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EDITED BY
Syed Far Abid Hossain,
BRAC University,
Bangladesh

REVIEWED BY
Shahid Ali,
Nanjing University of Information Science and Technology, China
M. Nazmul Islam,
BRAC University,
Bangladesh

*CORRESPONDENCE
Hock Siew Tan
tan.hocksiew@monash.edu

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Authentic research experience through mock grant application roleplay

Hock Siew Tan[1]*and Caryn Lim[2]

[1]School of Science, Monash University Malaysia, Bandar Sunway, Selangor, Malaysia, [2]Education Excellence Unit, Monash University Malaysia, Bandar Sunway, Selangor, Malaysia

Many universities resort to online teaching due to the COVID-19 pandemic. It is a challenging endeavour, especially in Biology courses that require lab access. Mock grant application roleplay is one alternative to lab-based activities. Although using mock grant applications as an assessment tool is not new, there have been few studies on students' opinions. To the best of our knowledge, this is the first time that it has been used in place of lab-based exercises and in conjunction with virtual lab modules. Students are engaged in three aspects: (i) targeted literature review, (ii) research proposal writing and (iii) 5-min project pitching. The design of this module is flexible, and other lab-based courses can adopt it. This module encourages undergraduate students to explore the lab techniques and concisely present their research proposals. Compared to the previous semester before COVID-19, the number of students that achieved the "Distinction" grade or higher increased by 6.3%, whilst the failures decreased by 3.2%. A similar trend was observed in 2021, the second year this activity was carried out. A survey amongst students who took this unit reported that student satisfaction with this unit has improved by 11.1%. This improvement could be attributed to this mock grant activity because the format and difficulty level of the student assessments had remained constant. Furthermore, qualitative analysis conducted *via* focus group interviews indicated that students agreed that the mock grant proposal assessment was useful in preparing them for future careers and was relevant to the course learning outcomes. Several participants pointed to the assessment's potential usefulness for careers in research. In conclusion, this roleplay module can fulfil the learning objectives of this course whilst providing an authentic research experience without lab-based activities.

KEYWORDS

mock grant application, recombinant DNA technology, roleplay, authentic learning, authentic assessment

1. Introduction

Recombinant DNA Technology is a branch of Molecular Biology that aims to add genes from one species into bacteria to produce a valuable product such as insulin for human consumption. Traditional teaching consists of lectures and complementary laboratory experiments. Laboratory activity is a core component because students learn important real-life lab skills during these sessions. Many universities have resorted to online teaching in the past 2 years due to the COVID-19 pandemic. It is a challenging endeavour, especially in Molecular Biology courses that require lab access. Due to the widely accepted "hands-on" focus of lab

practical sessions, switching laboratory-based units to online learning presents a unique challenge (Gewin, 2020; Ortiz, 2020).

In facing this challenge, the principal author introduced a mock grant application activity as an alternative to lab-based activities in a second-year undergraduate course in Recombinant DNA Technology. The mock grant application was considered a viable alternative as part of an authentic learning approach to provide students with practical research skills and to help them see the practical applications of this course (two of the unit's learning outcomes). We were surprised that students not only performed better in 2020 than in 2019 (before the restrictions on lab work), but were also more satisfied with the course (Tan, 2021, p. 519).

In 2021, still unable to return to our labs, the mock grant application was complemented with weekly virtual lab modules, which simulated certain experiments usually conducted in the lab. In addition, small improvements were made to the mock grant activity based on student feedback from 2020. Again, we wondered if this would improve student performance and satisfaction with the course. We also wanted to formally investigate how students perceived these activities.

Whilst using mock grant applications as an assessed activity is not new, few studies have reported on student perceptions. To our knowledge, this is the first used as a replacement for lab-based activities and in combination with virtual lab modules. In the Malaysian context, it is particularly important to investigate the impact of authentic, research-based activities such as this one because learning and teaching practices in STEM continue to be heavily teacher-centric and exam-oriented with few opportunities for independent inquiry (Thomas and Watters, 2015; Halim et al., 2021, p. 45). At the same time, Malaysian student interest in STEM disciplines appears to wane despite government efforts to attract and engage students (Halim et al., 2021).

