour was easily integrated into coursework; it could be exhibited in a lecture environment, or students could work through it at their own pace. As it was broad and the explanations of unit processes were general, this makes it easy to integrate throughout different stages of tertiary engineering across various course subjects. The use of the DST across various learning stages in engineering is yet to be investigated. This displays that there are pedagogical advantages of using DSTs from a student and teacher perspective, aligning with results from Robinson (2009).

Recommendations

To promote stronger levels of student enthusiasm and engagement, it is recommended that future DST modules are interactive beyond the use of a 360° camera. An example of this could be the inclusion of additional engineering support materials such as process flow diagrams or control philosophies, as seen in the immersive units developed by Norton et al. (2008) and Herritsch et al. (2011). These can also help to solidify the bridge between course learnings and its application to industry, thereby enhancing student understanding of both course outcomes and their engineering discipline. It will additionally assist with integrating the module more seamlessly into tertiary engineering courses.

Providing academic merit for the completion of these tasks will also increase student participation. Student engagement could also be improved by dedicating more time to the development of the tutorials; according to LoPiccolo (2013), virtual tour tasks should require the same amount of planning as a real site tour to ensure there are sufficient opportunities for active participation. Integrating the DST module more broadly and repetitively throughout the duration of a course with follow-up activities will also assist in improving engagement, as it will allow for the showcasing of various applications of engineering theory across different parts of the site. It will also allow for the development of a fuller representation of the engineering discipline.

Conclusion

Desktop site tours have been introduced as a solution to assisting students achieve professional engineering competencies in a remote environment. These aim to allow students to witness the application of course theory to industrial practice and develop a fuller understanding of their selected discipline. The results from this pilot study find that this aim is fulfilled, and hence that overall, DSTs are a useful module. They can be easily integrated into tertiary engineering courses, and student feedback indicates the resource is useful for enhancing understanding of course and discipline outcomes. General feedback shows that students were engaged with the DST, particularly as it made them feel like they could connect to industry. 6% of responses were less enthusiastic about using a DST module, quoting that it is “too similar” to a regular video. To overcome this, it is recommended that future iterations of DST modules include supplementary engineering material or prompts to increase student engagement and attention to the resource. This study therefore concludes that DSTs are a useful learning tool, all (100%) students were satisfied and agreed or more that DST enhanced their understanding of the course and connection to real life scenario. Going forward to further encourage enthusiasm and engage all students, more interactive teaching and learning scaffolded activities, complimenting the DST can be integrated into the course. Also, rigorous assessments of the professional skills that are being developed would further enhance the course and value of the program.

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