Virtual Field Trips for Experiential Learning in Undergraduate Agricultural Education: A Developmental Evaluation Study

Suresh Krishnasamy, BSc (Hons), PGDE, MSc

August 2024

This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

Department of Educational Research
Lancaster University
UK

Virtual Field Trips for Experiential Learning in Undergraduate Agricultural Education: A Developmental Evaluation Study

Suresh Krishnasamy, BSc (Hons), PGDE, MSc

Abstract

Virtual Field Trips (VFTs) are increasingly important across various disciplines because they offer practical real-world experience to complement theoretical knowledge. Recent literature has examined the use of VFTs to address educational and administrative constraints surrounding in-person field trips. This literature suggests that VFTs are a viable alternative or addition to in-person field trips with research showing high student satisfaction and improved assessment scores. However, the literature fails to critique student experiences of VFTs or relate these to broader educational outcomes.

This thesis documents the use of a Developmental Evaluation approach to iteratively integrate VFTs in undergraduate agricultural education. The project uses experiential learning theory as an explicit pedagogical framework to problematise student experiences and the attainment of student outcomes is mapped to core graduate attributes derived within the institution incorporating 21st century skills. Data sources comprise quantitative and qualitative data from student surveys and reflections on their VFT experience and learning, the developmental evaluators' reflections, and meeting discussion notes.

The findings from the phases reveal that successful integration necessitates clear task instructions and ample engagement duration. Sequential task building enhances students' innovative problem-solving skills. The scenario design emerges as a critical success factor, while pre- and post-activity discussions with facilitators enhance specific aspects of the student experience. Analysis across the phases of the work identifies these issues as crucial for

incorporating VFTs while allowing for customisation between uses across different disciplinary contexts and levels of study. Findings about student outcomes, mapped to the institution's graduate attributes, demonstrate improvements in social and civic responsibility, effective engagement with information technologies, and enhanced collaborative abilities.

The project contributes to the literature by shifting the evaluation focus from predefined outcomes to a process-oriented lens. By expanding the evaluation to encompass broader student outcomes, this project enhances understanding of the benefits of VFTs in experiential learning as a pedagogical process based on distinct student experiences. Based on these insights, the thesis contributes to the body of research on VFTs by introducing a carefully developed activity design framework rooted in experiential learning theory. This framework can serve as a guiding mechanism for educators in the design of VFT-centred activities with the explicit objective of augmenting 21st century skills.

Table of Contents

List of Figures and tables

Acknowledgements

I would like to express my sincere gratitude to one of my closest friends, Valliappan Renganathan. It was his selfless decision that made it possible for me to even entertain the thought of embarking on a doctoral programme, let alone completing it. You would not have known at that time how that decision changed the course of my life, along with that of my family. For that, I cannot express enough gratitude.

Secondly, I must give thanks to my supervisor, Dr Brett Bligh. I cannot imagine the challenge of having to supervise a student like me, let alone get me to change my views on how things should be done. Through our work together, I have seen myself change as a student and a researcher. More than that, I have seen your influence on my conduct as a supervisor for my students.

I would also like to take the chance to extend my thanks to Professor Paul Trowler, Dr Natasa Lackovic, Professor Malcolm Tight, and especially Professor Murray Saunders. In their role as the various module convenors during Part I of the HEREE programme, they shaped and refined my ideology and practice as an educational researcher.

This project would not have been possible without the support of my colleagues at the School of Agriculture and Food Sustainability at the University of Queensland. A special thanks go out to Dr Lynn Hoffman, Dr Alwyn Williams, and Associate Professor Ammar Abdul Aziz. They graciously opened their classrooms and allowed me to trial the use of virtual field trips in their courses. Similarly, I would also like to express my gratitude to the students whose views and responses formed a significant basis for my project.

Finally, I must thank my wife, Sarah. She had to develop additional levels of patience and tolerance to endure my undulating moods and constant irritations. Although they might not know their contributions, I must thank my pets, Sophie (a greyhound), and Simba (an orange tabby), who were always able to find the right time and means to help me destress.

Publications derived from work on Doctoral Programmes

An abstract for work done on Iteration 1 of the study was submitted to *The Australian Conference on Science and Mathematics Education 2022* resulting in a conference proceeding and a further full-text publication.

- **Suresh Krishnasamy**, Smith, Millicent R., Narayan, Edward, Abdul Aziz, Ammar and Hoffman, Eleanor W. (2022). Developing virtual field trips for Agriculture. *The Australian Conference on Science and Mathematics Education*, Perth, WA Australia, 28-30 September 2022. Sydney, Australia: The University of Sydney.
- **Krishnasamy, Suresh**, Smith, Millicent R., Narayan, Edward, Abdul Aziz, Ammar and Hoffman, Eleanor W. (2023). Developing virtual field trips for agriculture. *International Journal of Innovation in Science and Mathematics Education*, 31 (3), 3-19. Doi: 10.30722/ijisme.31.03.001

Chapter 1: Introduction

1.1 Introduction

Field trips are structured learning experiences that take place outside of the classroom and are designed with educational goals in mind. These trips have been a longstanding tradition in natural sciences education and are considered an essential aspect of providing students with the skills and knowledge necessary to succeed as scientists (Behrendt & Franklin, 2014; Jones & Washko, 2021). The value of field trips lies in their ability to provide students with hands-on learning experiences that allow them to engage in real-life observations and experimentation (Kundu, 2016; Litherland & Stott, 2012; Seifan, Dada, & Berenjian, 2019). By taking students out of the classroom and into the field, they are allowed to see academic concepts in action and gain a deeper understanding of the natural world (Cliffe, 2017; Schulze et al., 2021).

Field trips are seen to be valuable as they have been demonstrated to contribute to deep learning and improve student outcomes (Cliffe, 2017; Klippel, Zhao, Oprean, Wallgrün, et al., 2019; Shinneman, Loeffler, & Myrbo, 2020). It is argued that the opportunities they create for engagement with professionals and experts (Kolivras, Luebbering, & Resler, 2012; Stoddard, 2009; Stumpf, Douglass, & Dorn, 2008) open the minds of students and give them a clearer picture of how their learning has a place in the working world and how their theoretical knowledge is being applied. Furthermore, field trips have been argued to contribute to the enhancement of personal skills such as self-efficacy, autonomy, and a sense of ownership over one's work, as well as interpersonal skills like collaboration, feedback provision, and building a peer network (Atchison & Kennedy, 2020; Jones & Washko, 2021; Larsen et al., 2016).

Despite these benefits, from the early 2000s, the literature has focused on the considerable constraints in the delivery of in-person field trips ranging from administrative issues to accessibility issues even including the unpredictability of weather (Çaliskan, 2011; Hurst, 1998; Klemm & Tuthill, 2003; Tuthill & Klemm, 2002). The most commonly identified challenges are those of a logistical nature such as health and safety considerations (Kundu, 2016;

McMorrow, 2005; Wolf et al., 2021), lack of curriculum time (Hallein et al., 2024; Wolf et al., 2021) and increasingly large classes (Hurst, 1998; Seifan, Dada, & Berenjian, 2019) amongst others. Furthermore, most field trips take a long time to coordinate and organise including travel time and being subject to varying weather conditions (Çaliskan, 2011; Hallein et al., 2024; Shinneman, Loeffler, & Myrbo, 2020). There has thus arisen an impetus to seek an alternative means of providing students with “formal field experiences” where they are provided with an opportunity for hands-on, applied learning (Atchison & Kennedy, 2020; Dolphin et al., 2019; Patiar et al., 2020; Schulze et al., 2021). This is the premise for the entry and research of virtual field trips (VFTs) in higher education – in essence as a replacement or addition to for in-person field trips (Klippel, Zhao, Oprean, Wallgrün, et al., 2019; Kolås et al., 2020; Leininger-Frézal & Sprenger, 2022; Mead et al., 2019; Wolf et al., 2021).

Despite some scepticism, discussed further below, VFTs have been found to provide a range of benefits that enhance the educational experience (Dolphin et al., 2019; Litherland & Stott, 2012; Tuthill & Klemm, 2002). Firstly, they break down geographical barriers, allowing students to explore places and cultures they may never physically visit (Annetta, Klesath, & Meyer, 2009). In the realm of agriculture education in which this study takes place, this has become an important consideration with a decreasing number of students coming from rural backgrounds and an increasing internationalisation of the university curriculum (Barber et al., 2016; Hallein et al., 2024). This trend highlights the necessity of ensuring that agricultural education is accessible to a wide spectrum of students, irrespective of their geographical origins or backgrounds. VFTs offer educators the opportunity to design personalized learning experiences that align with specific curriculum objectives. For example, geography and geoscience students can virtually tour landscapes and terrains (Dolphin et al., 2019; Friess et al., 2016; Schulze et al., 2021), biology students can explore ecosystems (Shonfeld, Erez, & Litvak, 2003; Spicer & Stratford, 2001), and hospitality students can visit restaurants and hotels (Patiar et al., 2020; Patiar et al., 2017a; Patiar et al., 2017b), all from the comfort of the classroom or their place of residence. Moreover, VFTs also offer an opportunity

for interdisciplinary teaching and learning which is an implicit learning outcome that field trips can offer (Jacobson, Militello, & Baveye, 2009).

Furthermore, VFTs have shown the potential to cater to diverse learning preferences by embracing the affordances of technology. Students can engage with 3D models (Dolphin et al., 2019), interactive simulations (Hirsch & Lloyd, 2005), images (Grosser et al., 2023) and videos (Friess et al., 2016), enhancing their retention and comprehension of the subject matter. This technology-driven approach is often seen as captivating students' attention, making the learning process more enjoyable and fostering a sense of curiosity (Grosser et al., 2023; Jacobson, Militello, & Baveye, 2009). Additionally, the accessibility of VFTs can be seen to promote inclusivity, providing all students, regardless of their physical or financial limitations, with equal opportunities to participate in enriching educational experiences (Hirsch & Lloyd, 2005; Kolivras, Luebbering, & Resler, 2012; Stainfield et al., 2000). In disciplines where safety is paramount such as construction and engineering, the VFTs are found to provide students with a fail-safe environment where they can develop, practice and improve skills while not being placed in danger or risking the safety of others (Hai Chien Pham et al., 2018; Seifan, Dada, & Berenjian, 2019). These fail-safe environments allow them to grow in confidence when using those skills in real-world applications (Dolphin et al., 2019; Mead et al., 2019). The employment of technology allows the mitigation of challenges identified when embarking on real field trips. In the COVID-19 reality[1], challenges like accessibility and travel restrictions have come to the forefront (Buckley et al., 2022; Evelpidou et al., 2022). Considering that VFTs have been shown to overcome similar challenges (Arrowsmith, Counihan, & McGreevy, 2005; Friess et al., 2016; Seifan, Dada, & Berenjian, 2019), there is a benefit in exploring their potential in a post-COVID world. Embracing VFTs also has the potential to set us up for future epidemics should they arise.

Despite acknowledging the benefits of VFTs alongside the challenges of organizing an in-person field trip, practitioners and researchers have not been

[1] The project begun when COVID concerns were still an issue though this has eased considerably since then.

readily adopting them as a replacement solution without scepticism (Dolphin et al., 2019; Grosser et al., 2023; Schulze et al., 2021; Spicer & Stratford, 2001). It is claimed that the success of field trips comes from student immersion and the impact of engaging the affective domain and its importance to the student experience (Dolphin et al., 2019; Friess et al., 2016). With VFTs being unable to replicate that immersion, a belief is sometimes stated that it is not a perfect replacement and should not be used as such but rather as either a complementary or supplementary resource for in-person field trips (Dolphin et al., 2019; Friess et al., 2016; Grosser et al., 2023; Schulze et al., 2021; Spicer & Stratford, 2001). It is also claimed that the depth of immersion required for more advanced studies will render VFTs less effective than in-person field trips (Kolivras, Luebbering, & Resler, 2012; Stumpf, Douglass, & Dorn, 2008) which could potentially be an explanation as to why the majority of VFT studies are conducted in introductory courses across various disciplines (Dolphin et al., 2019; Friess et al., 2016; Hurst, 1998; Meezan & Cuffey, 2012; Seifan, Dada, & Berenjian, 2019). Similarly, the inability of VFTs to provide an interactive environment where students can interact with their instructors or the experts at the field site has been highlighted as another drawback in comparison to in-person field trips (Friess et al., 2016; Grosser et al., 2023). Exemplifying this as poor engagement of students on an affective level (Dolphin et al., 2019; Friess et al., 2016) puts VFT's ability to be an adequate replacement into question.

It's worth noting that even though VFTs may have some shortcomings, comparative studies that aim to determine whether they provide better student experiences or outcomes usually overlook these issues and implement VFTs as a direct replacement for in-person field trips (Kingston et al., 2012; Kolivras, Luebbering, & Resler, 2012; Palaigeorgiou, Malandrakis, & Tsolopani, 2017; Shinneman, Loeffler, & Myrbo, 2020; Stumpf, Douglass, & Dorn, 2008). This approach seems to assume that students will engage with VFTs in the same way they would on an in-person trip which may not be accurate (Spicer & Stratford, 2001). For instance, students typically experience an in-person field trip with others and engage in group interactions, whereas VFTs are used in a self-directed manner often requiring individual engagement (Friess et al., 2016; Stumpf, Douglass, & Dorn, 2008). Across the literature, it can be observed that

despite the extensive use of VFTs across various sectors, their integration into activities and lessons is often unguided and devoid of a pedagogical grounding. With a pedagogical basis, perhaps a fairer comparison between VFTs and in-person field trips would be attainable. One key outcome of students engaging in in-person field trips is skills associated with the affective domain including communication skills and teamwork (Ramachandiran & Dhanapal, 2016). Perhaps the notion that VFTs are unable to effectively connect with the affective domain of students has led to much focus on the student knowledge gain and satisfaction when engaging with them. Unfortunately, research into student attainment of broader educational outcomes has also been left largely unexplored. When the affordance of VFTs is harnessed and incorporated into the design of the activities, positive student outcomes have been noted in both cognitive and affective domains (Hirsch & Lloyd, 2005; Kingston et al., 2012; Spicer & Stratford, 2001) and are seen as comparable to that of a student going on in-person field trips (Stumpf, Douglass, & Dorn, 2008). Many of these points will be revisited in more detail in the literature review chapter.

Based on a conviction about the value of the capabilities of VFTs in providing students with an “experience” and a belief that the “experience” and associated outcomes can be influenced by the activity design, my project sets out to understand how to best use VFTs for “experiential learning” in undergraduate agricultural education by addressing the following research question.

How can an integrated VFT activity design support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education?

This introductory chapter continues with a sharing of my motivation for embarking on this project and is followed by an outline of the project’s policy, practice, and research context. I conclude it with a description of my research approach and conclude with an overview of the various thesis chapters.

1.2 Personal Motivation

To understand my motivation for this project, I need to bring you back to 2020. I had just moved to Australia to take on the position of Associate Lecturer (Curriculum and eDesign) at the School of Agriculture and Food Sustainability (AGFS)[2] at The University of Queensland (UQ). Having been a learning designer for 9 years at that point, it was a huge opportunity for me to take the step into an academic role an eight-hour flight away from home (Singapore) and at a rural campus (see Figure 1.1). In negotiating my work tasks for the year, I expressed an interest in teaching the undergraduate chemistry course that we had at the school so that I could do a team-based learning (TBL) project in undergraduate chemistry education. TBL has been an intrinsic passion of mine since 2015 when I was trained in its pedagogy and led the transformation of traditionally delivered courses, in the business and engineering disciplines, into the TBL format as part of Nanyang Technological University's Technology-enhanced Learning initiative (Centre for Research and Development in Learning, 2018). Seeing first-hand the increased student engagement and improved confidence in applying their knowledge, prompted my hope that the TBL pedagogy could be employed in chemistry education, which is my discipline.

Figure 1-1 Collage of UQ Gatton campus and my proud first day.

[2] The school was formerly named the School of Agriculture and Food Sciences and was renamed in July 2023

Unfortunately, as we have all come to endure, the COVID-19 pandemic forced universities to close, and courses to transition online (Lee et al., 2021; Smith & Kaya, 2021). This essentially required me to rely on my curriculum design and educational technology expertise to transition the school into a space where they could ride out the pandemic. Having previously had a specific idea of what my PhD project was to be, this closure was a huge blow. It forced me to reconsider my TBL project idea especially as it had a huge element of having students engage in a task synchronously. Thus, I had to devise a project idea that would firstly excite me and secondly open barriers and have far-reaching applications within the university and perhaps even potentially across institutions.

As I helped many colleagues transition to the fully online delivery mode, I increasingly found a challenge in converting the hands-on experience of a course into the online space. At the school, these hands-on experiences took the form of either practicals or field trips. In transitioning practical delivery to the online mode, I found that using videos and simulations seemed to hit the intended outcomes and was more than adequate in its transition. However, informal feedback from course coordinators indicated that these applications were unable to adequately provide students with the experience they would have had when going on an in-person field trip. The coordinators reflected that the students treated the videos and simulations just as they would any lecture recordings and were very focused on what they were supposed to learn from each learning resource rather than having a holistic learning experience like on in-person field trips. Scouring the literature for some ideas on how to improve the student experience by offering alternatives to in-person field trips I found numerous articles resonating with some of the challenges that I had heard colleagues talk about when discussing in-person field trips including the lack of administrative support, logistical challenges, larger enrolment numbers and the unforeseeable challenge of weather conditions. This scouring of literature and these conversations with colleagues identified an actual need that I was invigorated to address. Going through my list of experiences with various educational technologies like immersive VR and augmented realities along with their associated challenges, I decided to put forth an idea for the development

of a VFT application based on videos and interactivities. This idea was proposed and successfully awarded the Australian Council of Deans of Science (ACDS) 2021 Teaching and Learning Grant[3]. The VFT application developed using the grant funds formed the basis of the work documented in this thesis.

The development of a VFT application might have been a great project in technology terms, but my specific motivations arose from my experiences as a learning designer. In my previous role as a driving member of technology-enhanced learning initiatives at two universities in Singapore, I had come to the conclusion that an educational tool built without pedagogical considerations of how it would be used to support learning would ultimately be a white elephant, a similar idea which was also reported by Luckin et al. (2012). In my literature searches, described above, I found that the experiential learning theory (ELT) was often quoted as the pedagogical model used to guide in-person field trips across different disciplines (Djonko-Moore & Joseph, 2016; Higgins, Dewhurst, & Watkins, 2012; Larsen et al., 2016; Stern & Powell, 2020). I, therefore, decided to use the theory to underpin my exploration of designing experiential activities with VFTs.

Though I had come across ELT during my teacher training days, I had not used it as a pedagogical approach in my learning design journey. However, I read that Bradford et al. (2019) had found that experiential learning was more effective at increasing student agricultural knowledge than direct instruction. As such, I decided that my PhD project would be an investigation of how the tool I was developing could be integrated into an experiential learning activity and how that activity could be designed to maximise intended student outcomes. In doing that, I wanted to present a case where a single resource could be reused across courses and disciplines just like how going on an in-person field trip is an interdisciplinary experience.

In devising a research design, I looked back at something that had inspired me during Part One (years 1 and 2) of my PhD programme in *Higher Education: Research, Evaluation and Enhancement* (HEREE), where I learnt

[3] https://www.acds.edu.au/2021-successful-teaching-and-learning-grants/

about and embarked on a project involving Developmental Evaluation (DE). In one of my core modules, *EDS844: Evaluative Practice in Social Policy Domains: Higher Education*, I used this evaluation approach to support a blended learning initiative in a plant science course. Through that experience, I realised how flexible and responsive the DE approach was, along with how well it fit my educational research contexts. Beyond my personal best assignment in the programme, the assignment opened the door for me to present at my first educational conference. Though my work from that module is yet to be published in a peer-reviewed journal, my experience in using DE inspired me to adopt it across various research projects that I have embarked on. Similar to my work in the EDS844 module, I have used the DE approach across several other blended learning initiatives at my school. Beyond that, I have also used it in evaluating the effectiveness of feedback practices and improving sustainability education in in-person field trips. To say that it is now my go-to approach for a variety of intervention studies is an understatement. The greatest value I find in the approach lies in its flexibility which is ingrained in its guiding principles and how everything that is evaluated serves to develop the innovation as opposed to simply making a summative judgement on it.

On a personal note, through my PhD project, I wanted to demonstrate the benefits and potential of educational technology beyond that of just video lectures to my school colleagues. At the point of writing, this project already has had a quantifiable impact at the school, where the implementation presented in my thesis has gone through another academic year and is slated for the upcoming semester as well. Additionally, the platform has also incorporated additional VFTs (developed by the industry) to allow for additional courses and disciplines to use this technology. The continuing work is also yielding comprehensive data sets that could be used for publications in peer-reviewed journals which will go a long way in my fledging academic career. Similarly, for colleagues in the research community, I hope that through reporting on my PhD project, I will be able to shed light on the capabilities of using VFTs for experiential learning and for attaining broader student outcomes.

1.3 Policy Context

Field trips play a crucial role in education by providing students with real-world experiences that complement classroom learning. For this section, I have chosen to focus on Australia since it serves as the project's base. Three primary reasons support this decision. Firstly, policies tend to be shaped by the unique socio-economic, cultural, and political conditions of a particular country. By dedicating attention to Australia, I can gain a better grasp of the intricacies of this environment. Secondly, homing in on one country enables me to conduct a thorough examination of its policy landscape. This, in turn, can furnish me with an appreciation of the difficulties, accomplishments, and areas for potential growth within that specific setting. Finally, the DE approach I have taken for this project emphasizes the understanding of context. As I will describe in Chapter 3.4, a key tenet of the principles of DE is being mindful of how the innovation is situated within the boundaries and perspectives that are relevant to the intended users of the innovation. As my project takes root in an agricultural setting in an Australian university, with the VFT developed using funds from the ACDS, having an Australian focus on this section is apt.

The policy context surrounding field trips in Australia is shaped by a dynamic interplay of educational standards, safety regulations, inclusivity, community engagement, environmental sustainability, and government support in Australia. University policies concerning field trips can sometimes feel elusive, buried deep within administrative documents and websites. And when you finally unearth them, they tend to prioritize safety precautions over educational objectives[4]. While safety is undeniably paramount, it is unfortunate that such discussions often overshadow the primary purpose of field trips: to enhance learning through real-world experiences. It's crucial for universities to strike a better balance between ensuring student safety and emphasizing the

[4] Policies from some University Policy Libraries:

- Griffith University: https://www.griffith.edu.au/__data/assets/pdf_file/0028/327646/Field-Trip-Guidelines.pdf
- Flinders University: https://students.flinders.edu.au/feedback-rights-policy/whs/information-documents/topic/field-trips
- University of Canberra: https://www.canberra.edu.au/policies/PolicyProcedure/Index/168

educational value of these outings. By doing so, they can better equip students with practical skills, foster critical thinking, and provide opportunities for hands-on learning that complements traditional classroom instruction. Therefore, there's a clear need for policies that not only mitigate risks but also actively promote and support the educational goals of field trips, ensuring that students derive maximum benefit from these enriching experiences.

One key element to acknowledge at this juncture is how much of the policy context in Australia emphasises the schooling context with minimal references made to the higher education space where my project is situated. This could be because while the Tertiary Education Quality Standards Agency (TEQSA) is responsible for regulation and compliance with established quality frameworks, Australian universities are primarily self-accrediting (Australian Council of Deans of Science (ACDS), n.d.). The minimum standard of quality for the student educational experience at higher education is broadly described in the Higher Education Standards Framework (HESF). However, curriculum development and determination of threshold learning outcomes are left to the discipline-specific Council of Deans (The Higher Education Standards Panel, 2015). In exploring the threshold learning outcomes (TLOs) for Geography, developed by The Australasian Council of Deans of Arts, Social Sciences and Humanities, I noticed that the incorporation of fieldwork activities is mentioned as an afterthought rather than a central focus (Australian Learning and Teaching Council, 2010). Conversely, when looking at the geography curriculum at the science secondary level, the curriculum incorporates the term “fieldwork” across the learning outcomes from all the different learning units (*Geography - General Senior Syllabus*, 2019). This gives the impression that the outcomes at the higher education level in the geography context go beyond engaging in field activities. In connection to my project outcomes, it was notable that broader student outcomes like communication skills and working in teams were explicitly stated in the Higher Education outcomes (Australian Learning and Teaching Council, 2010).

Interestingly, this trend is also observed in the Agricultural context. Reviewing the TLOs for Agriculture, there is no mention of fieldwork or field-

related activities (Acuña et al., 2014). However, the senior science agriculture curriculum requires students to complete mandatory practicals that involve fieldwork (*Agricultural Science - General Senior Syllabus*, 2019). As seen in the geography context, the TLOs for Agriculture in Higher Education explicitly state outcomes like communication skills and working in teams. By weaving field trips into the early curriculum, it seems that Australian education authorities recognize the transformative potential of field experiences, providing students with a more holistic and contextual understanding of academic subjects. However, as students enter higher education, their intended outcomes expand to incorporate more holistic skills-based ones. Thus, it is important that using field trips or VFTs, as per my project, allows for the achievement of a broader range of educational outcomes.

1.4 Research context

As I will illustrate in Chapter 2, the literature already gives an excellent overview of various VFT implementations across different disciplines ranging from more obvious disciplines such as geography (Hurst, 1998; Kolivras, Luebbering, & Resler, 2012) to biology (Kolås et al., 2020; Shonfeld, Erez, & Litvak, 2003) but also applications in business (Mathews, Andrews, & Luck, 2012) and hospitality (Patiar et al., 2020; Patiar et al., 2017a; Patiar et al., 2017b). Yet we have a lot to learn about implementing VFTs with a sound pedagogical grounding and for achieving broader, holistic student outcomes. In reviewing the extant literature on various VFT implementations in higher education, I found three themes to which my project can contribute - *Pedagogical Considerations, Evaluation Approaches and Student Outcomes*.

Though the range of literature describes their implementations in some detail, they often do not delve into the pedagogical considerations involved when designing activities involving VFTs. In describing their implementations, researchers tend to focus on either the technology being employed (Fung et al., 2019; Treves, Viterbo, & Haklay, 2015; Wolf et al., 2021) or the activity surrounding the VFT (Friess et al., 2016; Hirsch & Lloyd, 2005; Seifan, Dada, & Berenjian, 2019) or both (Mathews, Andrews, & Luck, 2012; Mead et al., 2019;

Palmer, 2013). While some of these researchers do broach the notion of "experience" and often compare the student "experience" between in-person field trips and VFTs, there is often no reference to specific pedagogical models or approaches. Furthermore, the "experience" in such studies tends to be judged by students' self-reported satisfaction. In my project, I aim to contribute to the literature by developing an activity framework underpinned by ELT.

Across the literature, researchers have adopted a range of evaluation approaches. However, the intention behind the choice of approach is often not clear and only explained when a more iterative approach is adopted (Dolphin et al., 2019; Litherland & Stott, 2012; Mathews, Andrews, & Luck, 2012). The strengths and limitations of the approaches adopted lay the foundation for the approach adopted for my project. Here, my project aims to contribute to the literature by employing an evaluation approach that shifts the evaluation focus from predefined outcomes to a process-oriented lens.

Similarly, across the literature, student outcome measures are often used to determine the impact of the VFT implementation. These measures can be broadly categorised as either being a measure of *student satisfaction / perception* (Arrowsmith, Counihan, & McGreevy, 2005; Friess et al., 2016; Grosser et al., 2023; Hirsch & Lloyd, 2005; Patiar et al., 2020) or that of *knowledge gain* (Hurst, 1998; Mead et al., 2019; Meezan & Cuffey, 2012). Though the studies show that the use of VFTs has been successful in achieving student outcomes, in my opinion, the researchers have missed the opportunity to measure broader aspects of student learning by looking at a holistic view of the benefits of using VFTs. By expanding the evaluation to encompass broader student outcomes, this project enhances understanding of the benefits of VFTs in experiential learning as a pedagogical process based on distinct student experiences.

Based on these insights, I sought to contribute to the literature by designing and evaluating an activity sequence that is underpinned by ELT. Through the use of an iterative DE approach in an innovative manner, I also aimed to measure broader student outcomes moving from student knowledge gains to other skills such as working in teams and engaging with technology

which are part of the TLO for Agriculture (Acuña et al., 2014).

1.5 Practice context

The research project was conducted at AGFS in the Faculty of Science at UQ which offers undergraduate programmes in Agricultural Science (with majors in Agronomy, Animal Science and Horticulture), Agribusiness, Equine Science and Wildlife Science[5]. Graduates from the programmes offered are in demand both in Australia and overseas with the school being well-known for having a robust programme. Being the top-ranked agricultural school in Australia (*Rankings and Reputation*, 2020), and, importantly for the research, my home institution, provided a range of courses that employed field trips and academic staff who were eager and ready to incorporate more technology within courses due to their experiences during COVID-19. This along with access to agricultural students across various disciplines, made the school an apt research site. These reasons were also what made the research site critical to the project's success.