With these gaps and need in mind, our study asks:

1. What effect does the mock grant application have on student satisfaction and academic performance?
2. How do students perceive the mock grant activity in combination with the virtual lab modules

a. What aspects of the activities do students find useful to their learning?
b. What aspects of the activities do students find interesting and engaging?
c. What aspects of the activities did students find challenging or less relevant to their learning?

2. Literature review

Authentic learning refers to an approach to teaching that emphasises student-led inquiry, real-world or industry-relevant problem-solving, and collaboration (Callison and Lamb, 2004; Herrington et al., 2009). Core amongst its principles is the use of "authentic contexts," which give students a sense of what it would be like to use their knowledge in a real-world situation (Callison and Lamb, 2004; Herrington et al., 2009). In science education, authentic learning and the development of practical, career-relevant skills often happens in the laboratory. However, whilst technical lab skills are crucial, other equally important skills outside the lab often get overlooked in traditional lab sessions (White et al., 2013). Educators have highlighted that many undergraduates who completed lab-based courses could not synthesise new experimental designs and did not understand the limitations of different approaches (Shelby, 2019).

Research-based learning is one approach known to have a positive impact on student outcomes and student experiences. van der Rijst (2017), found that research-based education has positive impacts in both the cognitive and affective domains, including improved skills, matured dispositions, and enhanced knowledge and understanding. Studies also reported that students in research-led courses were more motivated, engaged and confident in their research abilities (van der Rijst, 2017, pp. 15–16). Some case studies also note that the effects of research-based learning are observed even after the courses ended. Valter and Akerlind (2010) found that the course not only enabled students to consider how their learning was relevant to their lives and that many students also continued to the research-based honours program at the end of the course. Similarly, Hurtado-Bermúdez and Romero-Abrio (2020) suggest that research-based learning could improve student attitudes towards science education and lead to greater interest in research careers. However, van der Rijst (2017, p. 16) cautioned that "for research projects to become transformative learning experiences, students need to have the feeling of ownership and autonomy over their research projects." The design of learning and teaching activities and their assessment is an important considerations. Instructors must consider a range of variables including balancing "the thin line between providing support and giving autonomy to students" (van der Rijst, 2017, p. 16).

Grant application activities and assessments are one-way educators have incorporated research-based learning into their courses. This type of activity is useful when laboratory-based research activities are impractical. However, it is necessary to support students in applying theoretical knowledge, analysing real data, synthesising the literature, and developing scientific communication skills (Sparks-Thissen, 2017). The implementation of grant application activities is well-documented, and several educators have shared their experiences and observations about the activity (see Felzein and Cooper, 2005; Cole et al., 2013; Itagaki, 2013; Köver et al., 2014; Evans et al., 2016; Sparks-Thissen, 2017). According to Itagaki (2013), the most obvious advantage of the assessment is that it gives them a taste of "the process of doing science" but emphasises the importance of a peer review aspect of the assignment, which allows students to "see their work with outsiders' eyes." Some students who went on to graduate courses also reflected that this was one of the most useful activities as it developed skills that they would later apply (Itagaki, 2013). Whilst useful, this study and many others referenced here have relied largely on anecdotal evidence. Only a few published works present data from students on their perceptions and experiences (see Felzein and Cooper, 2005; Köver et al., 2014).

Köver et al. (2014) introduced a grant proposal assessment in a first-year neuroscience course and subsequently collected student data on perceived learning and student experiences through a survey. The study found that students found the assessment and related activities challenging yet useful in increasing their understanding of the subject matter and developing scientific skills, including how to "think like a neuroscientist." It was also found that the grant proposal assessment led to improved interest in the field as well as interest in conducting neuroscience research. However, some disadvantages to this type of

assessment were also identified, including an increased workload for students and instructors and resistance from some students who "may have expected a more traditional curriculum centred on memorisation of factual information." Felzein and Cooper (2005) similarly developed a Science course specifically to expose students to the process of conducting scientific research. A large part of the assessment in this unit was a written grant proposal. A survey with close-ended questions was used to collect data on student perceptions of the usefulness of the course and its various components. It found that students perceived the grant proposal activity as the most helpful activity to their learning followed by a reading component and a peer-review component activity.

3. Methods

3.1. Experimental design

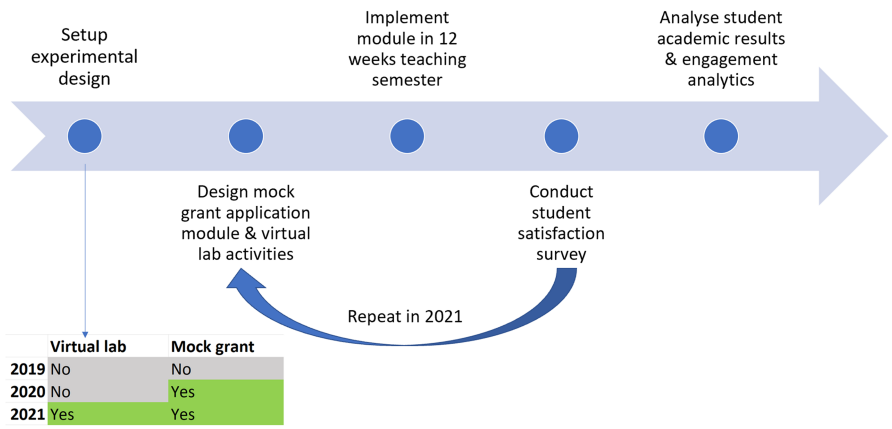
In 2020 and 2021, a series of virtual lab simulations and a mock grant application module were implemented to teach Recombinant DNA Technology fully online for an entire semester (Figure 1A). Students learned important laboratory concepts through the virtual lab. They were subsequently asked to write a proposal to clone any gene of interest based on their understanding of this unit's content. Students were divided into groups of five or six. Each group played the role of a team of investigators applying for a research grant to clone and express a recombinant protein as a vaccine against Neglected Tropical Diseases, in line with this course's learning outcomes. The lecturer informed the students that they were applying for a 1-year grant worth USD 2500 and were filling up an actual grant application form that had been slightly modified for the confidentiality of the funding body.

The three parts in this module (Figure 1B) were implemented *via* Moodle (the university's Learning Management System), as described previously (Tan, 2021). Briefly, the module timeline was carefully adjusted so that the grant planning skills coincide with the lecture content (Figure 2A). The virtual lab simulations were selected and curated from the freely available LabXchange (Figure 2B). The purpose of using LabXchange is to prepare students for the techniques used in the lab. It is a pre-lab activity that helps students familiarise themselves with the lab content. Students receive marks and feedback for each section. First, students conducted a targeted (non-exhaustive) literature review on the gene of interest and suitable cloning strategy. They were guided on literature search techniques and must highlight the novelty and significance of their proposal. Next, students draft up the actual research proposal. Here, the focus is on research methodology, project timeline and budget. One sample of a successful research grant was provided as a guide for students. Finally, they pitched their proposal in a 5-min video followed by a short question and answer session (Supplementary Figure S1).

3.2. Quantitative data collection and analysis

To evaluate the effectiveness of the mock grant proposal on student learning, both descriptive and inferential statistical techniques will be used in this study. Under the statistical inference, the independent *t*-test was used to compare the significant difference in student academic performance and overall satisfaction between three cohorts (2019, 2020, and 2021). The student satisfaction scores were extracted from the unit evaluation survey, focusing on the assessment's perceived usefulness, resources available, teaching activities and overall satisfaction. The student feedback was obtained from a qualitative unit evaluation survey conducted at the end of each semester.