The Bachelor of Agricultural Science programme is presented on the school's web pages[6] as a thoughtfully crafted programme to provide students with advanced scientific and technical skills that are essential for achieving success. Highlighting the internationally acclaimed instructors, with strong connections to both industry and government, guiding students, the school promises students access to state-of-the-art facilities at the Gatton (rural) campus and that they will gain practical experience through hands-on course practicals, industry placements, field trips, and study tours. Similarly, the Bachelor of Agribusiness programme is presented on the school's web pages[7] as one of the foremost agribusiness programmes in Australia meticulously developed through close collaborations with the global industry. The school similarly makes references to feature interactive and hands-on learning

[5] https://agriculture-food-sustainability.uq.edu.au/study/study-areas
[6] https://agriculture-food-sustainability.uq.edu.au/study/study-areas/agricultural-science
[7] https://agriculture-food-sustainability.uq.edu.au/study/study-areas/agribusiness

experiences, offering exposure to industry practitioners, agribusinesses, and real-world challenges.

Helmed at a rural campus, the school prides itself on using its close industry connections, innovative approaches to learning and world-class facilities to provide students with a competitive career edge. These close connections are intended to allow undergraduate courses to organize field trips as a key aspect of course deliveries. Despite the educational benefits, conducting field trips had become challenging due to a myriad of factors such as cost, large class sizes, proximity of field trip location to campuses, time constraints, and safety. These factors had also been exacerbated by the prolonged impact of COVID-19, specifically with the travel and social restrictions that were in place when this project was initiated. It was during this time that a group of us came together to discuss the possibilities of overcoming this challenge. In those discussions, my efforts in researching the possibilities offered by VFTs were shared. As described in section 1.2 above, the development of a VFT application formed the basis of the 2021 ACDS Teaching and Learning grant. The application was to be developed to be used across courses to either replace existing in-person field trips or supplement courses that had challenges in organising them. In section 4.3.3, I describe the process by which courses were identified and selected to be a part of this study. As discussed above, at the point of writing, the platform has successfully incorporated additional VFTs (developed by industry) allowing more courses across disciplines to make use of it.

The school takes great effort to establish and maintain collaborative alliances with partners spanning research institutions, industry groups, government bodies and policymakers as well as community organisations and businesses[8]. These partnerships allow researchers at the school to link their research to applied outcomes to improve everyday life across a range of settings. For the benefit of the student experience, these alliances open doors

[8] https://agriculture-food-sustainability.uq.edu.au/research/partner-us

for the creation of scholarships and teaching and learning opportunities including work placements and field trips.

Boomaroo Nurseries[9] is one of Australia's largest vegetable seedling and greenlife suppliers. Their base of operations is at Southbrook, Queensland which is about an hour away from UQ's rural campus. With innovation at the heart of their approach and their adoption of modern automated plant handling systems, they are on the cutting edge of technology adoption which makes them a perfect location for student field trips. However, the journey to and from their location would require two hours which was practically impossible to fit within the current timetabling requirements at the university. Hence, their acceptance to be the basis for the development of the VFT application was perfect.

There were, however, two challenges in conducting this research at the university. Firstly, the administrative processes around course enrolments were not judiciously followed. In practice, students are allowed to enrol in courses regardless of whether they have met the prerequisites of a course. In terms of the project, this meant that there was always a likelihood of a student having gone through the intervention in another course and potentially influencing the engagement levels of peers during the activities.

The second challenge would be the perception biases of the participants as well as the academic staff employing the VFT application. Across Australia, Queensland was the state that was comparatively less affected by COVID-19. Many staff and students who were able to return to campus expected things to be more like pre-COVID times rather than still having to contend with technology-infused lessons. With field trips being a key aspect of the agricultural education experience, asking them to come to campus in person but do a VFT might not be a preferred experience and might hinder their engagement during the activities. Thus, when designing the iterations, as illustrated in Chapter 5, care was taken to ensure that the impact of these challenges was addressed.

---

[9] https://boomaroo.com/

1.6 Thesis Overview

Chapter 2, titled *literature review*, summarises my review and analysis of existing literature on VFTs in higher education to help frame my project and its possible contribution. In the review, I identified and reviewed three themes, *pedagogical considerations, evaluation approaches* and *student outcomes*. Within each of the themes, I present a summary of the strengths and weaknesses that can be learnt from and taken into my project implementation. I also briefly provide an insight into how those lessons might be operationalised.

Chapter 3 describes the underpinning *theoretical framework* used in my research project. The chapter begins with a description of my ontological and epistemological underpinnings followed by a description of the ELT which underpins the pedagogical and activity design decisions taken during the project. The chapter continues with a description of DE which was the research approach adopted for the project, laying out my project's interpretation of the eight guiding DE principles.

Chapter 4 describes the *research design* I employed in this evaluation project, using the DE approach to understand how VFTs could be embedded in undergraduate agriculture courses to support experiential learning. This chapter starts by illustrating the evaluation project's interpretation of the eight DE principles followed by a description of the research context, data collection instruments along the analysis to be performed. The chapter closes with a description of the ethical considerations for the evaluation project and identifies limitations to the research design.

Chapter 5 reports the *findings* from three iterations where a VFT application was used for an experiential learning activity in three agricultural disciplines. The chapter is structured with each iteration as a sub-chapter beginning with a description of the activity design and key considerations in the execution of the iteration and describing the findings and analysis conducted. The sub-chapters close with my reflection on the iteration and a summary of the considerations to be made for the subsequent iteration. The final section of the

chapter summarises key guidance for course coordinators when implementing VFTs in their courses.

Chapter 6, titled *Discussion*, brings together the methodological approach and findings from the previous chapters and situates them within the broader literature. The chapter starts with an introduction to *VirtualVoyageVista*, an activity design framework bridging experiential learning and student outcomes through an integrated VFT design developed through the lessons learnt across the three iterations and closes with an illustration of my project's contribution to the literature through the three themes - *pedagogical considerations, evaluation approaches* and *student outcomes*.

The thesis draws to a *conclusion* in Chapter 7 revisiting the main research questions and its answer drawn from activities across the various chapters.

1.7 Terminology

As the project is conducted in Australia, there are terms used and references made in this thesis that might be different in different educational contexts and thus, Table 1.1 is used to define some of these terms and help with contextual understanding.

Term	**Definition**
Programme	At UQ, the list of courses you need to complete to gain a degree, diploma or certificate is called a programme.
Bachelor of Agricultural Science	At UQ, the Bachelor of Agricultural Science teaches students to apply and integrate the scientific, technological, managerial, economic, and social principles of agriculture to improve livestock and cropping outcomes for small, medium, and large-scale farming operations.
Major	A major combines courses in a programme that focuses on a specific discipline.

Term	Definition
Agronomy	As a major in the bachelor of agricultural science, it focuses on how agricultural practices and the environment can be managed to control the whole plant growth and crop production cycle. Specifically, students learn to examine variables such as crop rotation, irrigation and drainage, plant breeding, plant physiology, soil classification and fertility and the control of weeds, insects, and other pests.
Horticulture	As a major in the bachelor of agricultural science, it focuses on the intensive production of fruit, vegetable, nursery and floricultural crops and turf. Specifically, students learn to use scientific techniques in plant breeding, biochemistry, physiology, and propagation to improve plant yield, quality, nutritional value and resistance to insects, diseases, and environmental stresses.
Bachelor of Agribusiness	At UQ, the bachelor of agribusiness teaches students about the commercial side of agriculture, both in Australia and internationally covering all aspects of the growing, processing, trading, and financing of food and fibres, gaining valuable transferable business skills.
Course	A course is a distinct unit of study within a programme for which a result is given – like a subject at school. Full-time students usually study 3 to 4 courses (6 to 8 units) per semester.
Course Coordinator	Course coordinators are responsible for coordinating the development, preparation, delivery, and assessment of designing, planning, and teaching a course.
Virtual Field Trips (VFTs)	VFTs take different forms across the literature. In this thesis, the VFT application featured a visit to *Boomaroo Nurseries*, a seedling company who were approached to be a part of the programme due to their innovative approaches to production and their business.

Table 1.1 Terms used with definitions for contextual understanding

Chapter 2: Literature Review

2.1 Introduction

The purpose of this chapter is to summarise my review and analysis of existing literature on field trips in Higher Education to help frame my project and its possible contribution. The importance of field trips to the student experience and their achievement of student outcomes were presented in Chapter 1.1. Building on that, this chapter begins with an overview of my scoping process before synthesizing the pertinent themes. Guided by my previous experiences in employing technology including VFTs in teaching, I centre the review around aspects of activity design – leading to three themes which discuss pedagogical considerations and their implementation, evaluation approaches adopted and student outcomes. Within each theme, I review what has been done, presenting a summary of the strengths and weaknesses that can be learnt from and taken into my project implementation.

2.2 Scoping the Review

To shape my search strategy and better understand the current literature, I started with a broad search of field trips in education. In a quick review of this initial batch of research, I quickly realised that research adopted for in-person field trips was different from VFTs in being more explicit about their pedagogical and evaluation approaches. Seeing that these were not as evident in VFT research, I wanted to delve further into them to better understand why that was so, especially as VFTs were often framed as an alternative to in-person ones and because pedagogy and evaluation are central to my project.

In trawling through the VFT research, I found that terminologies such as “virtual field trips,” “virtual field work”, “virtual tours” and “virtual field guides” were interchangeable leading to much variability in the types of VFTs used. I decided to use all of them as keywords in my search terms to capture the range. Using these as keyword terms resulted in a vast number of articles

situated in high school and elementary education. As their context is quite different from my project, which is framed within a 13-week University course, I decided to focus on reviewing works in higher education. Using the ERIC, Scopus, and ProQuest databases, as a search strategy, I coupled the keywords noted above with “Higher Education.” With a long list of potential papers to engage with, I proceeded to review the abstracts and methodology sections to ensure that they met the key inclusion criteria of using a form of VFT and it being carried out in Higher Education. This cut the list down to 44 articles allowing me to analyse and draw conclusions from the appropriate articles published up to August 2023.

In my initial review of the 44 articles, I noted six prominent points of discussion in the literature that would shape my review:

- Pedagogical Considerations.
- Implementation Strategies
- Evaluation Approaches.
- Student Outcomes.
- Types of VFT employed
- Processes employed in developing VFTs

Two of these prominent points were not reviewed further in much detail, however: the various types of VFTs and the processes employed in developing them. They were not reviewed as my project dealt with the implementation of an existing VFT product with no ability to develop or amend it within the scope of the project. The other four points formed the basis of the four potential themes that I could explore. However, as I delved deeper into the articles, I realised that a theme addressing project implementation was closely tied to evaluation approaches and often described in place of one another. As such, I decided to condense those two potential themes into one, resulting in three themes that were of interest to my project which centred around aspects of designing a VFT activity. The themes were then ordered in an activity design flow starting from the pedagogical considerations in using VFTs, followed by

understanding their evaluation approaches adopted and finally closing with the student outcomes.

- Theme 1: Pedagogical Considerations. (Section 2.3)
- Theme 2: Evaluation Approaches. (Section 2.4)
- Theme 3: Student Outcomes. (Section 2.5)

Table 2.1 lists the 44 articles that were reviewed for this chapter and summarises the points of consideration for each article under the three themes. These three themes are reviewed in more detail in the subsequent sections.

Author	Discipline Area	Pedagogical Consideration	Evaluation Approach	Measured Outcomes
Annetta, Klesath and Meyer (2009)	Entomology	Online Learning	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Arrowsmith, Counihan and McGreevy (2005)	Geospatial Science	Action Research	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Buckley et al. (2022)	Geology	No Explicit Pedagogy	No Evaluation Conducted	No Outcomes Measured
Bursztyn et al. (2015)	Geoscience	Game-Based Learning	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Dolphin et al. (2019)	Geology	Inquiry-Based Approach	Iterative Evaluation Approach	Student Satisfaction / Perception
Evelpidou et al. (2022)	Geoscience	No Explicit Pedagogy	Summative Evaluation - Single Implementation Evaluation	Knowledge Gain Student Satisfaction / Perception
Friess et al. (2016)	Geography	No Explicit Pedagogy	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Student Satisfaction / Perception
Fung et al. (2019)	Chemistry	No Explicit Pedagogy	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Garner and Gallo (2005)	Environmental Science	No Explicit Pedagogy	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Knowledge Gain Student Satisfaction / Perception
Grosser et al. (2023)	Engineering	No Explicit Pedagogy	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Hai Chien Pham et al. (2018)	Construction	Mobile Learning	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Knowledge Gain Student Satisfaction / Perception
Harkess et al. (2007)	Agriculture	Computer Based Learning	No Evaluation Conducted	No Outcomes Measured

Author	Discipline Area	Pedagogical Consideration	Evaluation Approach	Measured Outcomes
Hirsch and Lloyd (2005)	Geography	Experiential Learning	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Student Satisfaction / Perception
Hurst (1998)	Geology	Case Study Approach	Summative Evaluation - Single Implementation Evaluation	Knowledge Gain
Jacobson, Militello and Baveye (2009)	Agriculture	No Explicit Pedagogy	Summative Evaluation - Single Implementation Evaluation	Knowledge Gain Student Satisfaction / Perception
Jolley et al. (2018)	Geosciences	No Explicit Pedagogy	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Student Satisfaction / Perception
Kingston et al. (2012)	Hydrology	Mobile Technology-Based Learning	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Knowledge Gain Student Satisfaction / Perception
Klippel, Zhao, Oprean, Wallgrün, et al. (2019)	Geoscience	Immersive Learning	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Knowledge Gain Student Satisfaction / Perception
Kolås et al. (2020)	Biology	Flipped Classroom	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Kolivras, Luebbering and Resler (2012)	Geography	No Explicit Pedagogy	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Student Satisfaction / Perception
Kundu (2016)	Geoscience	Blended Learning	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Leininger-Frézal and Sprenger (2022)	Geography	Experiential Learning	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception

Author	Discipline Area	Pedagogical Consideration	Evaluation Approach	Measured Outcomes
Litherland and Stott (2012)	Geography	No Explicit Pedagogy	Iterative Evaluation Approach	Student Satisfaction / Perception
Mathews, Andrews and Luck (2012)	Business	Action Research; Experiential learning	Iterative Evaluation Approach	Varied from run to run
McMorrow (2005)	Geography	No Explicit Pedagogy	Iterative Evaluation Approach	Student Satisfaction / Perception
Mead et al. (2019)	Geoscience	Education Through Exploration	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Knowledge Gain
Meezan and Cuffey (2012)	Geoscience	No Explicit Pedagogy	The Evaluation Approach Is Not Clear	Knowledge Gain
Palaigeorgiou, Malandrakis and Tsolopani (2017)	Education	No Explicit Pedagogy	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Student Satisfaction / Perception
Palmer (2013)	Physical Geography Geomorphology	Online Learning	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Patiar et al. (2017a)	Hospitality	technology-enhanced learning	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Patiar et al. (2017b)	Hospitality	(I) Situated Cognition Theory (ii) Distributive Cognition Theory (iii) Normative Theory	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Patiar et al. (2020)	Hospitality	Experiential Learning	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Procter (2012)	Sociology	Praxis Pedagogy	The Evaluation Approach Is Not Clear	Student Satisfaction / Perception

Author	Discipline Area	Pedagogical Consideration	Evaluation Approach	Measured Outcomes
Ramasundaram et al. (2005)	Environmental Science	(i) Exploration-based learning (ii) Analogy-based learning (iii) Science inquiry learning (iv) Abstraction-based learning through a hierarchy of abstraction spaces	No Evaluation Conducted	No Outcomes Measured
Schulze et al. (2021)	Soil Science	No Explicit Pedagogy	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Seifan, Dada and Berenjian (2019)	Engineering	No Explicit Pedagogy	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Shinneman, Loeffler and Myrbo (2020)	Geoscience	Self-Guided Explorations	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Knowledge Gain Student Satisfaction / Perception
Shonfeld, Erez and Litvak (2003)	Biology	No Explicit Pedagogy	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception
Spicer and Stratford (2001)	Biology	No Explicit Pedagogy	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Student Satisfaction / Perception
Stumpf, Douglass and Dorn (2008)	Geography	Learner-Centred	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Knowledge Gain Student Satisfaction / Perception
Treves, Viterbo and Haklay (2015)	Geography Ecology Geology	No Explicit Pedagogy	Summative Evaluation - Single Implementation Evaluation	Student engagement maps
Whitelock and Jelfs (2005)	Geology	No Explicit Pedagogy	Summative Evaluation - Single Implementation Evaluation	Student Satisfaction / Perception

Author	Discipline Area	Pedagogical Consideration	Evaluation Approach	Measured Outcomes
Wolf et al. (2021)	Environment Engineering / Urban Studies	Self-Directed Learning	Summative Evaluation - Comparative Study Approach in a Single Domain Context	Knowledge Gain Student Satisfaction / Perception
Zhao et al. (2021)	Geoscience	Biggs's 3-P model	Summative Evaluation - Single Implementation Evaluation	Knowledge Gain Student Satisfaction / Perception

Table 2.1 Summary of articles reviewed (sorted in author alphabetical order)

2.3 Theme 1: Pedagogical Considerations

The first theme discusses the pedagogical models adopted in VFT implementations, by which I mean the various approaches that researchers take to guide the educational aspects of their implementations. Across the literature I found a lack of definite pedagogical models adopted when using VFTs with only 25 articles out of the 44 reviewed, explicitly mentioning a pedagogical model underpinning their work (Dolphin et al., 2019; Klippel, Zhao, Oprean, Wallgrün, & Chang, 2019; Kundu, 2016; Mead et al., 2019; Procter, 2012). Additionally, only four articles discuss experiential learning (Hirsch & Lloyd, 2005; Leininger-Frézal & Sprenger, 2022; Mathews, Andrews, & Luck, 2012; Patiar et al., 2020) which was particularly surprising considering the role of the student experience in driving research into the use of VFTs.

The dominant rhetoric across much of the literature on VFTs is centred on the importance of providing students with an *experience* and the acknowledgement that this experience is traditionally delivered using an in-person field trip (Bursztyn et al., 2015; Mead et al., 2019; Schulze et al., 2021; Stumpf, Douglass, & Dorn, 2008). Some researchers make the explicit claim that the VFT implementation in their study was developed for the purpose of providing this very experience (Kolivras, Luebbering, & Resler, 2012; Meezan & Cuffey, 2012; Schulze et al., 2021). However, the definition of this experience is not concrete across the literature but there is a common thread where it is not simply about being in a place but an opportunity for students to gain and apply knowledge and skills linking theoretical concepts to practice (Patiar et al., 2017b; Seifan, Dada, & Berenjian, 2019; Whitelock & Jelfs, 2005). The importance of this experience is often connected to the nature of the discipline and is considered critical for the development of discipline-centric skills. Examples include doing field observations on actual field sites for geology studies (Dolphin et al., 2019; Hurst, 1998) and the co-development of interpersonal skills alongside hospitality management skills in the hospitality discipline (Patiar et al., 2020; Patiar et al., 2017a). Though this rhetoric emphasizes the importance of experience, it is interesting to note that most

researchers do not explicitly employ the experiential learning theory (ELT) or experiential learning cycle (ELC) in their implementation.

In the 25 articles (illustrated in Table 2.1), that explicitly mentioned a pedagogical model underpinning their work, the connection between that model and their activity design was mixed. In some cases, their pedagogical model was simple and easy to connect to their activity design. For example, in Kundu (2016) and Kolås et al. (2020), they adopted the flipped classroom as their pedagogical approach and this is observed in how they designed the pre-, during and after- segments of their activities. Others chose to be broad like in Mead et al. (2019) and Dolphin et al. (2019) where they adopted an *education through exploration* approach and an inquiry-based approach which meant that their students were allowed to freely engage with the VFT. On one hand, you had more detailed connections being drawn where articles such as the one by Ramasundaram et al. (2005) employed four different pedagogical approaches and clearly illustrated how each of the four are adopted in the student activities. While on the other hand, you had Zhao et al. (2021) who clearly elaborated on the use of Briggs's 3-P (presage, process and product) model but they framed the pedagogical model as a means of inspiration rather than being clearly mapped to the activities conducted. While such pedagogies do seem clearly stated in their own terms, their connection to adequately providing students with an *experience* through which they learn is not made clear. This raises the question of what does it then mean to have conclusions made about student experience-based learning when it is not guided by an experience-based pedagogy?

For the four articles that discuss the ELT or ELC, we see a diversity in how it is employed in the projects (Hirsch & Lloyd, 2005; Leininger-Frézal & Sprenger, 2022; Mathews, Andrews, & Luck, 2012; Patiar et al., 2020). Mathews, Andrews and Luck (2012) discussed the importance of experiential learning but did not discuss it in depth in the theoretical framework sections or how it plays into the activity design. Interestingly, they adopted an iterative action research methodology to improve their activity design but concluded that experiential learning outcomes were achieved. Patiar et al. (2020) discusses

the ELT and ELC in depth as part of their theoretical framework and claimed to infuse elements of it into their activity design. However, student activities are not clearly mapped to the ELC but are discussed as designed using a constructivist approach. Although the ELT is inherently a constructivist approach, the researcher's decision to switch between them from the theoretical framework to designing the activities without clearly illustrating their connection was confusing for readers. Leininger-Frézal and Sprenger (2022) emphasises the importance of ELT and describes it by contextualising it through the geography lens. However, they highlighted some deficiencies in its adaptation for specificities in Geography. Hence, they used the ELT to develop their own 4I model which governed their activity design. In each case, we can see that even though the articles have some level of description related to either the ELT or ELC, this pedagogical consideration did not follow through into their activity design. This brings about the question that if the ELC is not playing an influential role in the activity design, then are we leveraging the experience for optimal learning?

Despite these, Hirsch and Lloyd (2005) stands alone in that the researchers completed their article by illustrating how the student activities when engaging with the VFT experience was mapped to the four phases of the ELC. This provided an opportunity to see how harnessing the ELC in giving students a learning experience provided a means of developing a range of skills, including those I am keen to investigate in my project.

The premise for the entry and research into VFTs in higher education is in essence to seek a replacement for or as additional tool to complement in-person field trips. Due to considerable constraints in the delivery of in-person field trips ranging from administrative issues to the unpredictability of weather and accessibility issues (Hurst, 1998; Jolley et al., 2018), there was an impetus to seek an alternative means of providing students that "experience" where they are provided with an opportunity for hands-on, applied learning (Atchison & Kennedy, 2020; Dolphin et al., 2019; Patiar et al., 2020; Schulze et al., 2021). This drive to adopt VFT was also engineered by the rise of technology in education and the technology enhanced learning push across the sector

(Buckley et al., 2022; Stumpf, Douglass, & Dorn, 2008). This resulted in researchers often simply replaced the in-person field trips with the VFTs without amending the associated supplementary or complementary activities to ensure similar student outcomes.

It was noteworthy that besides Spicer and Stratford (2001), much of the earlier research do not clearly explain the differences in the student experience or their learning when using VFTs as opposed to in-person field trips. Interestingly, in more recent articles, there is increasing acknowledgement that not all aspects of an in-person field trip can be replicated by a VFT (Dolphin et al., 2019; Patiar et al., 2017a; Schulze et al., 2021). Many comparative studies found that students learn better through an in-person field trip rather than a VFT (Friess et al., 2016; Klippel, Zhao, Oprean, Wallgrün, et al., 2019; Kolivras, Luebbering, & Resler, 2012), though this is not unanimous (Palaigeorgiou, Malandrakis, & Tsolopani, 2017; Stumpf, Douglass, & Dorn, 2008). Building on Spicer and Stratford (2001), I believe that asking whether VFTs can replace in-person field trips is perhaps the wrong question but rather how we should design an activity to embrace VFTs to provide students with an experience and deliver appropriate student outcomes.

Learning from my review of the literature in their approaches in considering pedagogy, my project will contribute to the literature by proposing an activity design framework that explicitly embraces the ELT and operationalises it by leveraging the four phases of the ELC. This ensures that that values of the in-person fieldtrips can be preserved while also incorporating pedagogical understanding and appreciation of the differences between VFTs and in-person field trips. Furthermore, through my project I will also show that using pedagogically driven framework minimises the impact of VFT quality, which has been found to impact student outcomes (Patiar et al., 2017b), on student attainment of broader educational outcomes.

2.4 Theme 2: Evaluation Approaches

The second theme discusses the evaluation methodologies employed in the reviewed articles, by which I mean the various approaches researchers

used to assess the performance and impact of their VFT implementations. 41 of the 44 articles reviewed conducted an evaluation on their implementation and used the findings to look backwards at the innovation's performance and impact to make conclusions as to its success. The evaluations could be categorised as evaluating a single implementation (Fung et al., 2019; Jacobson, Militello, & Baveye, 2009; Palmer, 2013; Schulze et al., 2021; Seifan, Dada, & Berenjian, 2019), a comparative study (Friess et al., 2016; Hai Chien Pham et al., 2018; Palaigeorgiou, Malandrakis, & Tsolopani, 2017; Spicer & Stratford, 2001), or an on-going iterative study (Dolphin et al., 2019; Litherland & Stott, 2012; Mathews, Andrews, & Luck, 2012). The evaluations conducted were always summative in nature though the intention behind the choice of approach is not clear and only explained when an iterative evaluation is adopted. Though these evaluations provided lessons to be learnt, only 4 of the articles reviewed (Dolphin et al., 2019; Litherland & Stott, 2012; Mathews, Andrews, & Luck, 2012; McMorrow, 2005) adopted the lessons learnt and reevaluated the innovation in subsequent iteration(s). One commonality across all the evaluations is that they are outcome-focussed with an emphasis on achieving that outcome rather than informing the innovation being evaluated. The strengths and limitations of these approaches adopted lay the foundation for the approach adopted for my project.

Summatively evaluating a single implementation was the most common evaluation approach adopted by 21 of the 44 articles (Fung et al., 2019; Jacobson, Militello, & Baveye, 2009; Palmer, 2013; Schulze et al., 2021; Seifan, Dada, & Berenjian, 2019). They typically used surveys or quizzes at the end of the implementation to determine student perspective and performance respectively (Jacobson, Militello, & Baveye, 2009; Patiar et al., 2017a). They usually incorporate both quantitative and qualitative questions to get a holistic understanding of the student experience. The quizzes allowed for the conclusion of students' knowledge gained after using the VFT. This was questionable as there was no measure of their baseline knowledge before embarking on the VFT (Hurst, 1998; Jacobson, Militello, & Baveye, 2009). In a modified approach, 4 of the articles used a pre-and post-intervention design to determine the impact of the VFT (Howard, 2020; Patiar et al., 2020; Whitelock

& Jelfs, 2005; Zhao et al., 2021). Though this was an improvement on the approach, this was surprisingly only adopted for student knowledge gain by Whitelock and Jelfs (2005) whereas the others adopted the approach to investigate the change in student motivation (Howard, 2020) and their perception of knowledge (Patiar et al., 2020). The limitation of the single implementation summative evaluation is that though all of them gave a comprehensive picture of the iteration, there is a lack of how any lessons learnt were integrated into the innovation and whether those lessons led to an improved innovation. Furthermore, being a summative evaluation, the approach does not seamlessly allow for the researchers to investigate the granularity of their innovation as the students had to look back at their experience when engaging with the measures. There was also a lack of variety in the sources of data used across the articles. They were limited to questionnaires and surveys and though they incorporated both quantitative and qualitative elements, there are other valuable data sources such as reflections from the teaching team or tutors or even analytics that were not employed.

In another summative evaluation approach, 14 articles adopted a comparative study approach setting up different experimental conditions, investigating student perception and performance using surveys and assessments as described above (Friess et al., 2016; Hai Chien Pham et al., 2018; Palaigeorgiou, Malandrakis, & Tsolopani, 2017; Spicer & Stratford, 2001). These articles aimed to either compare VFTs with actual field trips (Friess et al., 2016; Hai Chien Pham et al., 2018; Spicer & Stratford, 2001) or VFTs against a combination model of VFTs and actual field trips (Klippel, Zhao, Oprean, Wallgrün, et al., 2019; Stumpf, Douglass, & Dorn, 2008) within the same cohort of students. It is interesting that when adopting the comparative approach, all the articles chose to study the student experience and their knowledge gain rather than a choice of either one. They attempted to control other variables and used various statistical techniques to compare the data collected to determine the difference between the experimental conditions. Like the approach above, we see that a small number (3) of the comparison articles adopted a pre-post-design to quantify the gains from using VFTs (Klippel, Zhao, Oprean, Wallgrün, et al., 2019; Stumpf, Douglass, & Dorn, 2008; Wolf et al.,

2021). This modification similarly strengthened the conclusion drawn as they could establish a baseline before their investigation. Once more, these articles are evaluated appropriately in their aim to compare VFT against actual field trips or a combined scenario. However, as we discussed in section 2.3 above, VFTs are inherently different from in-person field trips and thus I am left unsure as to how concluding that either is better in achieving set outcomes informs us about lessons learnt towards improving the innovation.