A



	Virtual lab	Mock grant
2019	No	No
2020	No	Yes
2021	Yes	Yes

B

Activities	Format	%
Literature Review	Written report – Individual submission (~ 600 words)	5
Research Proposal	Written report – Group submission (~ 1500 words)	10
Oral Presentation	Video presentation – Group submission (~ 3 min video recording)	5

FIGURE 1
(A) Experimental design and process workflow for this research project. **(B)** Summary of the mock grant application activities implemented in this unit.

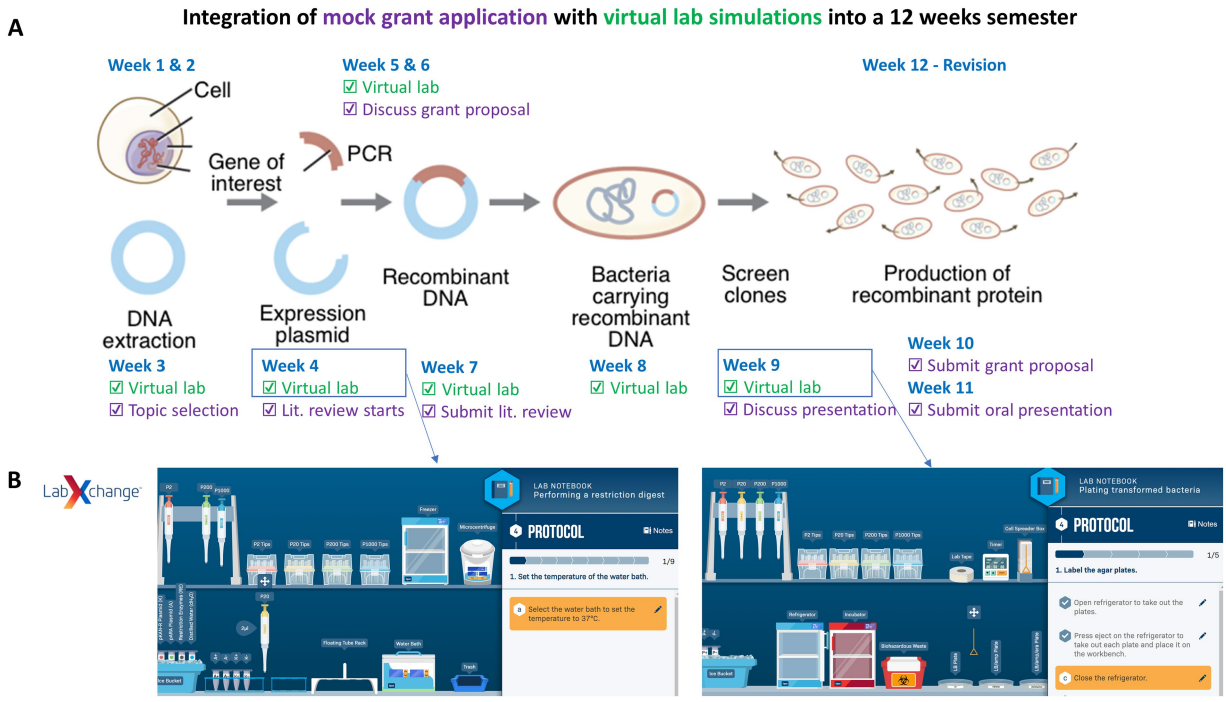


FIGURE 2
(A) Overview of the major concepts in the Recombinant DNA Technology unit and the integration of mock grant applications with virtual lab simulations. **(B)** Screenshot of two sample virtual lab simulations from Week 4 and 9 hosted on LabXchange.

3.3. Qualitative data collection and analysis

Focus groups were conducted with students to understand student perceptions and experience of the mock grant proposal and identify areas for improvement. A call for participants was sent out to all enrolled students of the unit during the semester. By the end of the semester, 14 students had volunteered to participate in the focus group. To ensure each participant had enough opportunities to speak, we ran two 90-min sessions. The first focus group consisted of seven students, and the second group had five due to two dropouts. Both focus groups were facilitated by the second author, who was not a teaching team member for this unit. The focus groups were recorded with students' consent and transcribed. This data was compared to the data derived from the unit evaluation survey to provide contextual nuance to the survey data.

4. Results

4.1. Quantitative data from the unit evaluation survey

Since this unit was implemented online *via* Moodle, student engagement with the content was quantified and normalised as the average number of Moodle views per week per student. The mock grant application module was first introduced in 2020 without accompanying virtual lab activities. A significant increase in the number of views in 2020 from 8 to 13 per week per student was observed (Figure 3A). The curated virtual lab activities that complement the techniques relevant to the project were included in 2021 in addition to the existing mock grant application activity. The number of views increased to 28 in 2021 and is statistically significant compared to 2020. Moreover, the virtual lab activity attracts and maintains many students attending in weeks 3–8 (Figure 3B).

Compared to 2019, before mock grant application and virtual lab activities were implemented, the number of students that achieved the "Distinction" grade and above increased by 6.3% and 21.1% in 2020 and 2021, respectively. Furthermore, the number of students receiving "Fail" showed a downward trend in 2020 and 2021 compared to 2019 (Figure 4A). A survey amongst students showed that this unit's overall satisfaction improved in 2020 and 2021. Specifically, the students agreed that the assessment, resources and activities implemented helped them achieve the learning outcomes of this unit (Figure 4B). This improvement could be attributed to this mock grant activity because the lecture content, format and difficulty level of the student assessments remained constant between 2019 and 2020.

Furthermore, the open-ended responses in the unit evaluation survey indicated that students agreed that the mock grant proposal assessment was useful in preparing them for future careers and was relevant to the course learning outcomes (Figure 4C). Several participants pointed to the assessment's potential usefulness for careers in research. Our results suggest a significant association between these teaching activities and student academic performance and satisfaction.

4.2. Qualitative data from focus groups

The data from the focus groups enrich our analysis in various ways, in some cases supporting our interpretations of the survey data, contradicting these interpretations, or pointing us towards new areas of analysis.

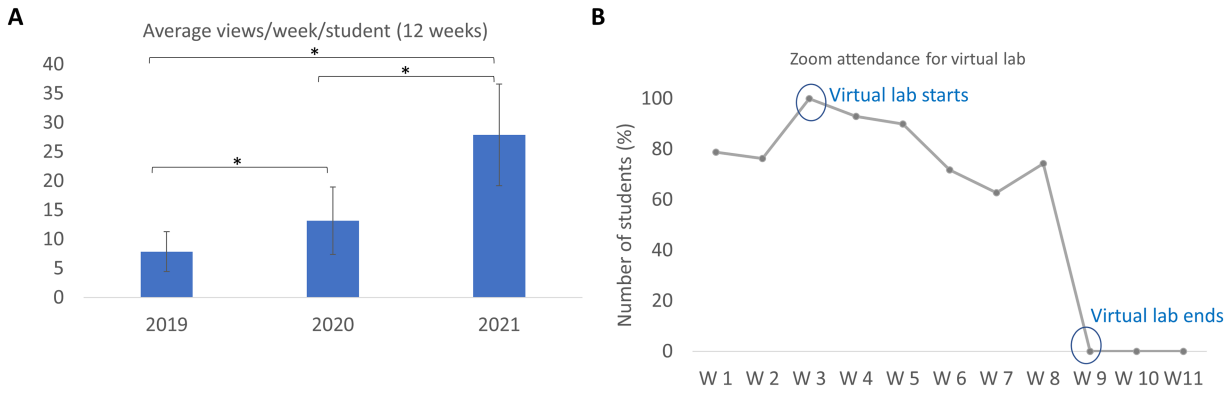
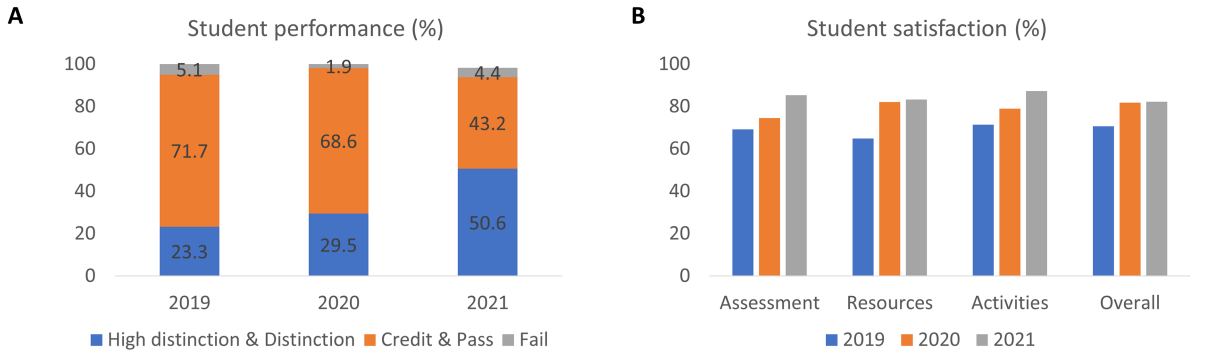