Four of the articles reviewed adopted an iterative evaluation approach (Dolphin et al., 2019; Litherland & Stott, 2012; Mathews, Andrews, & Luck, 2012; McMorrow, 2005). The benefit of the iterative evaluation approach is that it allows the outcomes from the evaluation to be reviewed and incorporated into the next iteration and subsequent evaluation. The approach taken by the articles were similar in that they focused on understanding the student experience in using the VFT. This was surprising considering that student knowledge was commonplace in the other approaches but not explored in any of these articles. Each of these articles approached the evaluation by using different cohorts across the study.

Litherland and Stott (2012) approached this by using the same VFT across two courses – a level 2 and a level 3 course. However, in adopting a short time frame between the iterations, they did not analyse the data from the individual iterations. Instead, they conducted a combined analysis which unfortunately missed an opportunity to understand each iteration and make appropriate adjustments if needed. On the other hand, Dolphin et al. (2019) adopted this iterative approach using the same geology course over two cohorts. The team used observational data to make changes to the VFT and its implementation. Due to this approach, the team was only able to work a small subset of students and clearly highlighted methodological limitations to their approach. McMorrow (2005) details an iterative approach they had planned to develop the VFT. Their approach involved trialling the application with tutors before making changes to the VFT prior to rolling it out for students. Though not reported in the article, the researchers make references to a plan involving three further iterations.

While an iterative approach is adopted by different evaluation models, only Mathews, Andrews and Luck (2012) explicitly adopted one - an action research approach - bringing together some of the methods used in this approach across four iterative cycles of development, implementation, and evaluation using a combination of a post-trip questionnaire and observations from the teaching team. This approach allowed them to learn from each iteration making adjustments such as the enhancement of learning objectives from iteration one to iteration two and the inclusion of a formal evaluation from iteration three. Despite its value in supporting ongoing evaluations, adopting an approach like action research has an element of rigidity in that the evaluation measures from iteration to iteration usually remain the same (Mathews, Andrews, & Luck, 2012).

Learning from my review of the literature in their evaluation, my project will contribute to the literature by adopting the Development Evaluation approach proposed by Patton (1994). Through its use, I aim to demonstrate the effectiveness of an evaluation approach that is integrated with the innovation being evaluated, allowing me to draw evidence from various sources and data points when seeking to understand the student experience at each stage of innovation and when making conclusions. Iterative evaluation approaches, as seen in articles like Dolphin et al. (2019) and Mathews, Andrews and Luck (2012), stand out for their ability to integrate lessons learned from each evaluation iteration into subsequent improvements. This iterative process not only enhances the effectiveness of VFT implementations but also fosters ongoing refinement, ultimately leading to more impactful educational experiences for students. Thus I aim to leverage the eight guiding principles (Patton, 2016a), to design an iterative approach that is flexible and responsive and process-focussed rather than outcome-focussed to allow me to evaluate elements of the innovation and improve it rather than just outcomes derived from it.

2.5 Theme 3: Student Outcomes

This third theme discusses the evaluation of student outcomes in VFT implementations, by which I mean the assessment of factors such as student satisfaction, perception, and knowledge gain resulting from the use of VFTs. In reviewing the literature, it became evident that student outcome measures were used to determine the impact of the VFT implementation as evidenced by its being an underpinning theme across 41 of the 44 articles reviewed. Out of the 41 articles that carried out an evaluation, student outcomes can be broadly categorised as either being a measure of *student satisfaction/*perception (26 articles) (Arrowsmith, Counihan, & McGreevy, 2005; Friess et al., 2016; Grosser et al., 2023; Hirsch & Lloyd, 2005; Patiar et al., 2020) or that of *knowledge gain* (three articles) (Hurst, 1998; Mead et al., 2019; Meezan & Cuffey, 2012). Of those 41, 10 of them investigated both categories to give a more holistic view of their implementation (Kingston et al., 2012; Shinneman, Loeffler, & Myrbo, 2020; Stumpf, Douglass, & Dorn, 2008; Wolf et al., 2021). A limited few looked at student engagement (Treves, Viterbo, & Haklay, 2015) and instructor perspectives (Patron, Ellis, & Barrett, 2009; Procter, 2012).

Across the disproportionate number of articles concerned with *student satisfaction or perceptions*, it was clear that their satisfaction and perception levels were positive in response to using VFTs. In measuring student satisfaction or perceptions, I noted that there were two clear foci to review further. One focus was specifically on the design and experience of using VFTs (Arrowsmith, Counihan, & McGreevy, 2005; Palaigeorgiou, Malandrakis, & Tsolopani, 2017; Palmer, 2013). Across these articles, it was clear that students were positive about using VFTs and seemed to focus on the media elements used in the application as a basis for their satisfaction ratings (Kolås et al., 2020; Spicer & Stratford, 2001; Wolf et al., 2021). Having said that, they did identify facets of the technology that did not work for them which included functionalities that they felt would be "good to haves" due to how they had engaged with the application such as the ability to "zoom in" (Fung et al., 2019) or "browser controls" (Arrowsmith, Counihan, & McGreevy, 2005). This was in line with Patiar et al. (2017a) who stressed that the quality of the system and

enjoyment as important factors influencing student satisfaction. Unfortunately, the influence of satisfaction levels on student learning was not explicitly investigated and thus it is possible to question whether the satisfaction is a result of a “novelty factor” – something suggested by Klippel, Zhao, Oprean, Wallgrün, et al. (2019).

Another focus of the *student satisfaction or perception* measure was that of the student learning experience (Hirsch & Lloyd, 2005; Shinneman, Loeffler, & Myrbo, 2020; Whitelock & Jelfs, 2005). Through this investigation, we could see how students perceived the impact of VFTs on their learning. In their reflections, students highlighted how the VFTs not only helped them gain a range of knowledge and skills in their discipline areas (Hirsch & Lloyd, 2005; McMorrow, 2005) but also provided an opportunity to pick up those knowledge and skills more efficiently than they would through an in-person field trip (Whitelock & Jelfs, 2005). They also raised how the VFTs gave them an increased spatial awareness of the landscape (Kolivras, Luebbering, & Resler, 2012; McMorrow, 2005; Stumpf, Douglass, & Dorn, 2008) which was a positive finding considering the inability to deliver spatial awareness was raised as one of the detractions against VFTs. Students also positively commented on the use of VFTs as preparatory materials for in-person field trips or for discipline fieldwork (Arrowsmith, Counihan, & McGreevy, 2005). One interesting point raised in using VFTs as preparatory materials was the affective aspect raised in Hirsch and Lloyd (2005), Shonfeld, Erez and Litvak (2003) and Wolf et al. (2021) where students highlighted enhanced “curiosity” and “excitement” along with a developing appreciation of attitudes and improved motivation. The achievement of affective outcomes was also highlighted by Shinneman, Loeffler and Myrbo (2020).

The importance of looking into student satisfaction or perception with VFTs as an educational technology can lead to a poor learning experience and become a barrier to learning. The measuring of satisfaction or perception of learning is also appropriate as the intention of these implementations is toward improving student learning. In investigating the student satisfaction or perception of their learning experience, the researchers have in my opinion,

identified another measure that would be important to understand towards an improved implementation. However, despite measuring this outcome across different disciplines, in most of those articles, no investigation of how the findings result in changes for subsequent iterations but a conclusion as to the implementation's success based on that measure. In a similar food for thought, despite high satisfaction or perception levels, students found it necessary to highlight they do not see VFTs as a replacement for in-person ones (Kolås et al., 2020; Seifan, Dada, & Berenjian, 2019; Spicer & Stratford, 2001).

Another outcome presented in the literature is that the use of VFT contributes to *student knowledge gain*. The measurement of this outcome centred on student performance on assessment tasks and all five articles that presented the student scores showed a significant increase in assessment scores (Hai Chien Pham et al., 2018; Kingston et al., 2012; Mead et al., 2019; Wolf et al., 2021), though in some cases, this improvement was not statistically significant (Klippel, Zhao, Oprean, Wallgrün, et al., 2019). Beyond simply the quantitative scores, articles also demonstrated improved student competencies by reporting improved complexity of student open-ended answers (Mead et al., 2019), and reduced assessment completion times (Wolf et al., 2021). In looking at higher cognitive outcomes, findings were mixed where some found the students lacking (Dolphin et al., 2019; Meezan & Cuffey, 2012), while others claimed that students were able to achieve them (Jacobson, Militello, & Baveye, 2009; Zhao et al., 2021). To compound that assertion of increased knowledge gain, Stumpf, Douglass and Dorn (2008) showed that student knowledge gain was achieved consistently across two different year levels.

In a learning environment, measuring student knowledge gained from an intervention always seems like a natural go-to. However, bearing in mind, the reasons for adopting VFTs, there is a question as to whether a successful VFT implementation should be limited to cognitive knowledge gains. When engaging in in-person field trips, affective elements like student engagement, collaboration and other social affordances are considered as benefits. However, when VFTs are evaluated (regardless of the approach adopted), knowledge gain seems to be of utmost importance. A quote from the reviewed articles

seems to point to why outcomes from the other learning domains are rarely determined.

> *"Affective learning outcomes are rarely assessed at any level, in large part because they are usually qualitative in nature and therefore more difficult to assess." (Meezan & Cuffey, 2012)*

Looking into the assessment types, we could ask two questions. Firstly, are these knowledge tests the best measure of student learning that occurs when engaging in field experiences? Secondly, when assessment items are redesigned to incorporate elements learnt from the VFTs, are they rigorous as compared to previous iterations? It is also noteworthy that whether the engagement with the VFT is done individually or with peers, the evaluations are always done on an individual basis. Though the articles show that there has been a knowledge gain, in my opinion, they have missed the opportunity to measure the affective aspect of student learning which may provide an alternative view to the benefits of using VFTs. Here is where my project will aim to contribute to the literature by investigating the attainment of effective student outcomes.

2.6 Summary of the literature review

Reviewing the 45 articles through the lens of the activity design gave rise to three themes – (1) pedagogical considerations, (2) evaluation approaches and (3) student outcomes. Table 2.2 summarise the main reflections from each theme and where my project aims to contribute to the literature. These aims will be revisited in Chapter 6 and Chapter 7 as I reflect on my contributions to the literature and conclude the project.

Themes	Main Reflection from Literature Review	Project Aims
Pedagogical Considerations	• Across the literature there is no consistent pedagogical model. • Though the dominant rhetoric is centred on the importance of providing students with an *experience* → most researchers do not explicitly employ the ELT or ELC in their implementation. • Articles that explicitly mention a pedagogical model underpinning their work, the connection between that model and their activity design was mixed. • Articles that discuss the ELT or ELC, show a diversity in how it is employed in the projects. In each case, this pedagogical consideration does not follow through with their activity design. • There is increasing acknowledgement that not all aspects of an in-person field trip can be replicated by a VFT.	My project aims to propose an activity design framework that explicitly embraces the ELT and operationalises it by leveraging the four phases of the ELC.
Evaluation Approaches	• The evaluations can be categorised as evaluating a single implementation, a comparative study, or an ongoing iterative study. • The evaluations were always summative, the approaches do not seamlessly allow for the researchers to investigate the granularity of their innovation as the students had to look back at their experience when engaging with the measures.	• My project aims to adopt the Development Evaluation approach. • I aim to demonstrate the effectiveness of an evaluation approach that is integrated with the innovation being evaluated allowing me to draw evidence from various sources and data points.

Themes	Main Reflection from Literature Review	Project Aims
	• Though these evaluations provided lessons to be learnt, only 4 of the articles reviewed adopted the lessons learnt and reevaluated the innovation in subsequent iteration(s). • One commonality across all the evaluations is that they are outcome-focused with an emphasis on achieving that outcome rather than informing the innovation being evaluated. • Approaches have an element of rigidity in the choice of evaluation measures.	• I aim to leverage the eight guiding principles to design an iterative approach that is flexible and responsive, and process focussed.
Student Outcomes	• Student outcomes are broadly categorised as either being a measure of student satisfaction/perception or that of knowledge gain. • In using VFTs, student satisfaction and perception levels were positive → The importance of looking into student satisfaction or perception with VFTs as educational technology can easily lead to a poor learning experience and become a barrier to learning. • In using VFTs, students demonstrated increased knowledge gain though findings were mixed at higher cognitive outcomes. • Researchers missed the opportunity to measure broader educational outcomes.	My project aims to contribute to this theme by evaluating student outcomes aligned to the UQ graduate outcomes encompassing desired skills and attributes such as problem-solving, collaborative skills, engagement with technology and a developing understanding of student social and civic responsibility.

Table 2.2 Summary of reflections from the literature review and project aim

Chapter 3: Theoretical Framework

3.1 Introduction

This chapter describes the underpinning theoretical framework used in this research project. The chapter begins with a description of my ontological and epistemological underpinnings followed by a description of the ELT which underpins the pedagogical and activity design decisions taken during the project. The chapter continues with a description of the Experiential Learning Theory (ELT) and the Experiential Learning Cycle (ELC) which drove the pedagogical parameters of the project. The chapter then moves along with a description of DE which was the research approach adopted for the project, laying out my project's interpretation of the eight guiding Developmental Evaluation (DE) principles. This is a key element as the interpretations guide the approach, the data collection process and how the findings fit together for each iteration and as an overall project to provide a succinct picture of how we can implement Virtual Field Trips (VFTs) for an experiential learning activity in undergraduate agriculture education.

3.2 Ontology and Epistemology

The terms *ontology* and *epistemology* have been challenging for me to grasp and fully understand despite being involved in educational research for several years now. However, the journey I have taken during this doctoral research project has opened my eyes to how these terms have played a significant role in the way I approach my research and the underlying assumptions that I bring to research projects. As discussed in section 1.2, in my previous role as a learning designer for almost 10 years, I engaged in multiple educational projects across a wide range of disciplines to varying degrees of success. This has led me to develop a strong belief that to understand the story your data tells, you need to develop an understanding of the context where the data is collected, the intended objective of collecting that data and importantly the mental model of the person conducting the analysis.

Across the literature, ontology is defined as the study of the nature of reality and what we believe to be its relation to the human experience (Levers, 2013). The different viewpoints centre around the divide of whether there is a notion of “truth.” From my current understanding of ontology, my stance is representative of a relativistic view. What this means is that I believe that reality is not fixed or absolute but is instead shaped by subjective experiences, cultural influences, and interpretive frameworks. With my background in science, this was not a previously held ontology as we were always guided by having a clear concept where experimentation was used to validate theories we had and thereby reinforce them (Hautamäki, 2020). This “truth” was thus something undeniable and devoid of the human element – i.e., you would get the same result regardless of who experimented. As I embarked on my journey into the realm of education, I began to understand and appreciate the fact that everyone learns differently. This is not just limited to the level of knowledge but also what they learn given the same stimulus. This meant that each student engaging in a learning activity has the potential to experience it differently and thus garner different outcomes. This difference could be a result of a range of factors ranging from complex social interactions to simpler individual preferences. These factors led me to better understand my ontological perspective is not one of pure relativism but rather bounded relativism where I have the belief that reality is integrally tied to the human subjective experience which is bounded by context, be it cultural, moral or cognitive (Moon & Blackman, 2014).

Stemming from that my epistemological viewpoint is one of constructionism. Epistemology is surmised as the way we illustrate what we know to be true (Levers, 2013). My belief about what is true is that everyone creates meaning from their experiences as they bring different views and personalities to the table. This belief aligns with the definition of a constructionist mindset assumes that each student understands the matter at hand in their way and that each of these viewpoints is unique, critical, and as valid as the next one (Moon & Blackman, 2014; Patton, 2002). This mindset pervades my research journey and how I approach publications as a reviewer and an author. The notion that every study has merit and there is something we could learn from it has become a fundamental principle of mine and it

pleasantly surprised me to see this way of thinking being illustrated in the literature (Sabnis & Newman, 2022).

Understanding my epistemological viewpoint has also allowed me to better problematise why I adopted the DE approach for my study and how my role as the DE evaluator allowed me to leverage this constructionist mindset. As the DE evaluator, I was able to integrate myself into the project stages and, through my communication with stakeholders along with the incorporation of reflective questions, better appreciate the different points of view and use that in the analysis of the data and subsequent conclusions that I drew. I have also come to appreciate the appropriateness of this mindset when engaging in experiential experiences in that it highlights how different students can get a vastly different experience from the same apparent stimuli. Mills, Ashford and McLaughlin (2006) showed how prior experiences in the construction industry influence the student experience when going on field trips. Kayes, Kayes and Kolb (2016) reason that the diversity in student prior knowledge and experience drives success when embarking on experiential learning in teams. These studies among others show how the student background impacts their views and in turn, the outcomes they get from engaging in the learning activity. Having a bounded relativist ontology coupled with a constructionist epistemology allows me to be aware of those possibilities and accounts for them during the study. However, it also serves to drive me towards seeking a framework that allows educators to harness this diversity towards student learning.

3.3 Experiential Learning Theory (ELT)

Experiential learning is defined as learning that is reflective, engaging and experimentative (*Association for Experiential Education*, 2021). This definition was borne from research and analysis of Kolb's ELT which describes learning as a process of knowledge creation through the transformation of experiences (Kolb & Kolb, 2017). This aligns with my epistemological perspective where each individual experiences the experience uniquely and

thus reaps the benefits according to that experience. Uses of experiential learning are associated with improved student motivation (Krakowka, 2012), improved thinking skills (Habib, Nagata, & Watanabe, 2021), increased perceived learning (Villarroel et al., 2020) and improved student outcomes (Coker et al., 2016).

The essence of experiential learning is described as taking place when students actively engage in meaningful tasks, reflect on their experiences, and apply their newfound knowledge to real-world situations (McCarthy, 2010; Sharlanova, 2004). Unlike traditional learning, which often relies on passive information transfer from instructor to student through lectures and textbooks, experiential learning is claimed to demand active student involvement (Raja & Najmonnisa, 2018). While traditional learning is deemed to prioritise content delivery, with students typically taking on a more passive role as recipients of information, experiential learning emphasises hands-on engagement, requiring students to immerse themselves in activities and reflect deeply on their experiences to derive understanding and knowledge (Bradford et al., 2019)

There has been some debate in the literature on the extent to which experiential learning is a phenomenon distinct from other forms of learning. In Hood Cattaneo (2017), five distinct active learning pedagogies were interrogated and though all of them were found to be underpinned by a constructivist epistemology, there were clear differences between them and experiential learning specifically where each approach places importance. While problem-based, discovery-based, inquiry-based, project-based, and case-based learning each focus on various aspects like process, collaboration, intrinsic motivation, and reflective practices, experiential learning is claimed to uniquely emphasize learning through direct experience, allowing students to engage deeply with real-world challenges and reflect on those experiences to construct knowledge (Hood Cattaneo, 2017; McCarthy, 2010; Sharlanova, 2004).

Another similar pedagogy that should be examined is action learning. Action learning and experiential learning are described as both involve learning through experience, but they differ in focus and approach (Cirillo et al., 2022;

Lombardi et al., 2021; Mughal & Zafar, 2011). Action learning is typically presented as being more structured and collaborative. It involves a group of learners working together to solve real problems, with the process of reflection and questioning being integral to both problem-solving and learning (Cirillo et al., 2022; Lombardi et al., 2021). The focus in action learning is on immediate application of knowledge to solve issues, with the learning process occurring as a byproduct of tackling real-world challenges. However, as described experiential learning emphasizes learning through direct, hands-on experiences where learners reflect on those experiences to develop understanding and skills (McCarthy, 2010; Sharlanova, 2004).

A significant reason for my decision to adopt the ELT as the underpinning framework for my research project was that experiential learning stands out from other effective learning methods by emphasizing learning through direct experience. Its focus on active participation, reflection, and real-world application distinguishes it from traditional, constructivist, project-based, and problem-based learning. By deeply engaging students in the learning process, experiential learning fosters a deeper understanding and retention of knowledge, making it a powerful approach to education. Another key reason for my decision came about from research done into the theoretical frameworks adopted by researchers studying in-person field trips across various disciplines (Djonko-Moore & Joseph, 2016; Lee, Stern, & Powell, 2020; Stern & Powell, 2020). Many of these field trip studies have leveraged on Kolb's ELT to guide their field trip development and implementation whether in-person or virtual (Atchison & Kennedy, 2020; Kenna & Potter, 2019; Krakowka, 2012). This is usually done by adopting Kolb's ELT and its associated ELC, detailed in section 3.3.1 below, to guide and structure a learning activity allowing students to build on their experiences and thereby improve student learning. I surmised that the ELT was an appropriate choice particularly as my project sought to implement VFTs in an agricultural setting which, to the best of my knowledge, has only been reported in grey literature. Therefore, by embracing a theoretical framework proven successful in other disciplines, I was able to leverage a robust foundation while tailoring it to the agricultural context, facilitating comparisons.

3.3.1 Experiential Learning Cycle (ELC)

One of the most common ways in which the ELT is operationalised is the ELC (Kolb & Kolb, 2017). The ELC is a model proposed by Kolb that allows educators to design learning activities that actively engage students and guide them in the knowledge-creation process. Thus, experiential learning is often studied by implementing learning activities using the ELC and evaluating their application skills (Ahn, 2008; Arsoy & Özad, 2004; Konak, Clark, & Nasereddin, 2014). This draws on the ELT's assertion that learning is a non-linear process and that experiences are necessary for learning to take place (Kolb & Kolb, 2019). This is operationalised by proposing a sequence of four learning phases where learners can act, experience, reflect and think as illustrated in Figure 3.1: *Active Experimentation (AE), Concrete Experience (CE), Reflective Observation (RO) and Abstract Conceptualization (AC)*.

To further leverage the non-linearity of the learning process, students can enter the cycle at any phase depending on the activity design (Kolb & Kolb, 2017). The framework emphasises the interconnectedness of all four phases of the cycle and allows educators to develop a holistic approach to experiential learning activities (Djonko-Moore & Joseph, 2016; Stern & Powell, 2020). The phases are connected through another insight from the ELT in that learning occurs when individuals engage in an information "taking-in" (CE and AC) process as well as an analysis (RO) and usage process (AE) (Kolb, 2015). The sequencing of the phases in various field trip studies has been reported to be different but has not been noted to affect the intended outcomes (Krakowka, 2012; Moseley et al., 2019).

I decided that the ELC was the best model for the project to underpin the activity design as the VFTs are being employed to give students an experiential learning lesson. In the context of field trips, the ELC has been actively used to structure field trip activities (Jose, Patrick, & Moseley, 2017; Krakowka, 2012; Moseley et al., 2019; Stern & Powell, 2020). Again, with field trips across various disciplines using it successfully to improve various student outcomes, my conviction for the present project was that providing the teaching team and students with a similar structured approach would be the strongest foundation

to build upon to achieve a seamless incorporation of VFTs within the design of an experiential learning activity. The following subsections describe the four phases of the ELC in the order they are employed in my project: *AE → CE → RO → AC*. Additionally, I also describe how I saw these phases being applied in my project.

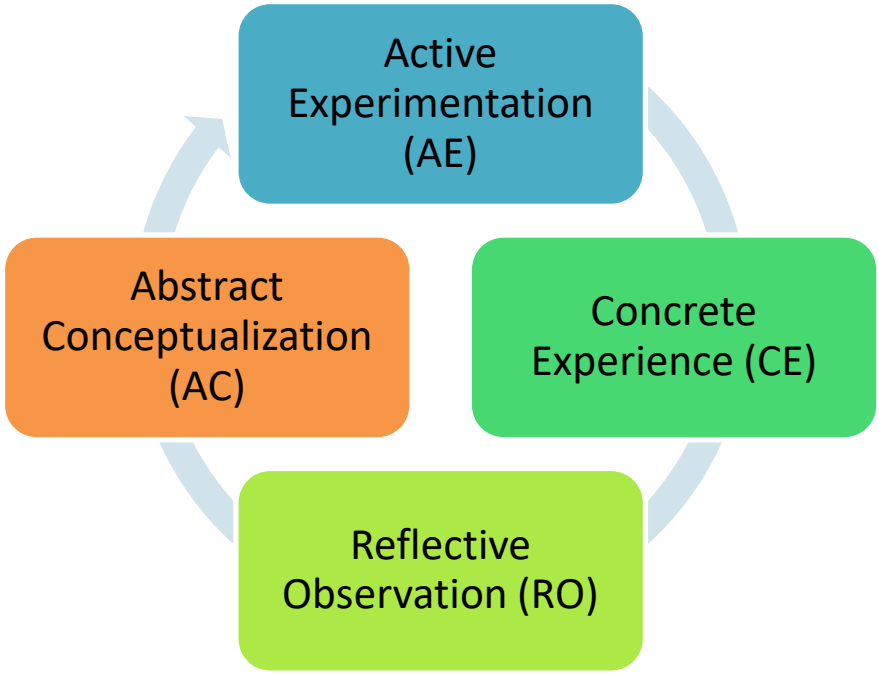


Figure 3-1 Experiential Learning Cycle phases as employed in the project

3.3.1.1 Active Experimentation (AE)

The *active experimentation (AE)* phase is described as the phase where students test their knowledge in complex scenarios (Djonko-Moore & Joseph, 2016; Kenna & Potter, 2019). In this phase, there is usually an emphasis on testing and usually involves students actively being involved in activities such as laboratory practical experiments (Abdulwahed & Nagy, 2009).

In field trip studies, the AE phase takes place in different forms such as planning and developing strategies for implementation (Krakowka, 2012; Stern & Powell, 2020) or actively engaging in activities using their newly acquired knowledge to solve problems or test-developed hypothesis (Stern & Powell, 2020). In this project, I aimed to present students with an application scenario,

related to the discipline appropriate to the iteration, requiring them to use their prior knowledge to the test by attempting to resolve the problem at hand. As they will be performing this activity in groups, it also allows them to see the scenario being attempted from different perspectives. This was a deliberate decision as the students enrolled have diverse backgrounds ranging from those having their family farms to those who have no experience with agriculture at all. This phase would serve students with different experiences to share knowledge within their groups.

3.3.1.2 Concrete Experimentation (CE)

The *concrete experimentation (CE)* phase is the phase where students are engaged in the experience which the learning activity is designed around. This is the phase where students are most actively involved in an information-gathering process, engaging cognitively, emotionally and in instances where a collaborative aspect is incorporated, socially (Morris, 2019). This is also the phase where students are put in a situation where they would be incorporating their prior knowledge in making observations which could either reinforce that knowledge or create a dissonance (Kenna & Potter, 2019).

In the case of field trips, this is where the students engage in learning using all their senses and are immersed in the experience (Alsaqqaf & Li, 2019; Krakowka, 2012). In a similar vein, the CE phase of my project is where the virtual field trip application is employed. Students will embark on a self-directed virtual field trip experience where they will explore Boomaroo Nurseries, a seeding company. The application comprises interactive 360º images of the facilities interspersed with information hotspots and bite-sized videos (maximum length of three minutes) including interviews with staff on-site. Through these features, I aim to give students the experience what they would experience if they went on the field trip in person.

3.3.1.3 Reflective Observation (RO)

Depending on the learner's entry point to the cycle, the *reflective observation (RO)* phase is where they make sense of what they had observed and/or experimented on (Kenna & Potter, 2019). This reflection and analysis process is vital to the learning process and has been connected to deep learning and gaining cognitive awareness (Morris, 2019). This is often the most important stage as this is the phase that allows them to make conclusions about the alignment between what they know and what happens in reality (Alsaqqaf & Li, 2019). This reflection when undertaken collaboratively can enhance the depth of reflection bringing about an increased self-awareness and higher-order thinking (Konak, Clark, & Nasereddin, 2014; Morris, 2019).

In field trips, this phase is the opportunity for them to address gaps in their understanding (Krakowka, 2012) comparing what they have observed on the field trip to their prior experiences. In my project, the RO phase takes place in two stages. Stage one involves students reflecting individually on the experience in the CE phase - how they approached it, what they observed and how the group dynamics influenced their experiences. Stage two involves students reflecting on their learning with their group mates discussing and comparing their reflections with their responses in the AE phase. Through the reflection activities, I aimed that they would be able to expand their knowledge and broaden the application of their ideas by contrasting their prior knowledge with new knowledge garnered and contrasting their peer's perspectives of the concrete experience with their own.