FIGURE 3
Student engagement statistics. **(A)** The average number of Moodle views per week per student. Student *t*-tests were conducted to determine statistical significance. **(B)** Students' attendance during virtual lab sessions conducted *via* Zoom.



C

"The group project 'Developing a recombinant vaccine against NTD' was an engaging and fascinating topic to study."

"I especially enjoyed the group project given to us although it was a tough challenge, and it helped me understand the expectations and obstacles that would arise if I were to pursue a career as a recombinant DNA scientist."

"This unit is very insightful, and I can apply the knowledge I've studied in the unit towards my future career."

"The content of this unit is very relevant to what's being done by researchers worldwide which is also very helpful, useful."

FIGURE 4
Student's academic performance and satisfaction survey. **(A)** The academic performance of the students. **(B)** The student satisfaction survey. **(C)** Sample qualitative feedback from students on their learning experience related to the mock grant application activities.

The focus group data showed that the students perceived the mock grant application activity as relevant and useful, further supporting the findings of the unit evaluation survey. In both focus groups, the student participants agreed that the mock grant proposal assessment was useful in preparing them for future careers and was relevant to the course learning outcomes. The students referred specifically to careers in research and others to a general future outside the university. Even those participants who had negative experiences with group mates appreciated the group work aspect of the assessment as being a good taste of what they may encounter in the future, as seen in the following excerpt:

> Participant 5: Yeah, I- I would say it definitely helped me, maybe in the future because we can't apply this now. Maybe [when] we have to apply for something…[like a research grant]
>
> Facilitator: Mm hmm. You mean, like in terms of job experience? Yeah. Mm hmm. What about Participant 6? Did you find this assessment sort of like… helpful for you, useful for you?
>
> Participant 6: I think this is very useful for me to gain experience as you work as a team for the research group, like a research team… and you [are], like, getting kind of an idea, like if you really want to study in research or others. [On the other hand] I also… like Participant 7, I get like really bad teammates because I was kind of a random selection. I just like randomly joined a group. I actually did like most of [the work], and that is kind of unfair. […But] you kind of get a lot of experience like how to feel, when you do this kind of like… when you can't start to conduct an experiment or when you can't start with a study. And I think

> it's very useful when you want to study a Ph.D. or other research. Yeah…

Whilst Participant 5 struggled to identify the relevance of the mock grant application activity to their current context, they nevertheless agreed that it was a useful experience or perhaps would be useful in a future workplace context. Participant 6, however, specifies two reasons they found this activity useful: (1) the activity helps them make career-related decisions by giving them "an idea" of what research would be like outside the undergraduate program, and (2) the activity simulates research workplace or PhD contexts in which group work and working with challenging colleagues is common. Interestingly, the student identified gaining experience in "how to feel" as a learning outcome resulting from the mock-grant application activity. We interpret this to mean that the activity taught the students how to think like scientists in research groups and how to modulate emotions and expectations when put in challenging work situations.

Another student, Participant 3, identified two other reasons for perceiving this activity as being useful: (1) the activity prepares them for the future in general, whether that future was in research or not; and (2) the activity allowed them to apply the knowledge they gained from other activities in the unit.

> Participant 3: I definitely enjoyed the research grant proposal because I felt like in a way, it was different from other units. Again, because it- it's like Dr. Patrick thought about not just for our unit, but like to prepare us for the future and if we ever become researchers or not like this is something for your future. So I really appreciated that and I enjoyed doing the research, even though, like, we got stuck a few times and [we had to] work it out together. So I enjoyed the research, I enjoyed everything. I think it was very useful and even helping me understand like the unit material because we had to do a plasmid map and like all that, so we had to… in order to do the plasmid map for the research we have to understand what was going on in the labtorial and in the workshops. So it's like an application of what we did. So I really found it very useful and helpful for me.

The focus group data also provides insight into the upward trend in student satisfaction and performance when comparing the 2020 and 2021 scores. From 2020 to 2021, only two changes were made. The first was the introduction of the virtual lab simulation activity, and the second was a limitation on the scope of the research project. In 2020, students were not limited in the research topics they could propose, whereas, in 2021, student projects were limited to vaccines against Neglected Tropical Diseases.

The focus group data indicates that the virtual lab simulation activity may be discounted from being considered a significant factor in student performance improvements. In both focus groups, students expressed confusion about how the virtual lab simulations were relevant to other activities in the unit. In addition, though most students in the focus groups reported that they completed the simulation activities, with some even describing the activity as enjoyable, the same students did not find it supported their ability to perform well on assessment tasks.

On the other hand, almost all the students agreed that it was preferable to narrow rather than widen the scope of the research project. Doing so made it easier for them to understand the expectations and scope of the project, as well as reducing the risk of tension amongst teammates. One participant even suggested that future students should be given a specific list of topics to choose from instead of coming up with their research topic.

The focus groups also tell us that group work posed a significant challenge to students and, in several cases, negatively impacted their overall experience. One participant, for instance, complained about being matched with group mates who were not as motivated, resulting in an unequal distribution of the work.

> Participant 7: I think it depends what teammates you have, I got a… yeah I basically done like more than 80 percent of the assignment. So, I think it's not enjoyable because my teammates [did not help] at all… it's like- the thing is that we don't know each other. […] You know we have different goals. Some just want to pass and just do it lousy. Like just do it for the marks only, do it just to pass. Some of us just do our best to get [as high] marks as possible, so when the group… it's not the same. It tends to be like, yeah, like in my case, I [did] everything myself.

Students who had more positive experiences of the assessed activity, on the other hand, related this to their positive relationships with their group mates:

> Facilitator: Participant 2, what was your experience? Did you like that kind of assignment?
>
> Participant 2: Yeah, I guess so, because the experience with my teammates are good and all of our goals is to… seem like we should do our best to get the… to get the best marks that we can get. Yeah. So I guess it is a good experience for me, it's a positive one for me."

Another participant also noted that working in a group meant dividing the work, which resulted in some individuals not having the opportunity to demonstrate certain learning outcomes.

> Participant 3: I guess, I have a teammate that is like, erm, carrying the team the most, because I don't know, he already knows all the knowledge, I guess so. Yeah, we just learned from him. Yeah. And I guess most of the practical techniques he kind of switched it up himself without telling us so. And when we ask him, I guess he just, I don't know, he doesn't answer much. So, yeah, I don't know.