3.3.1.4 Abstract Conceptualization (AC)

The *abstract conceptualization (AC)* phase is where learners are exposed to the concepts being used in the learning activity (Healey & Jenkins, 2007; Krakowka, 2012). This is also the phase where learners are expected to assimilate the knowledge from the observations and reflections and develop a mental model of the concepts (Alsaqqaf & Li, 2019; Kenna & Potter, 2019). This can be done through simple exercises where students embark on a conceptual

exercise to combine what they know before and what they know now as new knowledge (Konak, Clark, & Nasereddin, 2014).

In field trips, the AC phase can often be combined with the RO phase with a single activity (Djonko-Moore & Joseph, 2016; Stern & Powell, 2020) though activities have also been designed for students to formulate new understanding (Krakowka, 2012). In my project, the AC phase is where students actively communicate with one another and bring together their collective knowledge and skills garnered from the rest of the stages and their prior experiences to collectively resolve a scenario task.

3.4 Developmental Evaluation (DE)

The word “evaluation” is often used to portray the notion of standardized measurement classified as either formative or summative depending on its role in the learning experience (Kirnan & Luce, 2016). However, the DE approach was proposed as a novel alternative method focusing on the *process* of supporting innovative practice and its ongoing adaptation in complex environments that are dynamic and ever-changing (Patton, 1994, 2011). Patton (2011) describes that the DE approach is particularly appropriate for innovations that have an “adaptation and change” focus and how, compared to traditional evaluation methods, DE focuses on actively seeking data throughout the project and using the data to make quick adaptations as needed (Bailie et al., 2020). Since agriculture is a discipline that has embraced a lot of innovation in the industry, there is much potential for introducing innovations within the curriculum. Thus the “adapt and change” focus allows me to draw on the research methodologies and approaches and retrofit them towards my discipline.

As presented in section 1.2 and 3.2, as a learning designer for almost a decade, I worked on many educational projects across many different subjects, with varying outcomes. From this, I have come to strongly believe that to understand your data, you need to know the context of where it comes from, why it's collected, and how the person analysing it thinks. This ontology,

stemming from my experiences as an educational researcher and learning designer underpins why I chose the DE approach for my project. Firstly, evaluating initiatives in the education sector is challenging due to the dynamic environment where change is constant. Initiatives are often embraced and customized when being adapted from institution to institution, programme to programme, course to course, cohort to cohort and are subject to influences from social, political, and technological arenas (Szijarto & Bradley Cousins, 2019). This is very much the situation in Australia where government decisions and policies were implemented to shift the way agriculture is perceived long term (*Delivering Ag2030*, 2022) but "sudden" financial decisions lead to higher enrolments in agricultural courses (Maiden, 2020) and the inadvertent lack of resourcing to support it. This makes innovation difficult as the dynamic environments make for uncertainty and reduces the ability to be forward-thinking and proactive. Thus, it becomes critical to have an adaptable and flexible evaluation method that allows evaluators to sense-make data and iteratively inform the innovation process (Roy & Searle, 2020; Tremblay et al., 2020).

Secondly, higher education courses are usually offered for one semester (13 weeks) each academic year, in the case of the School of Agriculture and Food Sustainability where my project is carried out (see section 4.3 for more details). This often results in evaluative outcomes and lessons learnt only being applied in the next run of the course, which could be almost 30 weeks later. At that time, as discussed above, the context around the course could be very different and the intended actions may not be applicable anymore. As such, adopting an approach that is rapid and flexible like DE is ideal for such projects (Rey, Tremblay, & Brousselle, 2013).

Since its conception, DE has been used in various educational research projects including exploring the impact of lesson study (Godfrey et al., 2018), curriculum innovation in professional education (Leonard, Fitzgerald, & Riordan, 2015), communities of practice (van Winkelen, 2016), reframing a degree in a new school (Ahonen & Lacey, 2017) and supporting a change in sex education policy (Fagen et al., 2011). In these studies, DE was used in two types of

environments. They were either exploratory environments where innovations were in their infancy and, where DE was used as a means of evaluating the idea, or adaptive environments where pre-existing ideas in similar contexts were adapted towards their context. The key message that I drew from them was the importance of contextual understanding and application of the innovation.

Across these projects in the literature, a notable aspect is an adherence to the eight essential guiding principles as set out by Patton (2011, 2016a), (i) developmental purpose, (ii) evaluation rigour, (iii) utilization focus, (iv) innovation niche, (v) complexity perspective, (vi) systems thinking, (vii) cocreation, and (viii) timely feedback. These principles are essential elements of the DE approach and the contextual interpretation and adherence to them is what delineates the approach as being a developmental one as opposed to other forms of evaluation approaches (Patton, 2016b). Patton (2016a) describes the adoption of a principles-based approach rather than a prescriptive one as essential to evaluating innovations in a complex social context which is how I characterise my current context. This distinction stems from his definition of the underpinning fundamental of DE in that it is not like a formative or summative evaluation where there are "*recipe-like*" approaches but rather guidelines that should be adopted to varying degrees due to the complexities of a social environment (Patton, 2016c). With that in mind, the following sections lay out the eight principles alongside my interpretation of them for the project with further details of how the eight principles informed the project will be elaborated in Chapter 4.2.

3.4.1 Developmental Purpose Principle

The developmental purpose principle refers to the appreciation of what makes DE unique and that is to *illuminate, inform and support the innovation by identifying the nature and patterns of development along with the implications and consequences of those patterns* (Patton, 2016a). The emphasis of the principle as seen across numerous works by Patton is that all evaluation

processes, methods, data collected, and insights drawn serve a common purpose of supporting innovation (Patton, 1994, 2011, 2016a).

In my project, the developmental purpose is to focus on innovative use of an integrated VFT activity design rather than the VFT application itself, and the developmental purpose is to "*illuminate, inform and support*" that innovative use to support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education.

As such, keeping this principle in mind, I ensured that all activity design considerations, data collected, and analysis performed were targeted at achieving a better understanding of the innovative use of an integrated VFT activity and how it supports a process that links experiential learning to appropriate student outcomes. This allows me to draw conclusions which focus on the relationship between experiential learning as a pedagogical structure and the experiences the students reported. Working with the coordinators, I determined what information they would need and why. These ideas formed the basis of the evaluation, and the guidance made. Further details about how this principle was incorporated in my project is given in section 4.2.1.

3.4.2 Evaluation Rigour Principle

The evaluation rigour principle refers to the *use of rigorous evaluative thinking and situationally appropriate rigorous evaluation methods* (Patton, 2016a). The rigour of traditional evaluative methods is often based on the methods and procedures used for the study. However, in DE this is often not the case because, as illustrated across the other principles, the evaluation being carried out is highly contextual and is targeted towards the information that is necessary for the continued development of the innovation (Patton, 2016a). Adherence to this principle therefore requires DE evaluators and innovators to think and engage evaluatively meaning that they ask thorough and situationally appropriate questions and employ various but appropriate methodologies to gather data that allows specific lessons to be drawn.

In my project, the evaluation rigour principle is central to decisions taken by me and course coordinators about research design including the data collection method, instruments used, analysis approach and how the findings are interpreted through the lens of the other DE principles. Firstly, in aiming to employ the ELC, I mapped the individual activity stages to the ELC phases to ensure that the essence of the phases is leveraged for the student experience. Secondly, I adopted a mixed approach using quantitative questionnaires, qualitative reflections, and observations to corroborate our findings and conclusions. To ensure the rigour, I employed a combination of standardised measures (e.g. ELVIS, ExLSS) alongside specifically designed measures for the project.

One important aspect of the evaluation rigour principle is the use of *situationally appropriate rigorous evaluation methods*. In my project, this has been approached through two means. Firstly, the course coordinators, who are all senior lecturers with more institutional experience than me. As they collaborated with me in reviewing my measures, they were able to highlight its appropriateness or lack thereof. Secondly, my experience as illustrated in section 1.2, having been a learning designer in higher education for almost a decade and now having embarked on educational research at my home institution for a few years, helped me understand what is situationally appropriate for my project. Further details about how this principle was incorporated into my project is given in section 4.2.2.

3.4.3 Utilization Focus Principle

The utilization focus principle refers to the *focus on the intended use by intended users from beginning to end* (Patton, 2016a). In essence, this means that the DE being employed must be used to inform the innovation and adaptation through the lens of how the end-users intend to use it.

In my project, end-users were the course coordinators who collaborated with me throughout the project, teaching undergraduate agriculture courses

across various disciplines. They represent educators who would use an integrated virtual field trip activity design to support a process that links experiential learning to appropriate student outcomes. In and across each iteration, the coordinators were briefed and consulted on the implementation, evaluation, findings, and subsequent adaptations made. Many aspects of the activity design were tweaked with feedback from the coordinators and the discussions also prompted the introduction of new evaluation measures when more detailed evaluation was required.

Another group of important end-users are the students who directly engage with the VFT. As a direct user, their perspectives, satisfactions and learning outcomes are invaluable indicators of the success of the innovation. Incorporating student feedback into iterative evaluation processes not only ensures that the technology meets their needs but also enhances its overall educational impact. Therefore, embracing the perspective of both teachers and students as end-users enriches the evaluation process and contributes to the ongoing improvement of VFT implementations. Further details about how this principle was incorporated in my project is given in section 4.2.3.

3.4.4 Innovation Niche Principle

The innovation niche principle refers to the niche of DE which is the *elucidation of how the change process involves innovation and adaptation* (Patton, 2016a). In understanding this principle, it is necessary to contextualise what the term “innovation” means for the project. As discussed in Chapter 3.4, the extent to which an intervention is deemed innovative can be dependent on the “where” it is implemented and “how” the innovator(s) seek to employ it. It is evident that the use of VFTs is not new and has been researched across many fields across various disciplines including Biology (Kolås et al., 2020), Hospitality (Patiar et al., 2020), Geology (Dolphin et al., 2019), Geoscience (Litherland & Stott, 2012; Mead et al., 2019), Earth and Environmental Sciences (Çaliskan, 2011), Engineering (Seifan, Dada, & Berenjian, 2019) and agriculture (Harkess et al., 2007; Jacobson, Militello, & Baveye, 2009)

The element of innovation in my project is not the use of VFTs per se but rather how the integrated VFT trip activity can be designed to support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education. The need for this project was also highlighted in Chapter 2. Through the project, I aimed to develop a model that would assist educators in employing VFTs for a similar purpose. The '*niche'* is represented by the research site (AGFS) situated in a particular institution (UQ) which also offers the various sub-disciplines of horticulture, agronomy, and agribusiness in the study of agriculture.

The essence of adaptation is evident across different dimensions of the project. Initially, I customized the ELC, commonly utilized for in-person field trips, to craft the innovative VFT integrated activity design. Subsequently, through successive iterations, I perceive it as the adaptation of the innovation from one context, such as horticulture, to another, such as agribusiness. These adaptations involve refining contextualized scenarios to align with the sub-discipline where the innovation is applied. Further details about how this principle was incorporated into my project are given in section 4.2.4.

3.4.5 Complexity Perspective Principle

The complexity perspective principle refers to *understanding and interpreting the development through the lens of complexity and conducting the evaluation accordingly* (Patton, 2016a). This principle embraces the notion that complexity is part of any social system such as education and that the DE evaluator should ensure that the evaluation is informed by complexity concepts and understanding.

Innovations and associated research in education embodies the complexity idea of *nonlinearity* and tends to ebb and flow according to successful interventions or opportunities provided by innovative technologies or in the case of COVID-19, a social phenomenon. COVID-19, which also set the scene for my project, led to a boom in online learning research being published while the launch of ChatGPT by OpenAI in 2022 saw the explosion of research

into Artificial Intelligence. In my experience, COVID-19 also had an indirect effect of priming educators to embrace technological interventions more readily. In my project, being cognizant of this *nonlinearity* was an important aspect of conducting my DE on a timescale (one semester).

In adopting a DE approach, I embraced three other complex ideas of *emergence*, *adaptation* and *uncertainty* (Patton, 2011*)*. Having an emergent view was to be open and prepared for the evidence that might go contrary to our preconceived notions or illustrate patterns that we might not have had previously. Building on that, as a DE evaluator I had to be adaptive in allowing the findings to guide both the development of the innovation and further evaluations. This was critical as having the three iterations across different courses meant that each evaluation situation was varied. Each with the potential to be successful due to a combination of various conditions but could also easily fail due to a differing set of conditions. The appreciation of this *uncertainty* is to have the mindset that even in optimal conditions, outcomes are never guaranteed (Goertzen et al., 2020). Further details about how this principle was incorporated in my project is given in section 4.2.5.

3.4.6 System Thinking Principle

The systems thinking principle refers to the need to *think systematically through the entire evaluation paying attention to the interrelationships, perspectives and boundaries between the innovation and the context where it is applied* (Patton, 2016b). This principle requires the evaluation team to appreciate that innovations are not conducted in isolation and that a contextualised approach is necessary to make sense of data. This is even more critical in my project which is situated in a higher education setting which is a highly complex system characterized by its vast connectivity with other large systems including the social, economic and political realms (Ghaffarzadegan, Larson, & Hawley, 2017). This understanding that education is interconnected by various large systems was felt due to the COVID-19 pandemic where the education sector, as we knew it, ceased to exist (Sahu, 2020) or when the

Australian Federal government decided to increase the cost of arts degrees but slash that of math, science and agriculture potentially impacting student enrolment (Maiden, 2020). These examples just scratch the surface of a system that exhibits many characteristics of a complex dynamic system, (Sterman, 2002) and an understanding of these influences is important to successfully implement any innovations.

One of the challenges in adopting the DE approach was to ascertain my perspective in understanding the difference between the *systems thinking principle* and the *complexity perspective principle* above. In interpreting the definitions of the two principles, I devised my own definition to maintain clarity. To me the *systems thinking principle* relates to an appreciation and understanding of the various influences that affect the conduct of the implementation, specifically elements that affect the students and their learning experiences. On the other hand, to me, the complexity principle relates to the embracing of complexity ideas such as *nonlinearity*, *emergence*, *adaptation,* and *uncertainty* and allowing the uniqueness of each iteration to paint its own picture and for me as the evaluator to be open and receptive to it.

In my project, it is important to appreciate that a university students' perspective is highly varied due to the diversity of students that we encounter. We see students for whom education started at a young age and continues till adulthood. On the other hand, we see a vast number of adult students who embarked on university education to further themselves or their careers and we also have students in the middle who have taken gap years and been away from education for a considerable amount of it. Within and between these groups, students would have faced a multitude of successes and failures, expectations and a myriad of other factors that greatly impact and affect their outlook, perceptions, and motivations (Ghaffarzadegan, Larson, & Hawley, 2017). The exact reasons as to how and why students react to different learning interventions or their acceptance and rejection of them are often unclear and likely influenced by a myriad of factors. By adopting an inquiry framework of asking the appropriate basic questions, I was able to systematically determine factors that could potentially influence the evaluation outcomes. Figure 3.4

illustrates my system pyramid of factors that influence a successful student activity experience. The inner square are factors that are directly connected to the activity itself while the outer square illustrates external factors that could influence their experience. In developing the system pyramid, I also realised how this might be applied to a single student, a group of students or none of them at all. Further details about how this pyramid and principle was incorporated in my project is given in section 4.2.6.

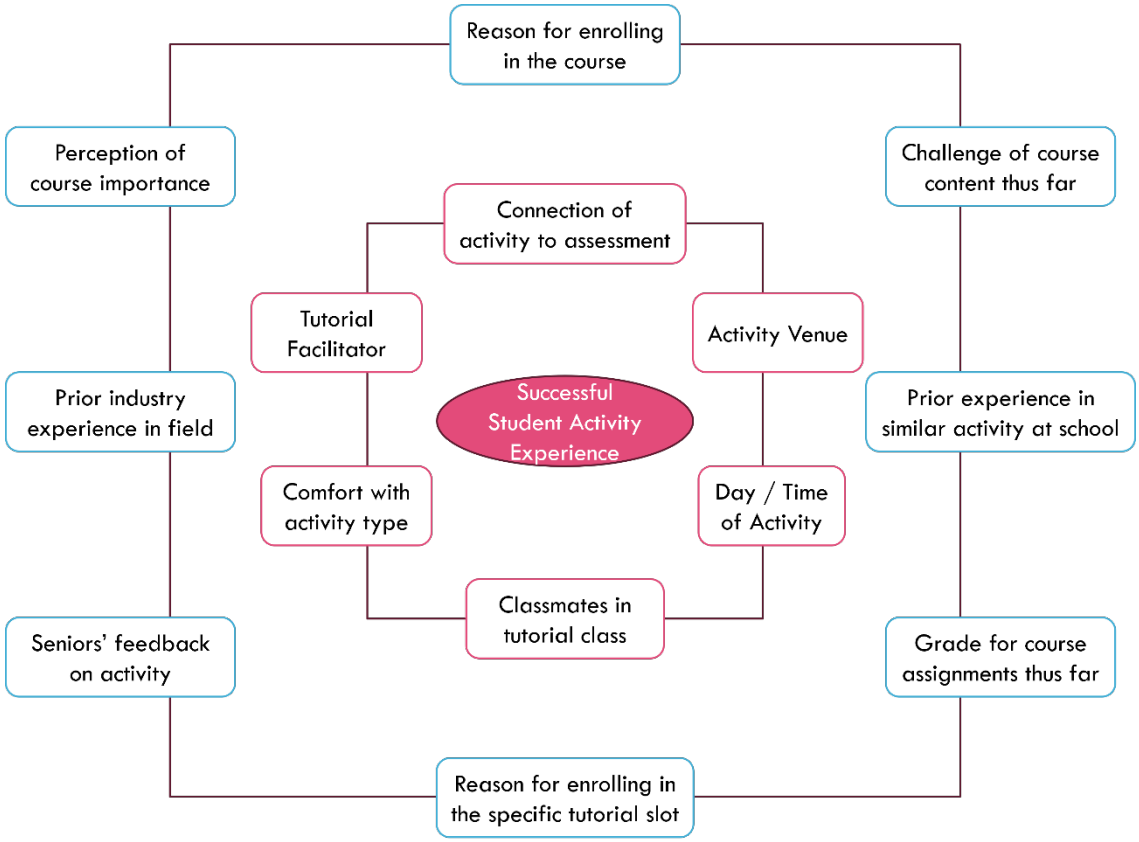


Figure 3-2 A system pyramid showing factors influencing a successful student activity experience

3.4.7 Co-Creation Principle

The co-creation principle refers to *developing the innovation and evaluation together so that the DE becomes part of the change process* (Patton, 2016a). This principle leverages the close relationship between the

innovators and the developmental evaluator. Their collaboration allows for a flexible approach to developing and adapting the innovation along with the evaluation aim, methods, and outcomes. Rather than seeing the evaluation as an independent process, this principle guides the developmental evaluator to seek to integrate the evaluation process with the intervention and vice versa.

In my project, this principle underpinned the decision that both the developmental evaluator and the course coordinators (who are also the end-users) engage in decisions related to the innovation, its implementation, evaluation, and subsequent adaptations. This allowed the requirements from the innovation and evaluations to be considered and appropriately incorporated by both parties during the implementation across the iterations. Further details about how this principle was incorporated into my project is given in section 4.2.7.

3.4.8 Timely Feedback Principle

The timely feedback principle refers to *timing the feedback process in a manner that appropriately informs the innovation rather than only predetermined times* (Patton, 2016a). This is an important principle as DE projects may ebb and flow along with how the intervention develops and the feedback process informing the intervention would also need to be flexible and timely so that the intended users would get essential information when they need it.

In my project, the timely feedback principle is used to govern the data collection process to ensure it fits within the implementation cycle so that feedback would be captured both within and between iterations to inform any adaptations to be made appropriately. It was also critical that analysis for one iteration had to be completed in a timely manner so that consultations with course coordinators could be completed and guidance implemented for the subsequent iteration. Further details about how this principle was incorporated into my project is given in section 4.2.8.

3.5 Using the frameworks together in the project

My intention was to leverage the strengths of both ELT and DE to underpin research project. I envisioned that these frameworks were to operate independently but in complementary ways, offering a comprehensive perspective on the project's implementation and evaluation. DE was utilized as a macro-level framework, providing a structured approach to evaluating complex, evolving initiatives. DE emphasizes real-time learning and adaptation, focusing on gathering ongoing feedback, assessing progress, and adjusting strategies based on the changing context. This framework helps in systematically analyzing the effectiveness of the project and making informed adjustments to enhance outcomes.

Conversely, ELT functioned as a micro-level framework, concentrating on individual learning experiences. It emphasizes the importance of hands-on activities and reflective practices as central drivers of learning. By promoting experimentation, observation, and subsequent reflection on outcomes, the intention was to use ELT to support an iterative process where learners continuously refine their approaches based on practical experiences. This framework was used in an attempt to ensure that individual interactions with the project are actively integrated into personal learning cycles, thus driving ongoing development.

Though ELT and DE approach the learning process from different angles, their integration within the project fosters a dynamic learning environment. This is exemplified by the instruments planned for at the start of the project and how those instruments changed as the iterations proceeded. This is detailed in sections 4.4, 5.2.3, 5.3.3 and 5.4.3. ELT’s focus on direct engagement and reflection complements DE’s emphasis on systematic feedback and adaptive strategies. Together, they ensure that insights from hands-on experiences are continuously fed into project planning and execution, thereby improving effectiveness and enhancing resilience in managing uncertainties. This synergy between the two frameworks contributes to a robust and responsive approach to project development and evaluation.

3.6 Conclusion

In summary, this chapter outlined the theoretical frameworks that guided my research project beginning with a discussion of the ontological and epistemological beliefs that shaped the study. By integrating the principles of Experiential Learning Theory (ELT) and the Experiential Learning Cycle (ELC), the chapter has highlighted the pedagogical rationale behind the design and implementation of Virtual Field Trips (VFTs) within the context of undergraduate agriculture education. Furthermore, the chapter detailed the adoption of the Developmental Evaluation (DE) approach, emphasizing its pivotal role in shaping the project's iterative process, data collection, and interpretation of findings. Through this framework, the chapter has laid the groundwork for understanding how VFTs can be effectively employed as an experiential learning tool, providing a cohesive structure for the subsequent exploration and analysis within this research. The next chapter will outline the research design used for the research study.

Chapter 4: Research Design

4.1 Introduction

This chapter describes the research design employed in my evaluation project where I have adopted the DE approach to understand how an integrated VFT activity design can support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education. In section 4.3.2, I describe a development project, which preceded my evaluation project, responsible for the development of the VFT application used as the focal point for the activity design. My evaluation project was conducted over three iterations where findings from each iteration informed the activity design of the subsequent one. This chapter starts by illustrating the evaluation project's contextualising of the eight DE principles introduced in the previous chapter. This is followed by a description of the research context, data collection instruments along with the analysis to be performed. The chapter closes with a description of the ethical considerations for the evaluation project and identifies limitations to the research design.

4.2 Contextualising and Operationalising the DE Principles

As discussed in the previous chapter, the eight DE principles form the core of all DE projects and are seen to be addressed to different degrees depending on the context and nature of the project being embarked on. The following sections describe how the eight principles are contextualised and operationalised in the project.

4.2.1 Developmental Purpose Principle

As discussed in section 3.4.1, the developmental purpose principle refers to the *illuminating, informing and supporting of innovation by identifying the nature and patterns of development along with the implications and*

consequences of those patterns (Patton, 2016a). In my project, this principle was held as the most important principle with clarity that I was evaluating the innovative use of an integrated VFT activity design to support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education.

As the DE evaluator, I ensured that all course coordinators joining me on the project had a similar understanding of the purpose of the evaluation. This was operationalised through our discussions with a focus on ensuring that the activity design for each iteration employed the ELC incorporating VFT thus allowing us to investigate the use of the integrated VFT activity design to support a process that links experiential learning to appropriate student outcomes specifically in undergraduate agriculture education. For example, the scenarios used in the activities were contextualised to the agriculture field and the VFT used formed the bases of the CE phase of the ELC. Additionally, in those discussions, we established the information required to make conclusions about the innovation and ensured that the right instruments were employed at the appropriate time. For example, reflections were distributed across the iteration for students to reflect on various aspects of the activity at the appropriate time. I also ensured the incorporation of data collection from a range of sources, including questionnaires, reflections to ensure a holistic view of the student experience could be obtained. Furthermore, during the analysis, the team also ensured that the data collected drove the conclusions despite our preconceived notions.

4.2.2 Evaluation Rigour Principle

As discussed in section 3.4.2, the evaluation rigour principle refers to the *use of rigorous evaluative thinking and situationally appropriate rigorous evaluation methods* (Patton, 2016a). In my project, the evaluation rigour principle was central to our decisions about research design including the data collection method, instruments used, analysis approach and how the findings are interpreted through the lens of the other DE principles.

Three ways in which we operationalised this principle were the activity design, the choice of situationally appropriate evaluation methods and the adoption of a mixed-method approach. Firstly, in aiming to employ the ELC, I mapped the individual activity stages to the ELC phases and developed student activities to ensure that the essence of the phases is leveraged for the student experience. Table 4.1 shows a summary of the mapping and student activities which are elaborated upon in Chapter 5. This was rigorous and situationally appropriate as it illustrates a thoughtful and structured approach to designing student experiences that aligned with established theoretical frameworks. By developing student activities to correspond with each phase of the ELC, I aimed to provide students with a comprehensive and scaffolded learning experience. This approach allowed for a systematic progression through the learning cycle, facilitating deeper engagement and understanding among students. Additionally, by leveraging the essence of the ELC phases, I sought to enhance the relevance and applicability of the student activities, ultimately promoting meaningful learning outcomes.

Stage	Name	Mapping to ELC	Student Activity
1	Opening	-	-
2	Prior Knowledge Discussion	Active Experimentation	• Explore scenarios using prior knowledge. • Share with groupmates
3	Exploring Boomaroo Nursery	Concrete Experience	• Explore the VFT location
4	“Return to Classroom”	Reflective Observation	• Review prior knowledge. • Share with groupmates
5	Attempt Scenario	Abstract Conceptualization	• Attempt scenario with groupmates
6	Closing	-	-

Table 4.1 Mapping of activity stages to ELC phases

Secondly, in discussions, I realised that the iterations were to be delivered within a timetabled workshop setting which would last two hours at most. To ensure that we maximised response rates and collected as much of the required data as possible, I made the decision to embed the data collection processes within the activity stages. The data collected from students was thus initially limited to questionnaires but subsequently included their activity contributions. This was rigorous and situationally appropriate as it enabled me to carefully consider both logistical constraints and the need for robust data collection to ensure that all relevant data points were captured effectively within the constrained timeframe of the workshop setting.

Thirdly, to leverage the data collected to get a holistic picture of the student experience, I adopted a mixed approach using quantitative questionnaires, qualitative reflections, and observations to corroborate our findings and conclusions. To ensure evaluation rigour, I employed a combination of standardised measures (e.g. ELVIS, ExLSS) alongside specifically designed measures for the project. This was rigorous and situationally appropriate as it demonstrated a thoughtful and systematic effort to gather comprehensive data and ensure evaluation rigor in assessing the student experience. The multi-faceted approach ensured that the evaluation process was thorough and robust, enabling a holistic examination of the student experience and by incorporating established instruments alongside the project specific measures, the study was able to leverage existing research while also addressing the unique objectives of the project.

4.2.3 Utilization Focus Principle

As discussed in section 3.4.3, the utilization focus principle refers to the *focus on the intended use by intended users from beginning to end* (Patton, 2016a). In my project, end-users were the course coordinators who collaborated with me throughout the project, teaching undergraduate agriculture courses across various disciplines. They represent educators who would use

an integrated VFT activity design to support a process that links experiential learning to appropriate student outcomes.

Before each iteration, the course coordinators were actively engaged in the design process. They provided directions on the type of scenario used and the activity instructions the students were given. They were initially slated to deliver the workshop sessions but were subsequently encouraged to be present during the session. They also actively shared what they would like to find out about the implementation which helped shape my choices of measures and qualitative questions. When discussing with them, coordinators gave their input into what the implications are, if any, when used for their students. Between iterations, the coordinators were engaged in discussion regarding the findings and any observations made that would influence the activity design. These discussions resulted in changes to duration and the removal of an assignment item which was initially introduced in Iteration 1.

The *VirtualVoyageVista*[10], an activity design framework bridging experiential learning and student outcomes through an integrated VFT design illustrated in Chapter 6.2, was developed in consultation with the coordinators bringing together learning points from across the three iterations. Educators who would like to use an integrated VFT activity design to support a process that links experiential learning to appropriate student outcomes could potentially adopt it for their implementations.

4.2.4 Innovation Niche Principle

As discussed in section 3.4.4, the innovation niche principle refers to the *elucidation of how the change process involves innovation and adaptation* (Patton, 2016a). In my project, I established that the innovation here is not simply using VFTs but rather how an integrated VFT activity design to support a

[10] The explanation and illustration of the framework is given in Chapter 6

process that links experiential learning to appropriate student outcomes specifically in undergraduate agriculture education.

As an outcome of the project, we developed the *VirtualVoyageVista* framework, illustrated in Chapter 6.2, which can guide educators keen on using a similar approach to what we adopted. The element of adaptation across various aspects of the project. Firstly, I adapted the ELC, often used for in-person field trips to develop the VFT integrated activity design which is the innovation being employed. Secondly, from one iteration to the other, I look at it as the adaptation of the innovation from one context (e.g. horticulture) to another context (e.g. agribusiness). These adaptions come in the form of contextualised scenarios amended according to the sub-discipline where the innovation is being employed. Further to that, lessons learnt from each iteration led to the revision of the innovation and adaptation appropriately. This included adjustments to duration, online data capturing tools and even an introduction of a new instrument (ExLSS) to help us better understand the innovation. These innovations are elaborated in Chapter 5.

4.2.5 Complexity Perspective Principle

As discussed in section 3.4.5, the complexity perspective principle refers to *understanding and interpreting the development through the lens of complexity and conducting the evaluation accordingly* (Patton, 2016a). In my project, I embraced four complexity ideas, *nonlinearity*, *emergence*, *adaptation,* and *uncertainty*.

COVID-19 had much impact on teaching and learning at all levels of education. This also had an impact on educators' and students' acceptance and embrace of technology which is often seen to be a replacement for in-person activities. Embracing the idea of *nonlinearity* and with an understanding that this openness and willingness to try technological innovations would ebb and flow according to other external influences, I sought to complete the DE iterations across a tight timeframe (1 semester) to minimise its impact.

Having an *emergent* and *adaptive* view became an important aspect of my project as each of my iterations was implemented on a course for a different sub-discipline and that worked in one iteration may not work as well in another. For example, in Iteration 2, building on what we had observed in Iteration 1, we designed a scenario that was expected to engage students in drawing lessons from the VFT in applying their agribusiness concepts. However, the findings suggested that the scenario was generic and hindered the students rather than supporting them. This surprised the team and highlighted the importance of the scenario design to the overall success of the activity. Additionally, observations from Iteration 1 helped me see which aspects of the activity design needed to be retained and which needed to be amended. With those amendments, there was an initial thought that I had a successful activity design but the observations and findings from Iteration 2 showed the importance of having an *uncertainty mindse*t where even in optimal conditions, outcomes are never guaranteed (Goertzen et al., 2020). For example, in scheduling Iteration 3, we assumed that being at the end of the semester without conflicting assessment items and that we framed the activity as an extension to the content, we would see an increased attendance rate, but it turned out to have the poorest attendance rate across all three iterations.

4.2.6 Systems Thinking Principle

As discussed in section 3.4.6, the systems thinking principle refers to the need to *think systematically through the entire evaluation paying attention to the interrelationships, perspectives and boundaries between the innovation and the context where it is applied* (Patton, 2016a). In my project, I employed a *systems thinking approach* to understand a range of factors that can influence and inform a successful student activity experience.

Firstly, understanding that prior attitudes and experience of VFTs can influence current attitudes and experience, I sought to capture data to understand key factors for each iteration to help contextualise the findings. I incorporated a pre-activity questionnaire that assessed the student's prior

experience and impression of VFTs. We also incorporated pre- and post- test questionnaire to better understand the impact of the activity compared on student perceptions of learning in an experiential learning context. Based on findings from the pre- and post- questionnaire, I designed the activity in stage 2 to leverage student prior experience to help them relate to the activity and bring their own experiences to fore.

Secondly, in order to obtain a holistic understanding of their overall experience I ensured the use of a variety of measures that would capture various aspects of the student experience. For example, I incorporated self-report quantitative questionnaires alongside reflective exercises measuring their perceptions and reflections on learning in an experiential learning activity. Additionally, I included questionnaires that sought the students' experience with the VFT specially which could potentially influence their overall learning experience. I incorporated my observational notes of the implementation which looked at factors such as depth of discussions and activity durations which influenced the innovation.

Thirdly, I chose to approach the evaluation of each iteration systematically. Instead of adopting a measure-by-measure approach, I collated the findings from different measures and instruments through the lens of the activity design and student outcomes.

4.2.7 Co-creation Principle

As discussed in section 3.4.7, the co-creation principle refers to *developing the innovation and evaluation together so that the DE becomes part of the change process* (Patton, 2016a). In my project, I used the co-creation principle to ensure that the evaluation process fits within the innovation across various activities.

This principle underpinned the decision to involve the course coordinators (who are also the end-users) in decisions related to the innovation, its implementation, evaluation, and subsequent adaptations. Before the

iterations, the coordinators provided information about the class involved in the iteration and provided their expertise in designing the scenario and activities for each activity stage. They also provided an insight into what information would be key in helping them evaluate the implementation. In analysing the data collected, they were once again consulted to make sense of the data along with contextualising the conclusions that are made. They supported the conclusions made regarding the activity design and where appropriate suggest improvements to the evaluation process. One of those suggestions resulted in the incorporation of the ExLSS for Iteration 2 to obtain more nuanced information about the student's experience in each phase of the ELC. This cycle of consultation and implementation was repeated across all three iterations albeit with different coordinators.

4.2.8 Timely Feedback Principle

As discussed in section 3.4.8, the timely feedback principle refers to *timing the feedback process in a manner that appropriately informs the innovation rather than only at predetermined times* (Patton, 2016a). In my project, I tied this closely to the evaluation rigour principle in looking at *situationally appropriate* evaluation methods.

With the three iterations, it was critical that each iteration had to be completed promptly so that lessons could be drawn and used in the subsequent iteration. Thus, this principle was adopted in two ways. Firstly, I ensured that all data was collected in a "just in time" manner whereby we collected data just after or during the activity stages. This allows for authentic and rich data to be collected by leveraging on the recency aspect of having just engaged with the activity. This resulted in three data collection phases – the pre-activity phase, the post-activity phase and during the activity itself. Focusing all data collection within the conduct of the iteration also meant that there was no waiting time between collection and analysis. All possible data was collected by the end of the session and analysis could begin immediately. Secondly, though a mixed method was employed, a large proportion of the data collected were

quantitative in nature. This allowed for analysis using SPSS and for conclusions to be drawn in a shorter time. These conclusions are then corroborated through the other qualitative measures being employed. In this way, the key issues were identified quickly and addressed for implementation in the next iteration.

In conclusion, my project contextualised and operationalised the eight principles (summarised below in Table 4.2) within the design of the study to leverage the potential of DE in supporting the innovation of using an integrated VFT activity design to support a process that links experiential learning to appropriate student outcomes undergraduate agriculture education.

DE Principle	**Definition** (Patton, 2016a)	**Examples of Contextualisation and Operationalisation in My Project**[11]
Developmental Purpose	"Illuminate, inform and support the innovation by identifying the nature and patterns of development along with the implications and consequences of those patterns"	• My Purpose: Evaluating the innovative use of an integrated VFT activity design to support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education. • Ensured that all course coordinators and I (evaluator) were on the same page of understanding the purpose of the evaluation. • Ensured that the activity design for each iteration employed the ELC incorporating VFT. • Established the information required to make conclusions about the innovation and ensured that the right instruments were employed at the appropriate time. • Ensured the incorporation of data collection from a range of sources to ensure a holistic view of the student experience. • Ensured that the data collected drove the conclusions despite our preconceived notions (e.g. using an inductive approach for thematic analysis).
Evaluation Rigor	"Use rigorous evaluative thinking and situationally appropriate rigorous evaluation methods"	• Mapped individual activity stages to the ELC phases and developed student activities to ensure that the essence of the phases is leveraged for the student experience.

[11] These examples are not an exhaustive list but highlights as elaborated in the sections above.

DE Principle	Definition (Patton, 2016a)	Examples of Contextualisation and Operationalisation in My Project[11]
		• Embedded data collection processes within the activity stages to maximise response rates and collect as much of the required data as possible. • The data collected from students was thus limited to questionnaires. • Adopted a mixed approach using quantitative questionnaires, qualitative reflections, and observations to corroborate our findings and conclusions. • Employed a combination of standardised measures alongside specifically designed measures for the project.
Utilization Focus	"Focus on the intended use by intended users from beginning to end"	• Coordinators were actively engaged in the design process giving direction on the type of scenario used and the activity instructions the students were given. • Coordinators actively shared what they would like to find out about the implementation shaping choices of measures and qualitative questions. • Between iterations, coordinators were engaged in discussion regarding the findings and any observations made that would influence the activity design. • The *VirtualVoyageVista* framework was developed in consultation with the coordinator bringing together learning points from across the three iterations.

DE Principle	**Definition** (Patton, 2016a)	**Examples of Contextualisation and Operationalisation in My Project**[11]
Innovation Niche	"Elucidate how the change process involves innovation and adaptation"	• Clearly established the innovation: how an integrated VFT activity design to support a process that links experiential learning to appropriate student outcomes specifically in undergraduate agriculture education. • Adapted the ELC, often used for in-person field trips to develop the VFT integrated activity design. • Adapted the contextualised scenarios from one iteration to the other as an adaptation of the innovation from one context (e.g. horticulture) to another context (e.g. agribusiness). • Used lessons learnt from each iteration allowed me to revise the innovation and make adaptations appropriately.
Complexity Perspective	"Understand and interpret the development through the lens of complexity and to conduct the evaluation accordingly"	• Embraced the idea of *nonlinearity* and sought to complete the DE iterations across a tight timeframe. • Embraced an *uncertainty* mindset to appreciate that what worked in one iteration may not work as well in another. • Embraced an *emergent* and *adaptive* view and allowed the findings from each iteration to guide the innovation and subsequent evaluations.
Systems Thinking	"Think systematically through the entire evaluation paying attention to the interrelationships, perspectives and boundaries between the innovation and the context where it is applied"	• I sought to capture data to help me understand the various factors that can influence a successful student activity experience to help contextualise the findings.

DE Principle	Definition (Patton, 2016a)	Examples of Contextualisation and Operationalisation in My Project[11]
		• When deciding the appropriate measures, I ensured that various aspects of the student experience would be measured to give me a holistic understanding of their overall experience. ich influenced innovation. • I approached the evaluation of each iteration in systematic manner by collating the findings from different measures and instruments through the lens of the activity design and student outcomes rather than a measure-by-measure analysis.

Co-Creation	"Develop the innovation and evaluation together so that the DE becomes part of the change process"	• This principle underpinned the decision to involve the course coordinators (who are also the end-users) in decisions related to the innovation, its implementation, evaluation, and subsequent adaptations.
		  ○ Prior to the iterations, the coordinators provide information about the class involved in the iteration and provide their expertise in designing the scenario and activities for each activity stage.
		  ○ They also provided an insight into what information would be key in helping them evaluate the implementation. In analysing the data collected, they are once again consulted to make sense of the data along with contextualising the conclusions that are made.
		  ○ They support the conclusion made regarding the activity design and where appropriate suggest improvements to the evaluation process.

DE Principle	Definition (Patton, 2016a)	Examples of Contextualisation and Operationalisation in My Project [11]
		• This cycle of consultation and implementation was repeated across all three iterations albeit with different coordinators.
Timely Feedback	"Time the feedback process in a manner that appropriately informs the innovation rather than only predetermined times"	• With the three iterations, it was critical that each iteration had to completed in a timely manner so that lessons could be drawn and used in the subsequent iteration. • I ensured that all data collected was in a "just in time" manner just after or during the activity stages → three data collection phases – the pre-activity phase, the post-activity phase and during the activity itself. • Focusing all data collection within the conduct of the iteration meant no waiting time between collection and analysis. • Though a mixed method was employed, a large proportion of the data collected was quantitative allowing for quicker analysis and for conclusions to be drawn in a shorter time.

Table 4.2 Examples of contextualisation and operationalisation of DE principles in my project

4.3 Study Context

4.3.1 School of Agriculture and Food Sciences

The research project was conducted at the School of Agriculture and Food Sustainability (AGFS) at the University of Queensland (UQ) which offers undergraduate programmes in Agricultural Science (with majors in Agronomy, Animal Science and Horticulture), Agribusiness, Equine Science and Wildlife Science[12].

Located within at a rural campus, the school prides itself on using its close industry connections, innovative approaches to learning and world-class facilities to provide students with a competitive career edge. These close connections allow undergraduate courses to organize field trips as a key aspect of course deliveries. Despite the educational benefits, conducting a field trip had become challenging due to a myriad of factors such as cost, large class sizes, proximity of field trip location to campuses, time constraints, and safety. These factors have also been exacerbated by the prolonged impact of COVID-19, specifically with the travel and social restrictions that were in place when this project was initiated.

Being the top-ranked agricultural school in Australia (*Rankings and Reputation*, 2020), and, importantly, my current institution, it provided a range of courses that employed field trips including academic staff who were eager and ready to incorporate more technology within courses due to their experiences during COVID-19. This along with access to agricultural students across various disciplines, made the school an apt research site. These reasons were also what made the research site critical to the project's success.

[12] https://agriculture-food-sustainability.uq.edu.au/study/study-areas

4.3.2 The Agriculture Corridor

The Agriculture Corridor [13] is the VFT application developed and used as the focal point of the activity design. This development was supported by the UQ Science eLearning team and UQ's eLearning Innovations and Partnerships in Science and Engineering (eLIPSE) unit. Both these teams provided software development services and technical support while an academic team from various disciplines at AGFS provided content knowledge. The development work was funded by a successful teaching and learning grant awarded to the team by the Australian Council for Deans of Science (ACDS). One fundamental design aspiration for the application is for it to be a transferable resource across disciplines and courses to alleviate some of the identified challenges and disadvantages of VFTs (Tuthill & Klemm, 2002). As such, the application did not feature integrated quiz questions or discipline-specific activities but rather it covered broad areas such as farm facilities, production processes, agricultural technologies, and business practices.

The application features a visit to Boomaroo Nurseries, a seedling company who were approached to be a part of the programme due to their innovative approaches to production and their business (*Boomaroo Nurseries*, 2022). The team identified various key locations around the nursery to anchor the content and student experience. At each of these anchors, students have the option to explore the site by rotating 360º images, clicking on information hotspots and watching bite-sized videos where key members of the facility provide information about the facilities and nursery operations. Figure 4.1 gives a collage of screenshots from the application illustrating the diverse options available for students to engage with.

At its core, the funding provided by ACDS was to develop the VFT application itself and did not consider an underpinning pedagogical model during its development. Thus, the evaluation project is initiated from the point of view that its purpose is to evaluate the innovative use of an integrated VFT

[13] https://agco360-uat.uqcloud.net/

activity design to support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education.

Figure 4-1 Screenshots from The Agriculture Corridor

4.3.3 Course Selection

A list of courses to be included in the evaluation project was shortlisted using two criteria. The first criterion was that the courses had to deliver the plant-centric concepts that were covered in the developed VFT application. Unfortunately, this meant that the animal-based courses had to be excluded while plant-centric horticultural and agronomy courses and agribusiness courses formed the shortlist. The second criterion was that the shortlisted courses should have some field trip component embedded within them. This was an important criterion as the use of VFTs at the school was a new initiative and the impact on teaching and learning was still not clear. As such, introducing an entirely new virtual field element into the course would require comparatively more work than redesigning an existing activity. From the project standpoint, it was also going to be easier to recruit partners if they already invested the benefits of field trips.

Course coordinators of the shortlisted courses were then contacted and briefed about the project and were encouraged to put their course forward for the project. At the end of the recruitment phase, three courses were identified, and work began for implementation in 2022 semester 1. The courses selected for the project were Horticultural Science (HORT2007), Agribusiness Planning & Management (AGRC2023) and Plant Production Principles & Technologies (AGRC1024) forming iterations 1, 2 and 3, respectively.

4.3.4 Course and Participant Description

HORT2007 is a second-year undergraduate horticulture course with an enrolment of 14 students in 2022 with 9 of them taking part in the project. The course content covers the principles of propagation and establishment of horticulture crops, model production systems and the maintenance of quality by appropriate post-harvest handling of horticultural products through the marketing chain. This is the first horticultural-specific course that students majoring in horticulture take as part of their programme. Traditionally the course

had a significant field trip component allowing students to see the horticultural concepts in action at nurseries in proximity to the campus. As the proximity factor limited the types of nurseries that the students could be exposed to, the use of VFTs could expand the student experience. This was the main motivation for the course coordinator to participate.

AGRC2023 is a second-year undergraduate agribusiness course with an enrolment of 64 students in 2022 with 17 of them taking part in the project. The course builds on the basic management functions applicable to most enterprises, with a focus on applying those concepts to organisations in the agricultural sector. The course incorporates guest lectures and field trips to farming enterprises regularly. As a second-year agribusiness course, the students have come to expect that course concepts are illustrated through industry applications done through field trips and guest lecturers. Once again, the challenges in arranging field trips to businesses with diverse management functions near the campus prompted the coordinator to nominate his course for the project.

AGRC1024 is a first-year undergraduate agronomy course with an enrolment of 53 students in 2022 with 9 of them taking part in the project. The course content introduces students to fundamental plant production principles that underpin agriculture including knowledge of major agricultural systems operating in Australia and globally, focussing on key concepts in soil, nutrient, water, and pest management. This course is the first course that agronomy major students take as part of their programme. The field trip element in the course has been linked to the hands-on practical where students visit a soil pit on campus and perform soil analysis. As the field trip element in the course was comparatively basic and organised with the campus itself, the coordinator was keen to explore the use of VFTs in improving delivery by connecting the course concepts to industry applications.

As all three courses ran in semester 1, it was important to schedule the iterations is a timely manner such that I could complete the analysis and determine the adjustments for the subsequent one. Rather than do it arbitrarily, I engaged the respective course coordinators of each course to determine

when and how the VFTs would be best placed within the semestral timeline. The coordinator for HORT2007 wanted to tie the iteration to an assessment item and thus wanted to position in before the mid-semester break so week 6 was selected as an appropriate time. The coordinator for AGRC2023 was happy for it to replace one of the planned in-person field trip that fell through and as such it was scheduled for week 11. However, the coordinator for AGRC1024 wanted to restructure his course delivery where the iteration became an extension of course content and thus, felt it was more appropriate to be organised in week 12.

4.4 Data Collection

With the aim of the evaluation project being to understand how the innovative use of an integrated VFT activity design can support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education, the data collection process was focused on collecting information pertinent to the activity design. Embracing the guiding principles in Chapter 4.2, the evaluation project involved the collection of both quantitative and qualitative data, and this was done in three phases – the pre-activity phase, the post-activity phase and during the activity itself. The data collected during the pre-and post-activity phases centred on qualitative data collected through my discussion notes and reflections. The data collected during the designed activity was done at three collection points embedded within the overall activity design. This comprised both quantitative and qualitative data collected through various instruments described in section 4.4.1.

The first data collection point involved collecting quantitative and qualitative data about students' prior experience with VFTs and their pre-activity students' perceptions of learning in an experiential learning context through the online pre-questionnaire. The second data collection point involved collecting qualitative data through an online platform where students answered open-ended questions based on reflective observations after going through the virtual field trip. The third data collection point involved collecting quantitative and

qualitative data about students' perception of the value of an experiential learning activity, their post-activity students' perception of learning in an experiential learning context and their experience with the virtual field trip application through the online post-questionnaire. In iterations 2 and 3, this is also where we collected information about the student learning experience across all phases of the ELC and their impact on student approaches to learning. Figure 4.2 illustrates how the data collection points are embedded across the project. This data collection approach was adopted across all three iterations of the implementation.

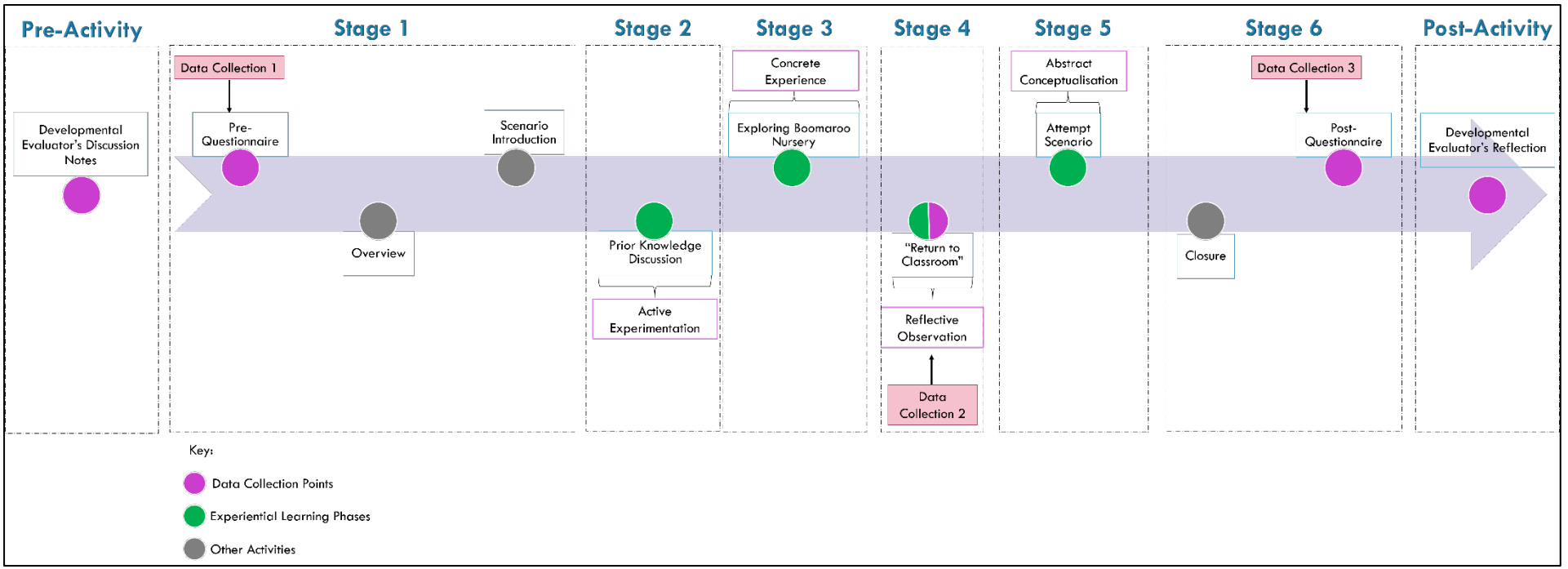


Figure 4-2 Data collection points embedded within the activity stages of an iteration

4.4.1 Instruments

Building on the DE principles in Chapter 4.2, I sought to have instruments that measure various aspects of the student experience that would be able to corroborate the findings from one another to support my conclusions on the effectiveness of the activity design and attainment of student outcomes.

Questionnaires are recommended when studying student attitude changes while open-ended questions and observations are recommended when it comes to evaluating behavioural changes or skill acquisition (Chan, 2023). Thus, I have adopted to use of a combination of quantitative and qualitative instruments through Likert-styled questionnaires and open-ended questions and the various instruments used are described below.

4.4.1.1 Experiential Learning Survey (ELS)

The Experiential Learning Survey (ELS) is a validated self-report instrument (Clem, Mennicke, & Beasley, 2014) designed to measure students' perception of the value of an experiential learning activity and was used as part of the post-questionnaire.

I chose the ELS primarily due to its four subscales: *Environment Authenticity*, *Active Learning*, *Relevance* and *Utility* which serve as four guiding pedagogical principles outlining the components of an experiential learning design. The subscales allowed me to evaluate the activity design with some granularity and was the main reason that the ELS was chosen over other experiential learning measurement instruments. It is intended as a method of assessing various characteristics of hands-on learning experiences, including how the environment influenced the learning objective, how useful the experience was in preparing the student for issues related to practice, and the likelihood of the student using the material learned from the activity into future social work practice. My challenge with the ELS was that the constructs were not intuitive and thus, I had to always refer to the construct definitions to guide

my conclusions. By measuring and clearly understanding these subscales for each iteration, I could make conclusions as to how to better design the activities such that students would be able to see their value, and this could lead to better outcomes.

As reported by Clem, Mennicke and Beasley (2014), the *authenticity* subscale refers to the way information is presented to the students such that they can deduce the intended outcome of the activity. The *active learning* subscale measures the level of engagement with the learning material comprising both mental and physical activity. The *relevance* subscale measures the activity's ability to allow students to connect past experiences with new knowledge and internalise it. The *utility* subscale measures the ability of the activity to let students connect the information to the future. The relevance and utility subscales were particularly difficult to tease apart in terms of the impact on activity design. Table 4.3 below lists the four subscales along with their respective items.

The instrument is a 28-item, 7-point Likert scale (1 = strongly disagree to 7 = strongly agree). Responses for each item of the ELS were summed to generate scores for the 4 subscales: Environment Authenticity, Active Learning, Relevance and Utility. When scoring, questions 3, 9, 15, 23, and 27 were reverse coded. Mean and standard deviation values for each subscale were determined and used to make conclusions about students' perceptions of the value of the experiential learning activity.

Subscale	Items
Authenticity # of Items: 5	1. The setting where I learn helps me understand the material better.
	2. I expect real-world problems to come up during this learning experience.
	3. The environment I learn does not enhance the learning experience.**
	4. The learning experience requires me to interact with people other than students and teachers.
	5. I expect to return to an environment similar to the one where this learning experience occurs.
Active Learning # of Items: 7	6. I am stimulated by what I am learning.
	7. The learning experience requires me to do more than just listen.
	8. The learning experience is presented to me in a challenging way.
	9. I find this learning experience boring.**
	10. I feel like I am an active part of the learning experience.
	11. The learning experience requires me to think about the information.
	12. I am emotionally invested in this experience.
Relevance # of Items: 9	13. I care about the information I am being taught.
	14. The learning experience makes sense to me.
	15. This learning experience has nothing to do with me.**
	16. This learning experience is enjoyable to me.
	17. I can identify with the learning experience.
	18. This learning experience applies to me and my interests.

Subscale	Items
	19. My educator encourages me to share my ideas and past experiences.
	20. This learning experience falls in line with my interests.
	21. I can think of tangible ways to put this learning experience into future practice.
Utility # of Items: 7	22. This learning experience will help me do my job better.
	23. This learning experience will not be useful to me in the future.**
	24. I will continue to use what I am being taught after this learning experience has ended.
	25. I can see value in this learning experience.
	26. I believe this learning experience has prepared me for other experiences.
	27. I doubt I will ever use this learning experience again.
	28. I can see myself using this learning experience in the future.

**Items that are reversed scored during analysis.

Table 4.3 Subscale and items from the ELS

4.4.1.2 Experiential Learning Student Survey (ELSS)

The Experiential Learning Student Survey (ELSS) is a validated self-report instrument (Walker & Rocconi, 2021) that measures undergraduate students' perception of learning in an experiential learning context and was used as part of the pre-and post-questionnaires.

The ELSS was specifically chosen as it allowed me to track the changes in student learning at the end of the activity compared to their prior knowledge. The basis of the instrument is that experiential learning takes place over all phases of the ELC and thus adopts a pre-test and post-test approach to measuring student learning. This was a key aspect as a sizeable proportion of the students enrolled in the school have prior experience and expertise in agriculture with many having grown up within that setting. Thus, it was important to have an instrument that can measure the student learning growth and their attainment of the student learning outcomes with consideration of their differing initial knowledge. As this is a self-report instrument, it gave me vital information on the experiential learning experience from the student participant's perspective.

The instrument is a 16-item, 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) self-report instrument measuring four experiential learning student learning outcomes (SLOs). Attainment of the four SLOs was determined using a paired sample *t*-test comparing student responses from the pre-and post-items. The test statistics were used to conclude the students' perception of learning in an experiential learning context. Table 4.4 below lists the four SLOs along with both the pre-and post-items.