In Focus Group 2, these issues with group work were less apparent, but some participants did allude to the same issues and "risks" when working in groups on large projects such as this. During a discussion about the possibility of expanding the weightage of the mock-grant project and allowing for more in-depth analysis (something the students initially said they wanted), the facilitator suggested that the assessment replace the final exams in the future. In response, two of the participants said that they preferred to keep the heavy final exam

(weighted at 60% of their overall grade) due to the apparent risks of group work:

> Participant 2: Well, I think the format, the current format is good, and I would prefer the format with [final exams].
>
> Facilitator: Yeah, really? Do you like [final exams]?
>
> Participant 2: Yeah. Because I don't want to have [such a heavy] weightage on one project, which depends on the group members also.
>
> Participant 4: … But I agree that if this is like if you want to make projects [a big proportion of the assessment regime], there should be maybe one individual project and one group project. Not like [where] the group project is the major part of the final exam because you depend on other people. So it's- it can be a bit risky. It can be a bit risky in a way and also cannot test your individual understanding.

5. Discussion

The results of the student evaluations and focus groups have helped us identify positive impacts resulting from the introduction of the mock-grant application activity as well as challenges that will need to be addressed in future iterations of this unit. Some of these positive impacts were expected and matched the findings of others who have implemented similar research-led activities into their curriculum. Like others who have introduced research-led and grant application-type activities into their curriculum, we found that these activities allowed students to apply theoretical knowledge to an authentic problem and gave students a taste of research that they found highly valuable and relevant to their future careers. Beyond knowledge and cognitive skills, the activities also allowed the students to develop specific attitudes and emotional skills necessary when working in groups and, more specifically, in scientific research teams. Based on the focus group discussions, we understand that student recognition and appreciation for these skills contributed to the high student satisfaction scores since the activity's introduction.

A major challenge to this type of authentic learning activity, however, is its dependence on group work and group cohesion. As students noted, the division of labour that often comes along with group work could lead to unequal workloads and learning outcomes. Meanwhile, being grouped with less invested group members could be demotivating for students. Gardner and Walters (2020) previously suggested that educators create groups through a selection process that results in groups with equal distributions of highly motivated and less motivated students. Our findings suggest that this may not be sufficient, as this perceived difference in motivation or prior knowledge amongst the students leads to unequal workloads and learning outcomes. As we learned, dissatisfaction with the group dynamic could occur when highly motivated students felt they were doing most of the work. In addition, less assertive students could be encouraged to take a back seat when a highly motivated or assertive student is in that group. Although issues with group work are commonplace, and this study suggests that students learn from these challenges, it is a significant impediment to their acceptance of authentic assessments involving collaboration. Because students perceived group work as risky, they conversely perceived exam-based assessment as safe and thus desirable. In future iterations of this unit, we plan to mitigate this challenge by ensuring a more even distribution between the group and individual assessments related to this project. We may also explore some activities to scaffold teamwork skills.

6. Limitations and recommendations

The scale of this project was small, with only 12 students participating in the focus group. This was due to the difficulties we faced with recruitment. The use of a survey with both Likert-scale and open-ended questions could provide different perspectives and richer data for analysis. It would also be useful to explore how scaffolding teamwork skills and a better distribution of individual versus group work might impact the students' experience and perception of authentic assessments.

7. Conclusion

In conclusion, this module encourages undergraduate students to explore the lab techniques they learned and concisely present their research proposal. We found that this mock grant activity could fulfil the learning objectives of this course whilst providing an authentic research experience without lab-based activities. This project aligns with the campus initiative to implement authentic learning and assessment in all degree courses at Monash University Malaysia by becoming one of the first units in the School of Science to make the change. It is a key unit with many students. Hence, we expect the successful implementation of this project will benefit many students. This project also developed and implemented a fully online learning environment to improve campus learning & teaching experiences in this unit. At a broader level, this project will contribute to our knowledge of authentic assessment from a student perspective and can inform similar innovations in the future. This project is also in line with the United Nations Sustainable Development Goal 4, which is to provide Quality Education to our students.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Monash University Human Research Ethics Committee (MUHREC). The patients/participants provided their written informed consent to participate in this study.

Author contributions

HT conceived the research project, executed the research in class, performed the quantitative analysis, and wrote the manuscript. CL conducted the focus group interview, performed the qualitative analysis, and wrote the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2023.1048947/full#supplementary-material

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