SLO 1: Students will value the importance of engaged scholarship and lifelong learning (# of Items: 4)	
Pre-Test Item	*Post-Test Item*
I often participate in activities that serve the needs of others.	I am interested in exploring the problems of society (i.e., the needs of others).
I think it is important for the university to use its resources for the benefit of society.	I think it is important for academia to use their resources for the benefit of society.
I often participate in academic activities/events that aim to help others.	I am interested in using the skills and knowledge that I have acquired from this course to contribute to the public good.
I typically like to explore more than usual when I am learning something new that interests me	I want to continue to develop relevant skills that are related to this experience.
SLO 2: Students will apply knowledge, values, and skills in solving real-world problems (# of Items: 5)	
Pre-Test Item	*Post-Test Item*
I can clearly describe a real-world problem related to this course to someone who knows little about the problem.	I can clearly describe a real-world problem related to this course to someone who knows little about the problem.
I have been introduced to more than one way to address real-world problem(s) related to this course.	I have been introduced to more than one way to address real-world problem(s) that my faculty member/professor brought up in this course.
I feel confident in my ability to develop a logical, consistent approach to address a real-world problem related to this course.	I feel confident in my ability to develop a logical, consistent approach to address a real-world problem related to this course.
I can list many potential ethical issues for real-world problems related to this course	I can list many potential ethical issues for real-world problems related to this course.
I can conclude data that has been collected.	I can conclude with data collected through this experience.
I can identify and apply information from this course to address and potentially improve real-world problem(s)	I can identify and apply information from this course to address and potentially improve real-world problem(s)

SLO 3: Students will work collaboratively with others (# of Items: 3)	
Pre-Test Item	*Post-Test Item*
I am often told I listen to and respect the ideas of others.	My classmates would say that I often listened to and respected the ideas of others.
I am often told I offer relevant questions and comments within a group setting.	My classmates would say that I was able to offer relevant questions and comments within a group setting.
I meet obligations for group assignments on a timely basis.	I meet obligations for group assignments on a timely basis.
SLO 4: Students will engage in structured reflection as part of the inquiry process (# of Items: 3)	
Pre-Test Item	*Post-Test Item*
In the past, I have purposefully reflected on what I learned from problems I encountered during a learning experience.	I purposefully reflected on what I learned from the problems I encountered during this experience.
In the past, I often reflected on what I have learned about myself from learning experiences.	During this experience, I reflected on what I have learned about myself from this experience.
I have thought about what it means to be a member of the broader community.	During this experience, I thought about what it means to be a member of the broader community.

Table 4.4 Subscale and items from the ELSS

4.4.1.3 Experiential Learning Stages Survey (ExLSS)

The Experiential Learning Stages Survey (ExLSS) is a self-report instrument adapted from a study conducted by Young, Caudill and Murphy (2008) to evaluate the student learning experience in all phases of the ELC along with their approaches to learning and was used in Iteration 2 and Iteration 3 as part of the post-questionnaire.

The reason I adopted the ExLSS was that it gave me a better understanding of student learning for each of the experiential learning stages which was important in helping me tweak the activity design for subsequent iterations. At the end of Iteration 1, which will be detailed in Chapter 5, I reflected upon the changes that might be required to the activity design for each stage. Unfortunately, there was no quantitative data to complement my qualitative reflections on which I based my specific suggestion and thus, the ExLSS was adopted for the 2nd and 3rd iterations to strengthen the guidance and conclusions being made. The flexibility to introduce new measures mid-study due to the needs of the evaluation to inform the innovation is a tenant of DE embracing the *developmental purpose principle* and the *evaluation rigour principle*.

Part 1 of the instrument is a 12-item, 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Each of the four phases – *Concrete Experimentation*, *Reflective Observation*, *Abstract Conceptualisation* and *Active Experimentation* – is measured as a separate construct with 3 items each. Responses for each item of the ExLSS were summed to generate scores for the 4 subscales. Mean and standard deviation values for each subscale were determined and used to make conclusions about students' learning experiences at each stage of the ELC. Table 4.5 summarises the constructs and items adapted for the ExLSS used in the evaluation project.

Part 2 of the instrument is a 20-item, 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Each of the four constructs – *Deep Motivation, Deep Strategies, Surface Motivation and Surface Strategies* – is measured as a separate construct with 5 items each. Table 4.4 summarises the constructs and

items. Responses for each item were summed to generate scores for the 2 subscales – Deep approach to learning (motivation & strategy) and surface approach to learning (motivation & strategy). The measures for students' approaches to learning, provide us an indication as to whether students could both understand the material and apply the information that was learned (deep approach) compared to students who focused on facts and ideas to memorize what they thought was important and what they would be required to reproduce at the end of the activity (surface approach). A successful experiential learning activity where students are actively engaged in all stages will positively correlate to a deep approach and negatively correlate to a surface approach to learning. The correlation between the 4 subscales in part 1 and the 2 subscales in part 2 were determined to make conclusions about the activity design.

Subscale	Items
Concrete Experience # of Items: 3	This activity provided me with a direct practical experience to help me understand the course concepts.
	This activity gave me a concrete experience that helped me learn the class material.
	This activity presented me with a “real world” experience related to this course.
Reflective Observation # of Items: 3	This activity assisted me in thinking about what the course material means to me.
	This activity helped me relate my personal experiences to the content of this course.
	This activity aided me in connecting the course content with things I learned in the past.
Abstract Conceptualisation # of Items: 3	This activity required me to think about how to correctly use the terms and concepts from this class.
	This activity caused me to think about how the class concepts were inter-related.
	This activity made me organize the class concepts into a meaningful format.
Active Experimentation # of Items: 3	This activity made it possible for me to try things out for myself
	This activity permitted me to actively test my ideas of how the course material can be applied.
	This activity allowed me to experiment with the course concepts to understand them.
Deep Motivation # of Items: 5	This course activity gave me a feeling of deep personal satisfaction.
	This course activity helped me create questions that I wanted answered.
	This course activity made me work hard because I found the material interesting.
	This course activity was at times as exciting as a good novel or movie.
	This course activity was interesting once I got into it.
Deep Strategies # of Items: 4	This course activity provided me with enough work on the topic so I could form my conclusions.
	This course activity caused me to look at most of the suggested readings that pertained to the activity.

Subscale	Items
	This course activity caused me to spend time relating its topics to other topics which have been discussed in different classes.
	This course activity's topics were interesting, and I often spent extra time trying to obtain more information about them.
Surface Motivation # of Items: 5	For this course activity it was not helpful to study topics in depth because all you needed was a passing acquaintance with topics.
	I was able to get by in this course activity by memorizing key sections rather than trying to understand them.
	For this course activity there was no point in learning material which was not likely to be on the exam.
	I did not find this course activity very interesting, so I kept my work to a minimum.
	My aim for this course activity was to complete it while doing as little work as possible.
Surface Strategies # of Items: 5	This course activity suggests the best way to pass exams is to try to remember answers to likely test questions.
	I believe that the instructor shouldn't expect me to spend significant amounts of time on this course activity if it's not on an exam.
	For this class activity I restricted my study to what was specifically required as it was unnecessary to do anything extra.
	For this course activity I learned things by going over and over them until I knew them by heart even if I did not understand them.
	For this course activity I only applied what was given in class or on the course outline.

Table 4.5 Subscale and items from the ExLSS

4.4.1.4 Student Reflection on Virtual Field Trip Experience

This student reflection questionnaire was developed to complement the information obtained from the instruments above. The VFT application itself forms a central part of the designed activity and as such has a considerable influence on the student experience. Thus, student input into various elements of the application could improve their overall experience with the activity and potentially make it easier for them to engage with the activity.

This measure was used as part of the post-questionnaire. The quantitative aspect of this measure was a self-report instrument adapted from Klippel, Zhao, Oprean, Wallgrün and Chang (2019), Patiar et al. (2020) and Patiar et al. (2017a) measuring the student experience with VFTs post-activity. This questionnaire consists of a 14-item, 5-point (1 = strongly disagree to 5 = strongly agree) scale containing 3 subscales: VFT Interface and Media, Learning with VFT and Perception of VFT. Table 4.6 summarises the items adapted for each subscale.

The qualitative aspect of the instrument consists of the following three open-ended questions:

- What did you like best about the virtual field trip to Boomaroo Nursery?
- What benefits do you think there are from using VFTs in place of actual field trips?
- Has the virtual field trip experience helped you become more interested in this field and if so, why?

The three questions were used to determine elements that they liked and whether the student's perception of the VFT and their use mirrored the reasons why VFTs were adopted in the first place. This information was important to the overall design as the students would ultimately be the recipients of the activity and their experiences and reflections would help to refine the innovation.

Subscale	Items
VFT Interface and Media # of Items: 3	The virtual field trip application was easy to navigate
	The multimedia (e.g., videos and floor plan) helped me engage with the virtual field trip application
	The interface of the virtual field trip application was user-friendly
Learning with VFT # of Items: 6	The virtual field trip application enabled me to accomplish the task effectively
	The virtual field trip application complemented the course material
	The virtual field trip allowed me to see course concepts being used in the industry
	The virtual field trip application provided an appropriate learning opportunity
	The virtual field trip application added to the enjoyment of learning
	The virtual field trip application allowed me to gain knowledge that I previously did not have
Perception of VFT # of Items: 5	I would rather visit an actual field site than experience a virtual field trip**
	I would rather experience a virtual field trip than have no field trip experience.
	Virtual field trips can replace actual field trips**
	I would like to see the use of more virtual field trips in my courses
	I think both virtual field trips and actual field trips can be useful in agricultural courses

**Items that are reversed scored during analysis.

Table 4.6 Subscale and items from students' reflection on VFT experience

4.4.1.5 Prior Experience with Virtual Field Trips

Prior experience is an influencing factor on students' perceptions (Koohang, 2004; Smart & Cappel, 2006), motivation (Kori et al., 2016; Yusri et al., 2012), and performance (Holden & Weeden, 2003; Lawrence, 1987) which are all the aspects that I am interested with in this project. Particularly, I was keen to understand the impact, if any, of their experience with VFTs on their experiences going through the designed activity.

As this questionnaire was a fairly simple one in my opinion, I decided to develop the instrument myself. The prior experience with VFTs questionnaire is a self-report instrument consisting of two questions and was used in Data Collection 1 as part of the pre-questionnaire. To begin, students were presented with the following question:

Which of the following statements reflects your prior experience relating to the use of virtual field trips?

- I have used virtual field trips prior to this activity, and it was a pleasant experience.
- I have used virtual field trips prior to this activity but it was not a pleasant experience.
- I have not used virtual field trips prior to this activity but I am aware of what it is all about.
- I have not used virtual field trips prior to this activity, and I have no idea what it is all about.

Along with answering the question, students with prior experience with VFTs are prompted to provide a brief description of their experience while students without prior experience are prompted to reflect on what they think VFTs are all about.

From this questionnaire, I would be able to understand the students' impression and perception of VFTs which have the potential to influence their learning experience.

4.4.1.6 Reflection on Learning

The *Reflection on Learning* questionnaire is a self-report instrument consisting of a series of open-ended questions attempting to understand the student learning experience. Modelled on Schon's Reflection-on-Action model (Wain, 2017), students were asked to reflect on how their thoughts, feelings and learning during the experiential learning activity. The questions were designed to determine student outcomes both from a cognitive perspective and identified UQ graduate outcomes.

As this questionnaire had to be customized to the activity that was being conducted, I decided to customise a series of questions covering both cognitive and affective elements of the student experience,

The following were the five open-ended questions that students were presented with:

- What were you thinking and feeling during the learning activity?
- List two (2) things that you know now that you did not know before the activity.
- How did you approach the learning activity and why?
- How did your relationship with your group mates influence your experience?
- After going through the activity, what are your thoughts about ways in which the agriculture industry needs to develop to best meet the needs of the community?

4.4.1.7 Developmental Evaluator's Discussion Notes

In a partnership, each course coordinator would provide content and contextual expertise while I provided pedagogical expertise. When designing the activities for each iteration, we would come together, analyse the findings

from previous iterations, and discuss necessary adjustments for activities in the next iteration. These were captured as discussion notes and formed the basis for the questionnaires and the analysis that was conducted.

In the pre-activity discussions, the focus of the notes was like a learning needs discussion where I would ask a series of questions related to the course. The questions that assisted in the conversation were:

- What is the enrolment in the course?
- Do you have any idea as to their prior experience in horticulture/agribusiness/agronomy?
- What is a good real-world scenario that students will be able to attempt with a combination of their prior knowledge and the knowledge they gain through the activities?

The responses and subsequent discussion allowed me to design the activities with input from the coordinator regarding course content and expected outcomes from the students. For iterations 2 and 3, this is where findings from the previous iteration were shared with the coordinator to determine how we would learn from it. Figure 4.3 captures an image of the discussion notes for the three iterations. In the analysis stage, the discussion notes focused on the coordinators' responses to questions used in the qualitative aspect of the student reflection of the VFT experience paying particular attention to any differences in perspectives between the student experience and the coordinator experience. This gave the coordinator an opportunity to reflect on their experience and what they might do differently in a future iteration. This process was not conducted for Iteration 2 as the coordinator was unable to be present during the session to observe the students.

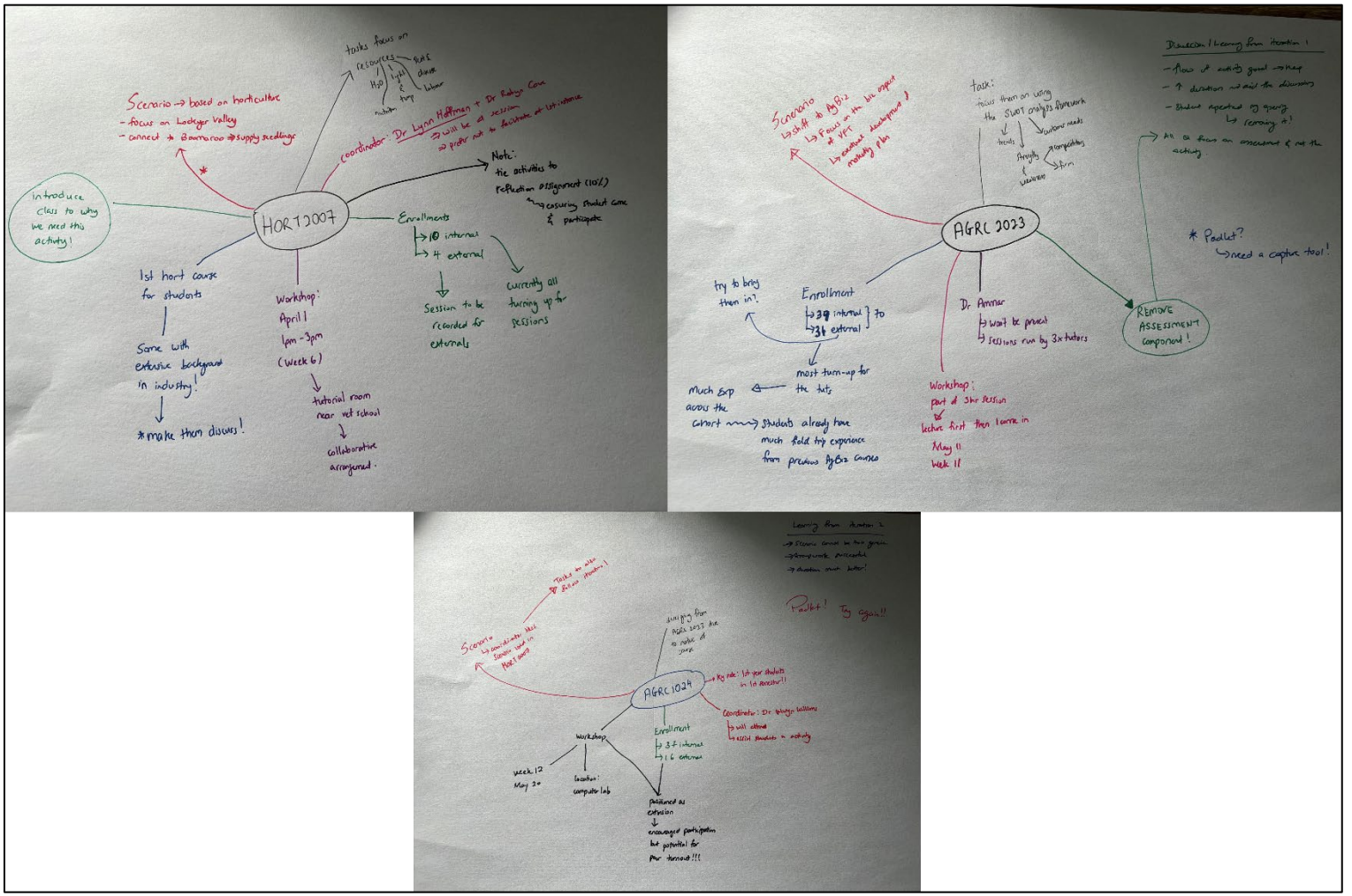


Figure 4-3 Pre-activity discussion notes for the three iterations

4.4.1.8 Developmental Evaluator's Reflection

At the end of each iteration, I engaged in a reflection process to consider various aspects of the iteration including the design and the implementation itself. This is critical to the analysis of the data as various aspects of a successful lesson activity might not be captured through quantitative and qualitative measures. To have a consistent and integrated approach to this reflection, I decided to adopt the ELC as my reflection model. Figure 4.4 presents the ELC given how my reflection process employs it.

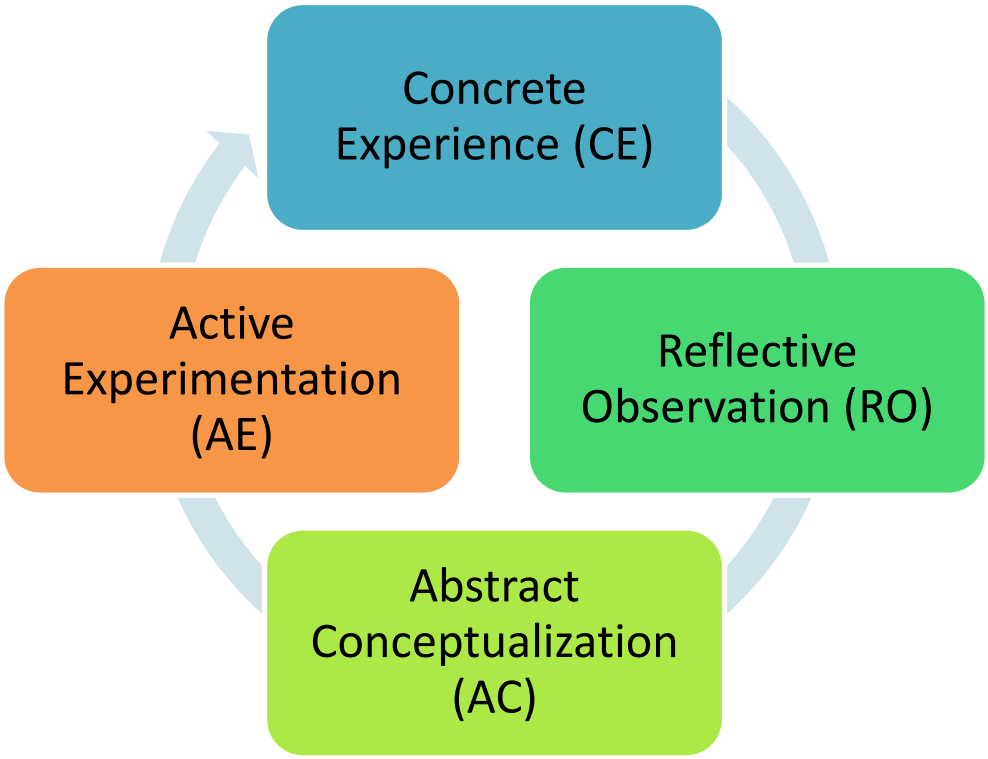


Figure 4-4 ELC phases as employed for my reflection

Using the iteration as my CE phase experiencing the innovation for the first time. This is followed by me looking back and reflecting on the experience (RO). Here I consider the strengths of the iteration and any areas of improvement through the lens of what helps the innovation achieve its goal and what is hindering it. This reflection leads to the formation of abstract concepts (AC) where I had to make sense of reflections, and this came together with the analysis of the qualitative and quantitative data collected. I did this by making

links between what I had done, what I already knew and what I needed to learn. I then use these to develop lessons learnt and implications for the new iteration which then becomes my AE phase where I get to plan the changes required for the next iteration. The cycle is then repeated for each iteration. Figure 4.5 captures an image of my reflections across the three iterations

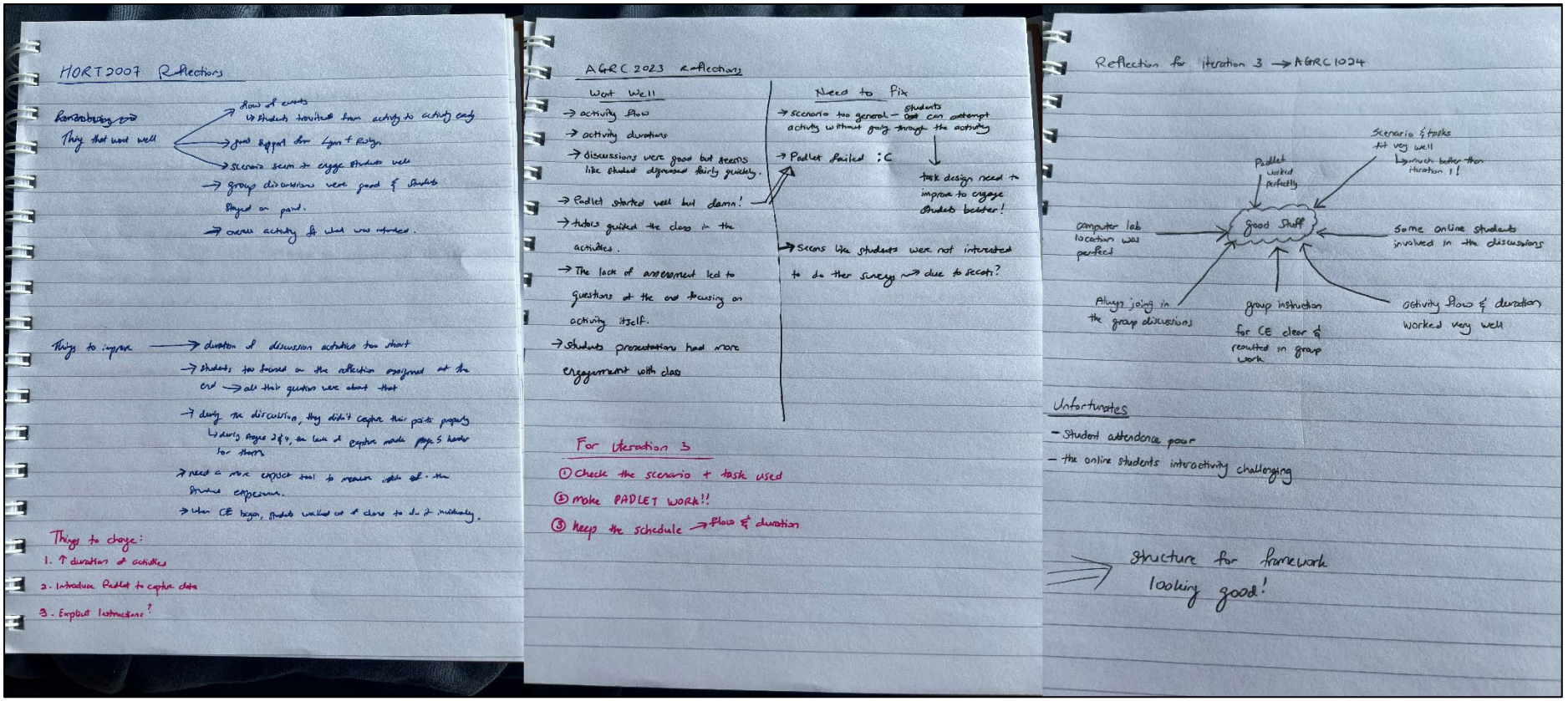


Figure 4-5 Reflection notes for the three iterations

4.5 Data Analysis

My project aimed to use a DE approach to understand how an integrated VFT activity design can support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education. To achieve this aim, I adopted a strategy that allowed me to categorise the data collected into two categories: the activity design and student outcomes. These two categories were investigated in each iteration and a holistic picture of these categories was determined to give insight into developing the innovation.

4.5.1 Activity Design

The investigation into the activity design drew on both quantitative and qualitative data from across the different measures that were used. The data collected spoke to the student perceptions and learning experience which are used as a proxy for the effectiveness of the activity design. The analysis was done in 2 stages.

Firstly, the data was analysed based on the stages in the experiential learning activity that it would have an impact on. For example, the data collected in the reflections done in the reflection observation stage gave insight into how they engaged with the virtual field trip application in the previous concrete experience stage. These data came from my discussion notes with the coordinator, my reflection notes and the three student reflections. An inductive thematic analysis was conducted using my experience to identify themes and commonalities in the responses that were given. This approach was adopted in line with the *emergent mindset* towards the *complexity perspective principle* where the data is analysed without a pre-determined outcome in mind. For the quantitative data, descriptive statistics were determined and compared against one another used to make conclusions about the student experience and thus the activity design.

Secondly, data from my reflection notes, the ELS subscale correlations and the ExLSS were analysed broadly to inform the overall activity design. These data captured the activity as a whole and spoke to the effectiveness of the various stages of the ELC about each other and gave me a means of adapting specific stages from iteration to iteration.

Keeping the eight DE principles in mind, the data collected had a specific purpose of informing the innovation and any patterns that arise during the iteration help guide and contextualise the findings.

4.5.2 Student Outcomes

For my project, intended student outcomes were guided by the UQ graduate attributes. This was intentional as VFTs have broad applicability and the activity design leveraged on that potential. This guidance also allowed me to link experiential learning to appropriate student outcomes beyond the knowledge domain. This is also a potential area for consideration in future implications of the policy context of the study described in Chapter 1.3.

Using the UQ graduate attributes, the student outcomes which are relevant to the project were:

1. Student will display an understanding of social and civic responsibility.
2. Student will display the ability to engage effectively and appropriately with information and communication technologies.
3. Student will display the ability to interact effectively with others to work towards a common outcome.
4. Student will display the ability to identify problems, create solutions, innovate, and improve current practices.

The data that was collected to inform this investigation came through two measures. The first was the ELSS which employed a paired sample *t*-test

comparing student responses from the pre-experience survey and the post-experience. This gave me a quantitative measure of whether students attained the SLOs associated with engaging in an experiential learning activity. In an ideal state, the students would show improvements in all 4 SLOs. The second measure was the qualitative data collected from both the student reflection on learning and their reflection on the virtual field trip experience. Like the activity design, an inductive thematic analysis was conducted using my experience to identify themes and commonalities in the responses that were given. With the systems-thinking principle in mind, individual questions whether in the quantitative or qualitative questionnaires were mapped to the most appropriate student outcome and used to determine student attainment (see Table 4.7).

Student Outcome	Quantitative Data	Qualitative Data (Student response to…)
1	SLO 1 + SLO 4 from ELSS	After going through the activity, what are your thoughts about ways in which the agriculture industry needs to develop to best meet the needs of the community?
2	Student reflection on the VFT Experience	• List two (2) things that you know now that you did not know before the activity. • How did you approach the learning activity and why? • What would you change about the virtual field trip experience to enhance it for future students?
3	SLO 3 from ELSS	How did your relationship with your group mates influence your experience?
4	SLO 2 from ELSS	• What benefits do you think there are from using VFTs in place of actual field trips? • Has the virtual field trip experience helped you become more interested in this field and if so, why?

Table 4.7 Mapping of data analysed to determine attainment of each student outcome

Looking across the findings or both categories allowed me to draw conclusions about my research question: *How can an integrated VFT activity design support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education?* The conclusions inform the adjustments made to the innovation and evaluation of the subsequent iteration. This iterative manner of implementing and evaluating formed the basis of key considerations in proposing the activity design framework.

4.6 Ethical Considerations

Ethical Clearance for this evaluation project was provided for by Lancaster University and the University of Queensland Faculty of Science LNR Committee (2021/HE000888).

As the research study was conducted in my current institution there were some ethical considerations that I had to navigate carefully. Firstly, as an academic at the school, I am in a position where I could influence student performances including grades not just within the courses involved in the project but other courses they might be enrolled in during the semester. This would be a potential ethical concern as the students might feel that they need to be a part of the study as someone of authority is conducting it. Even with informed consent being requested at the start of every data collection point, this might not alleviate the students' feeling of being pressured.

I attempted to mitigate this in two ways. Firstly, as I was unable to be excused from teaching duties entirely, I made sure that I was not teaching any of the project courses in any capacity. Further to that, I also made sure that to the best I could, I was not teaching any of their courses that semester though this was not perfectly feasible, and I did have a guest lecture slot for one of the other second-year courses. For AGRC1024 which was a year 1 course, it was perhaps a positive that we decided to put the iteration towards the end of the semester (week 12) to give as much time between the lecture I give for another

course, in weeks 2 and 3, and the iteration. I also made sure that I made it clear to students that I was not involved in any of their assessment outcomes.

Secondly, at each data collection point, I emphasised to the students that all data collected was anonymous and that as the researcher, I was the only one who would be able to view the results in a raw form. I also requested that the course coordinator reinforce this message to the students at the start and end of the session.

Another ethical consideration that I had to be mindful of was my colleagues and the potential that they might be concerned that if they do not participate in the research project, they will damage their working relationship with one of their departmental colleagues (me). Mitigating this was a little easier as the academics had also previously embarked on doctoral projects and understood the challenges that go with it. I did take the opportunity at the start of the project to reassure them that the research study is voluntary and that not participating in the study would not affect their relationships with me. I also explicitly made it clear to them I was not evaluating their teaching on behalf of the institutional management. I tried to ensure that they involved during activity design discussions and data analysis as part of the DE process so that they understand each step of the research being conducted and are not surprised by the findings put forth.

4.7 Research Challenges

The evaluation project had three main challenges due to enrolments. Firstly, the enrolment numbers in the individual courses were small. Unfortunately, due to university rules around COVID-19 regulations, the sessions were not compulsory which resulted in a smaller group attending the face-to-face session. Despite a large majority completing the questionnaires, the total number of participants numbers across all three iterations was 35. This sample size meant that the transferability of the findings to other disciplines would be limited and that further iterations should be conducted to see its applicability in any new contexts.

The second challenge is due to the programme structure in the school. Most courses in the school have no prerequisites for enrolling in them. Hence, many students take courses across their year of study. In this evaluation project, some students were enrolled in both AGRC2023 and AGRC1024 which were the Iteration 2 and 3 courses. This resulted in some students not attending the session as they thought it was the same activity across both courses.

Lastly, the timing of when the iterations were run in various courses posed a challenge which was reflected in the student numbers as well as my observations and reflections. The placement of the activity was done with consideration of the overall course structure and learning plans. As such Iteration 1 was able to run earlier in the semester with Iteration 3 coming in the last few weeks when the content lectures were wrapped up. This mirrored the student attendance for the session where Iteration 1 saw 64.3% of the class at the session while Iteration 2 had 26.5% and Iteration 3 had only 17.0%. Attendance drop-offs as the semester progresses are a common observation in the school and the findings from the iterations gave something to consider about when the experiential learning activity should be ideally run in the course.

Chapter 5: Findings

5.1 Introduction

The purpose of this chapter is to report the findings from the DE of three iterations to understand how an integrated VFT activity design can support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education. The three iterations centred on one of three agricultural disciplines – horticulture, agribusiness, and agronomy, respectively. The chapter is structured with each iteration as a sub-chapter beginning with a description of the activity design and key considerations in the implementation of the iteration. It continues with a description of the findings and analysis in line with the measures and analysis described in Chapters 4.4 and 4.5. The sub-chapters close with my reflection on the iteration and a summary of the lessons learnt which guides the amendments to be made to the implementation for subsequent iterations. Figure 5.1 gives a pictorial representation of the overall project design showing how the evaluation and iterations fit together. The chapter closes with a summary of the lessons learnt across the three iterations leading to the presentation of the *VirtualVoyageVista*, in Chapter 6, which is an activity design framework I developed bridging experiential learning and student outcomes through an integrated VFT design.

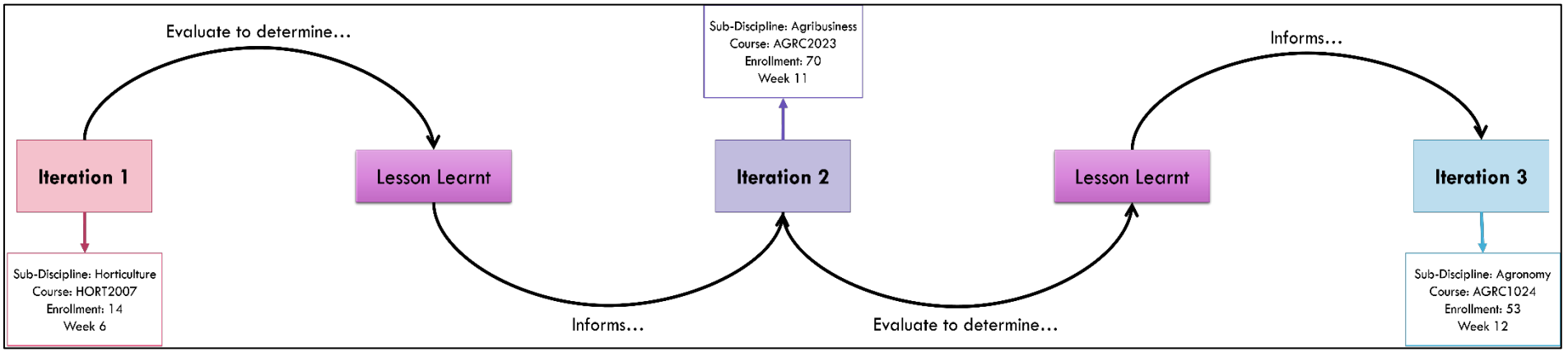


Figure 5-1 Pictorial representation of overall project design

5.2 Iteration 1: Horticultural Science (HORT2007)

5.2.1 Introduction

As described in section 4.3.3, Iteration 1 was conducted on HORT2007: Horticultural Science, a second-year undergraduate horticulture course with an enrolment of 14 students in 2022. HORT2007 was selected as the course for Iteration 1 for two reasons. Firstly, the small cohort compared to the other shortlisted courses meant that it could function as a pilot implementation allowing me to better understand the processes involved and identify any strengths and particularly gaps in my data collection process and its impact on my evaluation. Secondly, from a course delivery perspective, based on the course concepts being covered and the intention of the coordinator to have an associated assessment meant that the innovation was best implemented in the first half of the course which was much earlier in the semester than the other courses.

Iteration 1 was conducted in a collaborative tutorial room as shown in Figure 5.2. Though the campus timetabling unit dictated the choice of location, it served as an appropriate one. This was because the furniture in the room would allow students to be seamlessly organised into groups and easily engage in discussions around a round table. With the small enrolment in HORT2007, most of the venue would be left unused and as it was a standard tutorial room, students had to be informed that they were required to bring their own devices to engage in activities. This venue was not new to the students as they would have had tutorials for this course at this venue for the four weeks prior and as second year students, they would have had tutorials at similar styled classes across their first year. However, as HORT2007 had a small cohort, the venue allowed the students to come together when required but also seamlessly space out to pursue some activities stage 3 (see Figure 5.4) individually if they chose to. This became a concern that will be discussed in section 5.2.3 below.

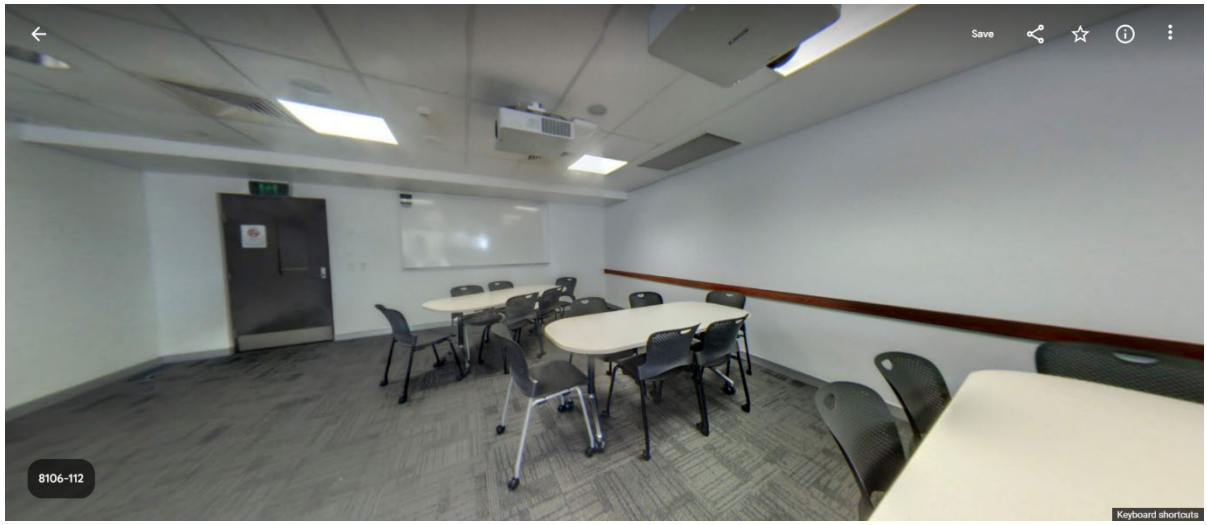


Figure 5-2 Collaborative tutorial room where iteration 1 was conducted.

5.2.2 Activity Design

As described in Chapter 4.4, the iteration features three phases – the pre-activity phase, the post-activity phase, and the activity itself. The activity design was developed with consideration of information collection during the pre-activity discussions and the nuances of the ELC described in section 3.3.1

5.2.2.1 Pre-Activity Phase

From the pre-activity discussions, it was noted that of the 14 students enrolled, 10 of them were enrolled in the internal mode of study which required them to attend on-campus activities in person. These students were selected as the target audience for the iteration as involving the external students would have required the activity to be delivered in a hybrid mode which the course coordinator and I were not confident of delivering. During the pre-activity discussions, it was decided that I would facilitate the activity due to my familiarity with the delivery approach and data collection processes.

Additionally, the course coordinator expressed her desire to observe the delivery before attempting to deliver it on her own in future runs. The course coordinator was also worried about student participation and deliberately

inserted a course assignment, weighing 10%, that built on the activities. Administratively, a suitable two-hour timetabled tutorial slot was chosen for the activity to give students enough time to engage in the various planned activities. Figure 5.3 summarises the key discussion points from the pre-activity discussion with the course coordinator.

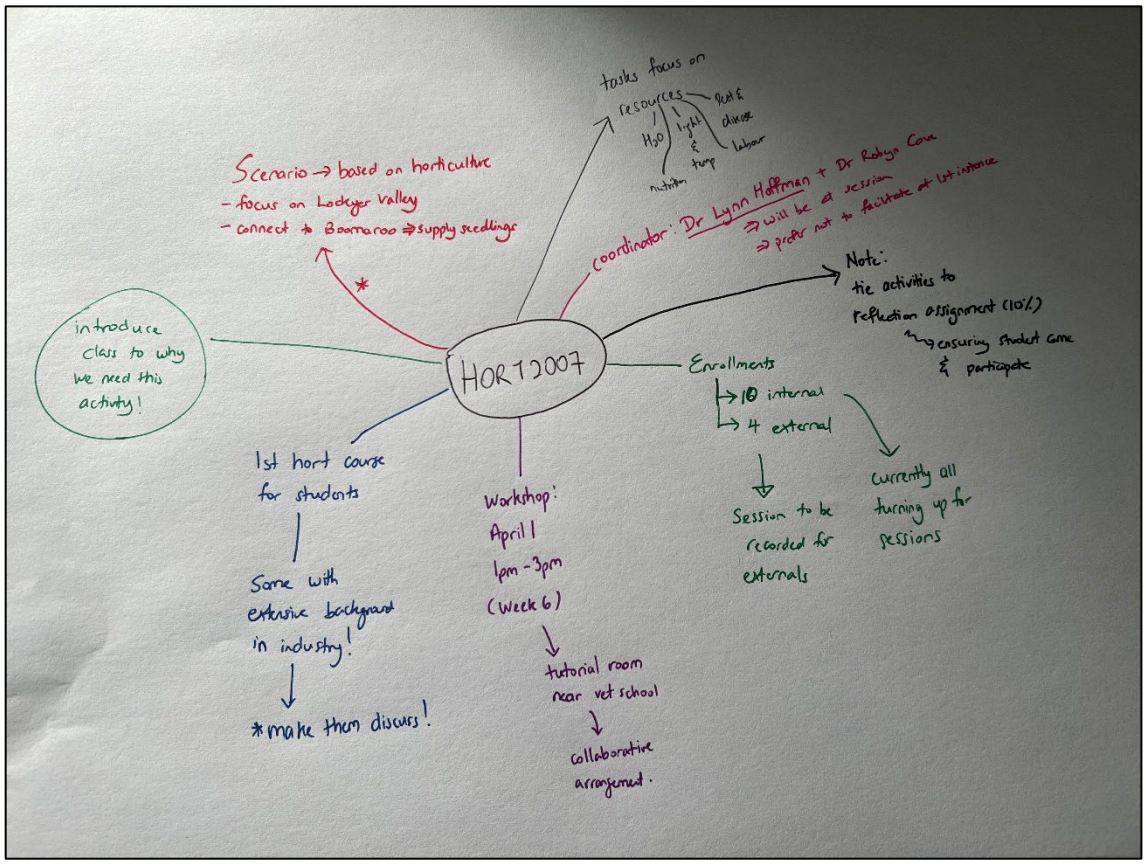


Figure 5-3 Pre-activity discussion notes for Iteration 1

The activity session was designed such that students would be actively engaged in the four phases of the ELC. The activity was broken up into six stages with an opening and closing stage bookending the four stages mapped to the ELC phases. Figure 5.4 below provides an overview of the various stages in the session along with the data collection points that were interspersed across them. The individual stages comprise both individual and group activities alongside data collection activities. The student activities were designed using a constructivist pedagogical approach (Richardson, 2003) ensuring that there were avenues for sharing prior knowledge and beliefs,

opportunities to challenge that knowledge and beliefs and group activities allowing the development of a shared understanding of the concept being covered. A summary of the various stages and the activities involved are provided below in Table 5.1 and the upcoming sub-sections describe them in detail.

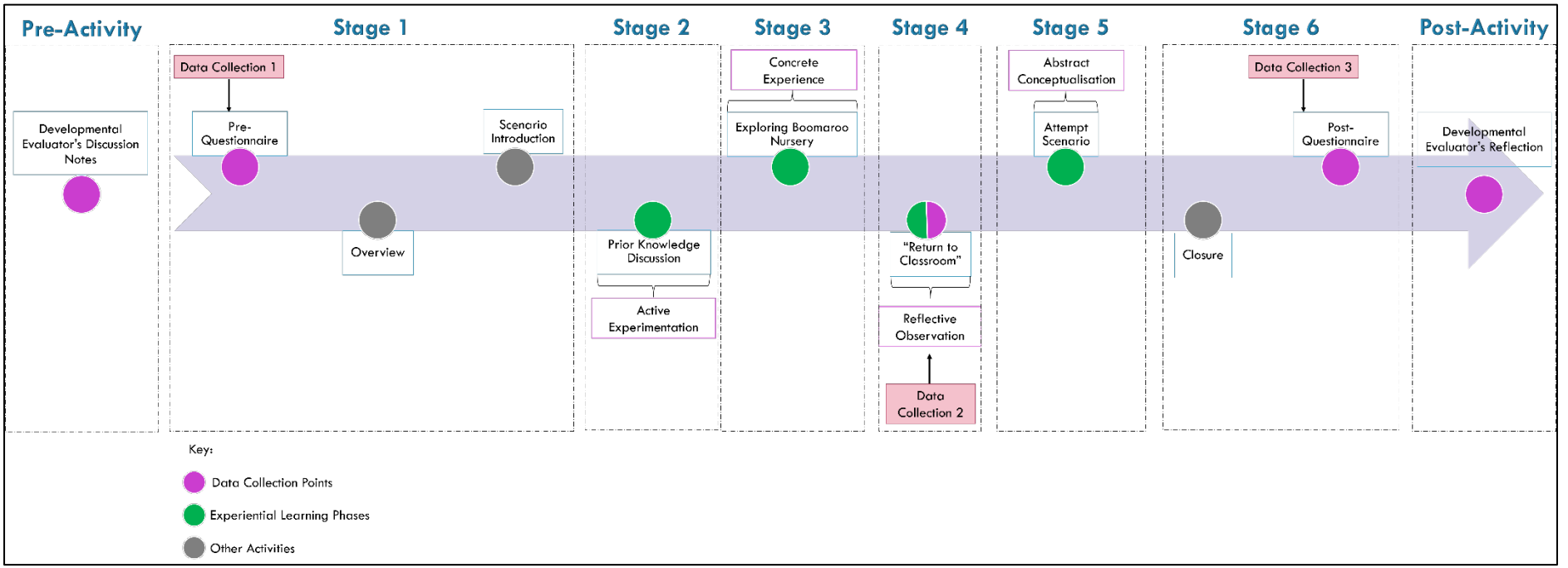


Figure 5-4 Overview of activity stages and data collection points in Iteration 1

Stage	Name	Mapping to ELC	Student Activity	Tools Used	Group/Individual Activity	Duration (min)
1	Opening	-	• Respond to pre-questionnaire. • Listen to briefing.	Online Form	Individual	15
2	Prior Knowledge Discussion	Active Experimentation	• Explore scenarios using prior knowledge. • Share with groupmates.	-	Individual / Group	15
3	Exploring Boomaroo Nursery	Concrete Experience	Explore VFT location.	VFT Application	Individual	25
4	“Return to Classroom”	Reflective Observation	• Review prior knowledge. • Share with groupmates.	Online Form	Group	20
5	Attempt Scenario	Abstract Conceptualization	Attempt scenario with groupmates.	Butcher Paper	Group	20
6	Closing	-	• Respond to post-questionnaire. • Listen to briefing.	Online Form	Individual	15

Table 5.1 Summary of activity stages in Iteration 1

5.2.2.2 Stage 1

Stage 1 began with students responding to a pre-activity questionnaire aimed at determining their prior experience with VFTs and understanding their perceptions of learning in an experiential learning context. Determining their prior experience with VFTs was useful on two fronts. For the course coordinator, this information gave her an indication of how innovative the use of VFTs was to the horticulture students so that she could consider its application in other courses she teaches into. For me, determining their prior experience was useful in understanding the impact, if any, of their experience with VFTs on their experiences going through the designed activity. Further to that, this information was of interest to me in considering potential future projects.

The second part of the pre-questionnaire used the pre-activity questions from the ELSS to measure students' perception of learning in an experiential learning context before they embarked on the learning activity. The data collected at this stage was used to provide a baseline measure for comparison with their post-activity perception measured in the post-questionnaire during the closing stage.

The data collection was followed by an introductory presentation sharing with students the value of field trips in agriculture and the impact of environmental, such as COVID-19 and logistical factors, such as student enrolment numbers and time, on the successful delivery of in-person field trips. This was an important aspect of setting the scene as these students had years of online learning due to COVID-19 and were returning to campus for the first time since their enrolment. Having to come on-campus but still engage in activities virtually would potentially be frustrating and thus, having the introductory presentation explicitly outline the role of VFTs and how they help support learning in the current climate was deemed important to help students understand why the activity was relevant and needed. Figure 5.4 was also shown to the students to give them an overview of the session so that they would be prepared for the various activities in particular the closing so that they would stay around to complete the post-questionnaire. The introductory

presentation culminated with the horticulture scenario that formed the basis of the session, shown below in Figure 5.5.

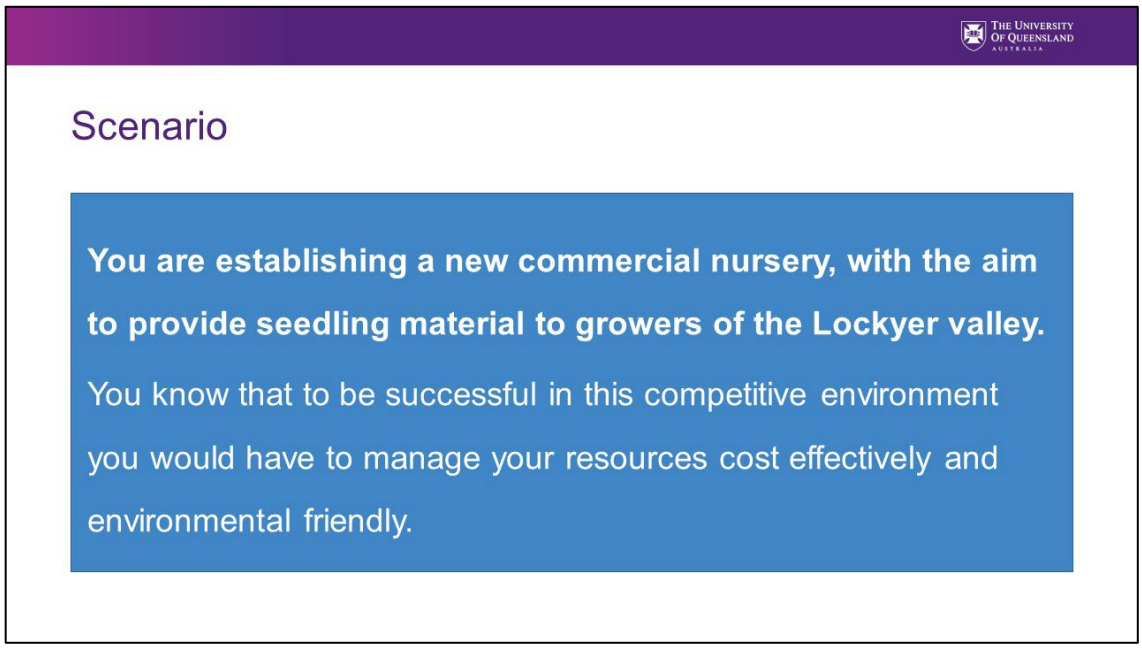


Figure 5-5 Horticulture scenario for Iteration 1

5.2.2.3 Stage 2

Stage 2 was designed to get students to use their prior knowledge to address the scenario shown in Figure 5.6. This stage is mapped to the AE phase of the ELC as described in section 3.3.1. In the pre-activity discussions, the coordinator mentioned that some of the students had extensive prior experience with the horticulture industry. In this activity, students were asked to select a resource from a list and share with their group how it could be used in the design of a nursery. The confining of resources to the list was to help focus their thought processes. Numerous factors can be considered to address the scenario, but the course coordinator had wanted to keep the discussion to the concepts covered in the course and hence the resource list in Figure 5.6 was developed. The ensuing discussions provided an opportunity for knowledge sharing and for students to better understand the members of the group and their experiences.

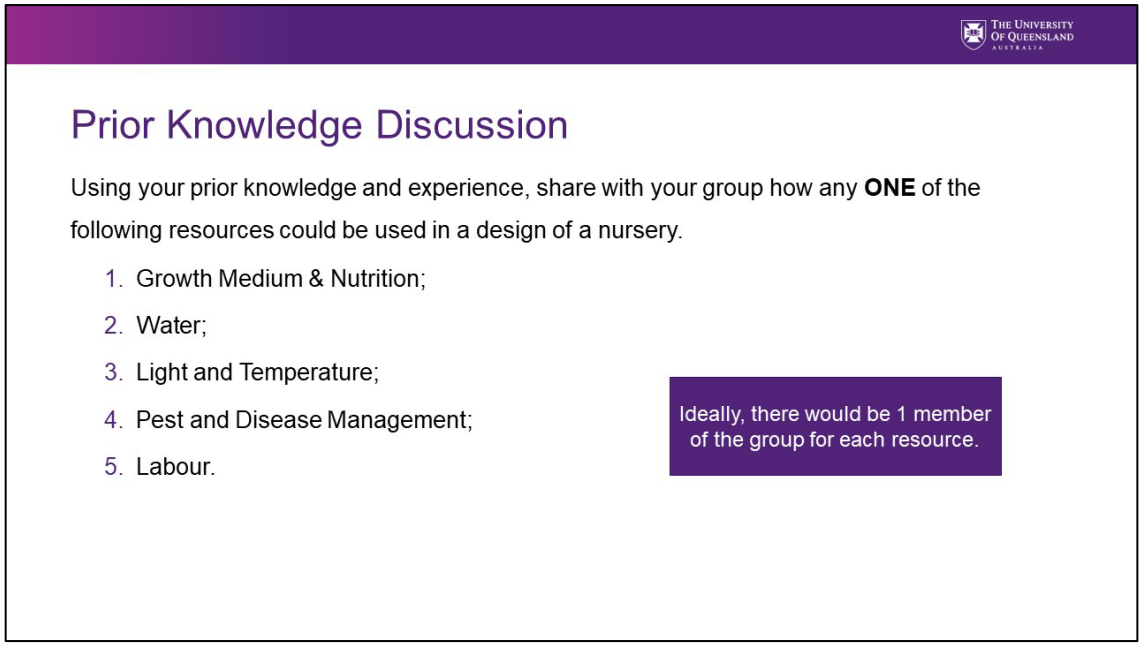


Figure 5-6 Activity instructions for Stage 2

5.2.2.4 Stage 3

Stage 3 was designed to give students time to engage in a self-exploratory journey with the virtual field trip. The key aim of the stage was to allow students to have a new learning experience mapped to the CE phase of the ELC and thus, much of the scheduled time was allocated for this stage of the activity allowing students to have free reign to navigate different location spots in the Boomaroo Nursery facility. At each of these location spots, students had the option to explore the site by rotating 360º images, clicking on information hotspots and watching bite-sized videos where key members of the facility provide further information about the facilities and nursery operations. Section 4.3.2 introduced the VFT application illustrating the diverse options available for students to engage with.

5.2.2.5 Stage 4

Stage 4, termed “return to classroom” is where students returned to their groups after they explored the VFT. This stage was designed to allow students to compare their prior knowledge and experiences with what they had learnt

and experienced when exploring the VFT. This reflection could reinforce their knowledge or require them to resolve any inconsistencies between their knowledge and experience. This resonates with the RO phase of the ELC and was split into two parts. They were first asked to reflect individually on their experience and learning in engaging with the VFT application.

After the individual reflections, students were asked to revisit their selected resource from Stage 2 and share how the concrete experiences reinforced or contradicted their prior knowledge. The reflection activities served as a way for us to determine how the CE phase helped students gain knowledge and how it changed their perceptions and thoughts related to horticulture in the community.

5.2.2.6 Stage 5

Stage 5 was designed to allow students to consolidate their learning and combine both their prior knowledge along with knowledge and experience gained through the session by attempting the horticulture scenario, shown in Figure 5.7. The key aim of the stage is to assess ideas and explore different possibilities before coming to a consensus of a group design for their nursery, it formed the basis of the AC phase of the ELC. The group design ideas were shared with the rest of the class for feedback, which the groups could use to refine their ideas and designs.

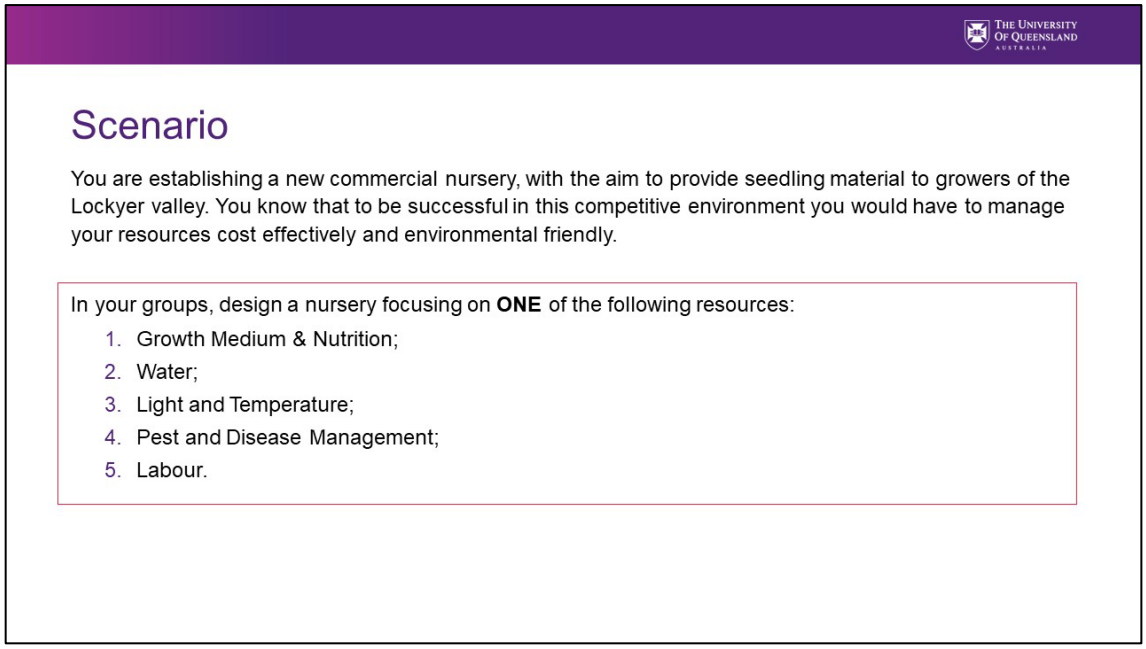


Figure 5-7 Activity instructions for Stage 5

5.2.2.7 Stage 6

Stage 6 closed the session with two activities. Firstly, the students were given instructions regarding a course assessment item - a reflection assignment (see Figure 5.8) building on their knowledge and experience from the course content and the session. Though the intention of having an assignment tied to the activities was to encourage student participation and interest in the activities, I helped the course coordinator design it to be an integrative assessment so that students could see the relevance of the VFT in the larger course context.

The second activity was a data collection activity where students responded to the post-activity questionnaire where they were asked to share their perceptions of learning and the value of the experiential learning activity after they had gone through the experience-based learning activity. Additionally, they were also asked to reflect on their experience with the VFT application enabling us to determine if improvements might be required before subsequent iterations.

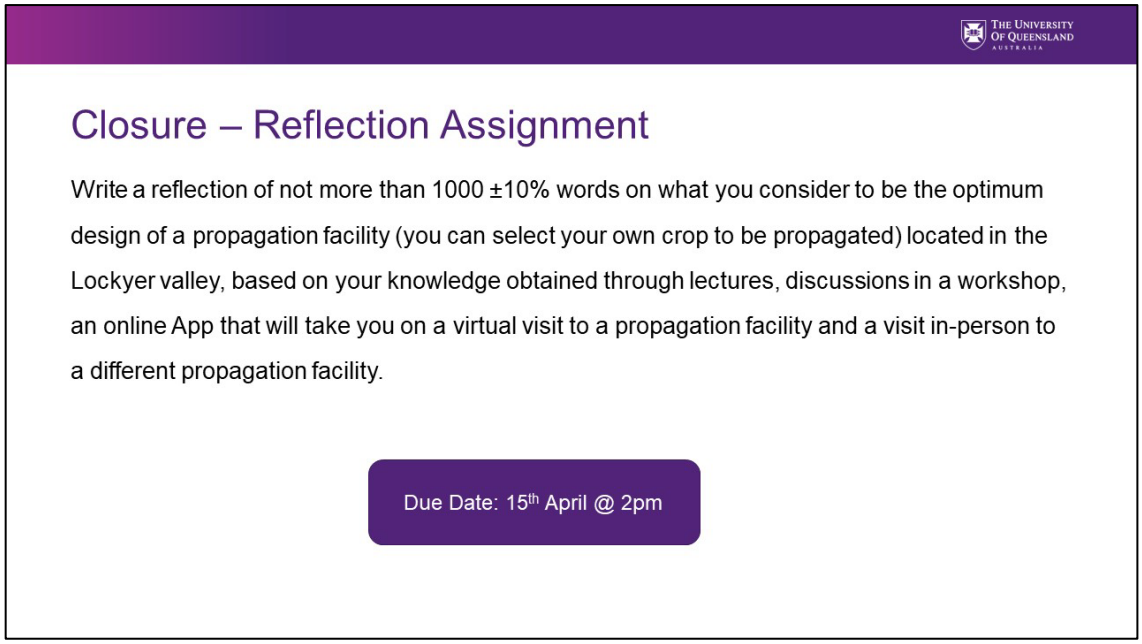


Figure 5-8 Closure activity connecting session to reflection assignment

5.2.2.8 Post-Activity Phase

In the post-activity reflection, I noted some observations about aspects of the activity that went well along with some aspects which did not go as well and had to improve. Aspects like the flow of activities and the student engagement observed during the group activities were positive. Conversely, the lack of data capture during those discussion and the short duration afforded to them had to be improved. Figure 5.9 captures my reflection notes at the end of Iteration 1. Specific reflections are highlighted across the appropriate evaluation sections in section 5.2.3 and supported the findings from the other measures in allowing me to make conclusions and draw out lessons learnt.

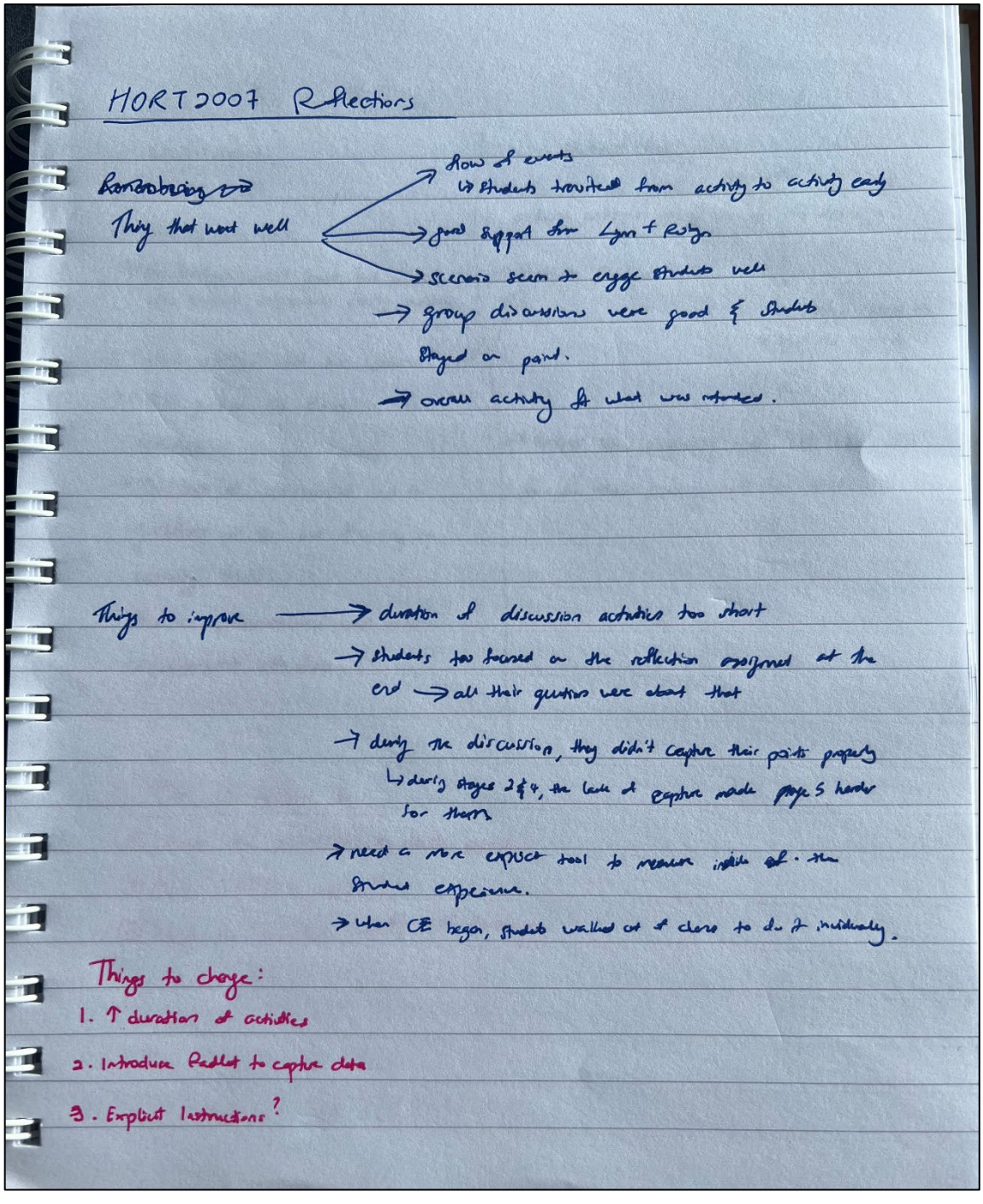


Figure 5-9 Reflection notes for Iteration 1

5.2.3 Evaluation

As described in section 4.5, I adopted an evaluation strategy that allowed me to categorise the data collected into two categories: the activity design and student outcomes. The investigation into the activity design drew on both quantitative and qualitative data from across the different measures that were used along with data from my reflection notes. The investigation of student outcomes came through two measures; the ELSS which employed a paired sample *t*-test comparing student responses from the pre-experience survey and the post-experience and the qualitative data collected from both the student reflection on learning and their reflection on the virtual field trip experience.

5.2.3.1 Activity Design

The evaluation of the activity design drew on both quantitative and qualitative data from across the different measures used along with my evaluator reflections and discussion notes. As described in section 4.5.1, the analysis was done in 2 stages. Firstly, the data were analysed according to the activity stages and subsequently, data from the ELVIS and the ELSS was analysed broadly as they captured student feedback on the activity as a whole and spoke to the effectiveness of the various stages of the ELC about each other and gave me a means of adapting specific stages from iteration to iteration.

5.2.3.1.1 Stage 1

In Stage 1, student demographics was collated along with their prior experience with VFTs. There was a roughly even student gender distribution with 55.6% (*n*=5) female and 44.4% (*n*=4) male which meant that we could assume that there are no gender effects on the findings. As this was a 2nd year undergraduate horticulture course, it was not surprising that 88.9% of the

students majored in horticulture as part of their programme with 66.7% enrolled in the single major programme and 22.2% enrolled in the dual programme of Agribusiness and Agricultural Science.

As shown in Figure 5.10, 77.8% of the students *"have not used virtual field trips before the activity and had no idea what it is all about."* Together with the 11.1% that *"have not used virtual field trips before this activity but am aware of what it is all about,"* meant that only 1 student had previously used VFTs. Following on from their responses, participants were asked to describe what they thought VFTs field trips were all about. The students with prior experience with VFTs mentioned that *"it was a worthy experience"* and responses from students who had not used VFTs previously showed three themes – a virtual experience, an interactive experience and an exploratory experience as summarised in Table 5.2. Having most of the participants with no prior experience was good for the pilot iteration as it removed prior experience as a possible moderator of their perceptions and reflection.

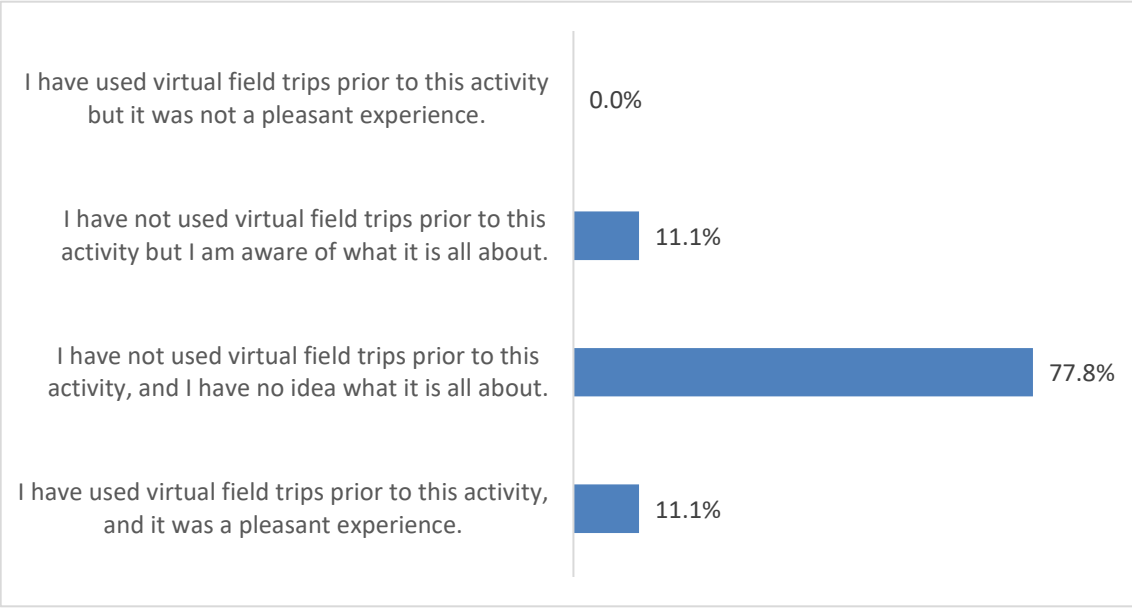


Figure 5-10 Summary of student prior experience with VFTs

Theme	Sample Quote
VFTs are a Virtual Experience	*Emulating the experience of an out-of-class field trip virtually*
VFTs are an Interactive Experience	*Interactive scenarios and scenes within the location selected*
VFTs are an Exploratory Experience	*Exploring the site through various videos*

Table 5.2 Thematic analysis of what students thought VFTs are all about

5.2.3.1.2 Stage 2

In Stage 2, students used their prior knowledge to address the scenario shown in Figure 5.6 and shared this with their groups.

"I noticed that the students who had prior experience in the industry dominated much of the discussion. This coupled with the short duration of the activity the groups were unable to talk through all the resources in the list."

-reflection notes, Iteration 1, 12/04/2022

Another aspect that I observed that did not go smoothly was the capture of discussion points. There were no formal instructions for students to capture their discussion points and the associated challenge became evident in Stage 4 where they had to reference the resource chosen in this stage, but some students had forgotten the details their groupmates had shared.

5.2.3.1.3 Stage 3

In Stage 3, students engaged in a self-exploratory journey with the VFT application.

"At the start of the stage, I was surprised to note that all students embarked on the application individually with some even leaving the classroom to find a quieter space.

-reflection notes, Iteration 1, 12/04/2022

This observation was surprising as they were not given any specific instructions of how they should engage with the application but all of them had assumed that it was an individual activity. Another facet of their engagement with the application that I found interesting was that different students engaged with it in diverse ways. Some located the video panel and proceeded to watch all the videos at a go before visiting the individual hotspots while others used the hotspots as a guide and watched the linked videos in context. Though not a focus of this study, this could be an aspect that is investigated in future research.

5.2.3.1.4 Stage 4

Stage 4 involved students' reflecting on their experience and learning both individually and subsequently in their groups. Responses to the reflection question, *"What were you thinking and feeling during the learning activity?*" were analysed to understand the influence of the VFT application on the student experience which is valuable to the activity design.

Reviewing 7 out of the 8 responses which were reflective of a positive experience, two themes emerged: the activity was interesting and engaging and the featured nursery was impressive (see Table 5.3). There was 1 response pointing out that *"there were no captions or transcripts on the videos it made it difficult to understand the person talking"*. This was an important finding for the

activity design where negativity towards online learning has been found to reduce student engagement (Ferrer et al., 2020).

Theme	Sample Quote
The activity was interesting and engaging	*The more I followed along the more I wanted to learn about the facilities. This was influenced by watching how one procedure in the nursery leads to the next and how the production of the seedlings is developed.*
The featured nursery was impressive	*I felt very impressed by the nursery, how clean and organised it was, and how mechanised they made it.*

Table 5.3 Thematic analysis of what students were thinking and feeling during the learning activity

"In the group discussion, some students seemed to be repeating what they had described in Stage 2. When asked, the groups explained that they did not capture what was previously discussed and thus they had to repeat themselves."

-reflection notes, Iteration 1, 12/04/2022

This repeated discussion impacted the duration allocated for the activity as the students had to be rushed to wrap up their discussion so that they could proceed to the next stage of the activity.

5.2.3.1.5 Stage 5

Stage 5 saw students applying their collective aggregated knowledge in attempting the scenario in Figure 5.7. The groups were actively engaged, and each group put together a comprehensive design plan for their nurseries. They captured this design on a butcher paper and presented their ideas to the class. The design showed that they were able to integrate elements from their prior knowledge and knowledge garnered from the VFT. The course coordinator provided them with feedback, particularly with a focus on the related assignment they were expected to submit.

5.2.3.1.6 Stage 6

With the first part of the stage devoted to the reflection assignment, students were focused on various assessment requirements and criteria which took the bulk of the time allocated for the stage.

"Unfortunately, although the assessment discussion did not seem to affect the activity itself, I felt that it broke the momentum of the stages especially as they subsequently had to respond to questionnaires related to the activity."

-reflection notes, Iteration 1, 12/04/2022

In the second part of the stage, we collected data using the ELS which measured students' perception of the value of experiential learning activities. Table 5.4 summarises the mean values for the individual subscales associated with aspects of experiential learning.

Results from ELS showed the *relevance* subscale with the highest mean score of 6.18 indicating that students found that the activity allows them to internalize and reflect on their past experiences to connect new and old information. This was positive as this was deliberately planned for in Stage 2 of the activity. Conversely, the *active learning* and *utility* subscales, which

measured the level of engagement the student has with the learning material and its connectivity to future applications scored comparatively poorer. This was of concern as Stages 3, 4 and 5 were designed to engage students in active participation and the scenario was designed to allow them to make that connection seamlessly.

Scale	Number of Items	Mean	SD
Environment Authenticity	5	5.73	0.60
Active Learning	7	5.21	0.52
Relevance	9	6.18	0.72
Utility	7	5.31	0.64

Table 5.4 Means and SDs for individual ELS subscales

The subscales serve as guiding pedagogical principles outlining the components of an experiential learning design. Thus, as described by Clem, Mennicke and Beasley (2014) a correlation analysis was performed to understand the relationship between the ELS subscales. As shown in Table 5.5, there is a strong positive correlation between the *relevance* and *utility* subscale, which was statistically significant ($r = 0.826$, $p = 0.006$), indicating that the more students found the activity relevant, the higher the likelihood they can see it being useful in the future.

	Environment Authenticity	Active Learning	Relevance	Utility
Environment Authenticity	1	0.343	0.616	0.576
Active Learning	-	1	0.394	0.160
Relevance	-	-	1	0.826**
Utility	-	-	-	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5.5 ELS inter-scale correlations

There was also a strong positive correlation between the environment *authenticity* and *relevance* subscales (r = 0.616, p = 0.077) as well as the *environment authenticity* and *utility* subscales (r = 0.576, p = 0.105), though these correlations were not statistically significant. There was a weak positive correlation between the *environment authenticity* and *active learning* subscales (r = 0.343, p = 0.367), a poor positive correlation between the *active learning* and *relevance* subscales (r = 0.394, p = 0.294) and a poor positive correlation between the *active learning* and *utility* subscales (r = 0.160, p = 0.681) all of which were not statistically significant. These correlations indicate that quantitatively, the students were not able to perceive the value of the activity about their real-world application.

5.2.3.2 Student Outcomes

As described in section 4.5.2, the student outcomes to be evaluated from the activity were guided by the UQ graduate outcomes and their attainment was determined by analysing quantitative and qualitative data collected from the ELSS, student reflections on learning and VFT experience, and reflection notes.

The student outcomes evaluated for my project were:

1. Student will display an understanding of social and civic responsibility.
2. Student will display the ability to engage effectively and appropriately with information and communication technologies.
3. Student will display the ability to interact effectively with others to work towards a common outcome.
4. Student will display the ability to identify problems, create solutions, innovate, and improve current practices.

Each of the following subsections represents the analysis and determination of the attainment of the respective student outcomes based on Table 4.7.

5.2.3.2.1 Student will display an understanding of social and civic responsibility

To evaluate this student outcome, I looked to SLO 1 and SLO 4 from the ELSS and the reflection question, “After going through the activity, what are your thoughts about ways in which the agriculture industry needs to develop to best meet the needs of the community?”.

In the ELSS, an increase in the mean scores from the pre- to the post-activity response indicated that students had attained that SLO. SLO 1 had a mean increase of 2.83 with SLO 4 having a comparatively lower increase of 0.17 indicating that students had attained SLO 1 to a larger extent than SLO 4. Table 5.6 summarises the mean scores from the pre-and post-survey results along with the *t*-test results comparing them. The paired *t*-test result for SLO 1 showed that there was a statistically significant improvement from the pre-(M = 23.33, SD = 1.75) to post-(M = 26.17, SD = 2.09) experience, $t = 6.107$, $p = 0.000$. The paired *t*-test result for SLO 4 showed that there was an improvement from the pre-(M = 17.00, SD = 2.25) to post-(M = 17.17, SD = 2.82) experience, $t = 0.217$, $p = 0.834$ though it was not statistically significant.

This was an interesting finding as SLO 1 was not deliberately designed as part of the activity design while the improvement for SLO 4, which could be connected to deliberately designed activities, was not found to be statistically significant. This might indicate that the activities were not suitable or sufficient for this group of students to attain those outcomes though from a statistical point of view, there potentially might not be enough power to discern any difference.

	# of Items	Pre		Post		Mean Diff [Post-Pre]	t	df
		Mean	S.D.	Mean	S.D.			
SLO 1: Students will value the importance of engaged scholarship and lifelong learning.	4	23.33	1.75	26.17	2.09	2.83	6.107**	8
SLO 4: Students will engage in structured reflection as part of the inquiry process.	3	17.00	2.25	17.17	2.82	0.17	0.217	8

**. $p < 0.01$

Table 5.6 Means, SDs and *t*-test Results for ELSS SLO 1 and SLO 4

When students were asked to reflect on ways in which the agriculture industry needs to develop to best meet the needs of the community, all students were also able to provide thoughtful examples of areas that the industry needed to develop. In analysing their responses, 3 clear themes stood out: *sustainability*, *community engagement* and *insect management* (see Table 5.7). It was interesting to note that all but 2 respondents provided examples that were not presented in the VFT application.

Theme	Sample Quote
Sustainability	*The adaptation towards sustainability, job security and reassurance to the grower and consumer that these guidelines are met in a meaningful way*
Community Engagement	*I live close to Boomaroo and have never heard of it so the agricultural industry in general needs to become more advertised in the community and openly allow outsiders even if virtually able to engage with the productions.*
Insect Management	*Using beneficial insects instead of relying solely on chemicals should be implemented whenever possible.*

Table 5.7 Thematic analysis of ways in which the agriculture industry needs to develop to best meet the needs of the community

5.2.3.2.2 Student will display the ability to engage effectively and appropriately with information and communication technologies

To evaluate this student outcome, I looked at the quantitative aspect of the student reflection on the VFT Experience and the reflection questions, “List two (2) things that you know now that you did not know before the activity”, “How did you approach the learning activity and why?” and “What would you change about the virtual field trip experience to enhance it for future students?”.

The responses for the “*VFT interface and media*” construct highlighted the high expectations that students had about the VFT application though they had reflected no prior experience with it. They deemed that the multimedia helped them engage with the VFT application (M = 4.22, SD = 0.83) but appraised the interface (M = 3.67, SD = 1.32) and navigation (M = 3.33, SD = 0.71) of the application comparatively poorly. Their perception of VFTs where they rather experience a VFT than no field trip experience (M = 4.44, SD = 0.73) and that they think both VFTs and actual field trips can be useful in agricultural courses (M = 4.44, SD = 0.73) illustrate the value that they place on these forms of technology and its integration in course. However, it is also noteworthy that they were not as keen to see more VFTs in their courses (M = 3.78, SD = 1.09).

In the use of the “*learning with VFT*” construct, we have a high subscale mean of 4.15 across all 6 items related to their learning experience. There were high mean scores for items related to the application of concepts in industry (M = 4.56, SD = 0.53) and how it allowed them to gain knowledge (M = 4.33, SD = 0.50). Additionally, the high mean score for how the VFT application added to the enjoyment of learning (M = 4.00, SD = 0.71) was pleasing from both an activity design perspective and highlights a comfort in engaging and using the application for their learning. It was interesting to note that they did not feel that they were able to accomplish the given task effectively (M = 3.67, SD = 1.00). The mean scores for the individual items and the overall subscales are summarised in Table 5.8 below.

Items [subscales in bold]	Mean	S.D.
VFT Interface and Media - 3 Items	**3.74**	**0.88**
The virtual field trip application was easy to navigate.	3.33	0.71
The multimedia (e.g., videos and floor plans) helped me engage with the virtual field trip application.	4.22	0.83
The interface of the virtual field trip application was user-friendly.	3.67	1.32
Perception of VFT - 5 Items	**3.82**	**0.72**
I would rather visit an actual field site than experience a virtual field trip.	4.44	0.73
I would rather experience a virtual field trip than have no field trip experience.	4.00	1.22
Virtual field trips can replace actual field trips.	2.44	1.33
I would like to see the use of more virtual field trips in my courses.	3.78	1.09
I think both virtual field trips and actual field trips can be useful in agricultural courses.	4.44	0.73
Learning with VFT - 6 Items	**4.15**	**0.49**
The virtual field trip application enabled me to accomplish the task effectively.	3.67	1.00
The virtual field trip application complemented the course material.	4.22	0.44
The virtual field trip allowed me to see course concepts being used in the industry.	4.56	0.53
The virtual field trip application provided an appropriate learning opportunity.	4.11	0.60
The virtual field trip application added to the enjoyment of learning.	4.00	0.71
The virtual field trip application allowed me to gain knowledge that I previously did not have.	4.33	0.50

Table 5.8 Means and SDs for VFT experience subscales

Reviewing what students reflected on, “What would you change about *the VFT experience to enhance it for future students?”,* we see that their responses were focused on the multimedia used in the application with 7 of the 9 responses suggesting improvements to the clarity of the video and improvement to the software. This was interesting as their quantitative

response indicated that the media helped them engage with the application, but it formed much of the recommended enhancement.

The way they approached the learning activity gave us insight into how they engaged with the application. The guiding questions focused the students' responses on the path they had taken through the activity and why. There were two themes identified with some indicating that the path was not easy to follow with others indicating that they followed a path like what they would have done if the trip were done in person summarised in Table 5.9. Further to that, their elaboration on why they pursued a certain path gave further insight into what would have to be improved.

Theme	Sample Quote
Path not easy to follow	*I attempted to follow the path from the map in the corner but as things were not numbered it made it difficult to ensure I was going in order. Once you clicked on the main I and were taken into the room it was even more difficult to know which one to click on first which meant some of the information was unclear and out of order.*
Followed the path as they would have done if the trip were done in person	*I clicked on everything I could, and I took my time. I would have followed a similar path if I were there in person.*

Table 5.9 Thematic analysis of benefits of using VFTs

From a cognitive perspective, when asked to list 2 things that they knew after the activity that they did not know before the activity, all students were able to pick up elements from the VFT and gave varying examples ranging from course content elements like, “Recommended media for organics, ability for return and reuse of trays” to broad concepts like “The value of mechanisation in this industry” and “The sustainability of nurseries in terms of water usage and how they recycle their water.”

In my reflection on the iteration, I noted that students had no difficulty assessing the application and they did not look to the course coordinators or myself when going through it. The confidence and self-directed nature with which they engaged with the application coupled with the keen eye they used to evaluate it gave me much confidence in them attaining this outcome – albeit not necessarily simply due to engaging in the activities.

5.2.3.2.3 Student will display the ability to interact effectively with others to work towards a common outcome

To evaluate this student outcome, I looked to SLO 3 from the ELSS and the reflection question, “How did your relationship with your group mates influence your experience?”.

In the ELSS, an increase in the mean scores from the pre- to the post-activity response indicated that students had attained that SLO. SLO 3 had a small mean increase of 0.67. Table 5.10 summarises the mean scores from the pre-and post-survey results along with the *t*-test results comparing them. The paired *t*-test result for SLO 3 showed that there was an improvement from the pre-(M = 16.33, SD = 1.39) to post-(M = 17.00, SD = 1.68) experience, $t = 0.883$, $p = 0.403$ though it was not statistically significant.

	# of Items	Pre		Post		Mean Diff [Post-Pre]	t	df
		Mean	S.D.	Mean	S.D.			
SLO 3: Students will work collaboratively with others.	3	16.33	1.39	17.00	1.68	0.67	0.883	8

Table 5.10 Means, SDs and *t*-test results for ELSS SLO 3

When students were asked to reflect on how the relationship with their group mates influenced their experience, 6 of the 9 students focused their responses on the CE stage rather than the entire experience and indicated that they did the activity alone with no influence from their group mates. However, 4

of the 9 highlighted the benefits of group discussions including, "*My group mates' knowledge allowed me to become more engaged based off their knowledge allowing me to desire to grow my own further.*" These remarks reflect an existing understanding of the value and impact of the group-based activities which may also explain why we see no significant improvements in SLO 3.

In my reflection, I noted that one aspect of the entire activity that worked well was group work. They were randomly grouped as they walked into the session and when the activities began, there was little apprehension to get the discussions going. I did notice a little deference to those with more industry experience when discussing the prior knowledge activity, but that deference disappeared when engaging in the scenario.

5.2.3.2.4 Student will display the ability to identify problems, create solutions, innovate, and improve current practices

To evaluate this student outcome, I looked to SLO 2 from the ELSS and the reflection questions, "What benefits do you think there are from using VFTs in place of actual field trips?" and "Has the virtual field trip experience helped you become more interested in this field and if so, why?".

In the ELSS, an increase in the mean scores from the pre- to the post-activity response indicated that students had attained that SLO. SLO 2 had a mean increase of 1.83. Table 5.11 summarises the mean scores from the pre- and post-survey results along with the *t*-test results comparing them. The paired *t*-test result for SLO 2 showed that there was an improvement from the pre-(M = 31.83, SD = 2.46) to post-(M = 33.67, SD = 3.68) experience, t = 1.444, p = 0.187 though it was not statistically significant. Again, with the activity being designed around a real-world scenario, it was interesting that the attainment of SLO 2 was not significant. The high mean scores for students' perception of the value of an experiential learning activity from the ELS described in section

5.2.3.1.6 above, showed that they valued the activity and could see its relevance despite no significant improvements in SLO 2.

	# of Items	Pre		Post		Mean Diff [Post-Pre]	t	df
		Mean	S.D.	Mean	S.D.			
SLO 2: Students will apply knowledge, values, and skills in solving real-world problems.	6	31.83	2.46	33.67	3.68	1.83	1.444	8

Table 5.11 Means, SDs and *t*-test results for ELSS SLO 2

When students were asked to reflect on the benefits of using VFTs in place of actual field trips most students were able to link its benefits to themes of accessibility, efficiency and it being a back-up plan as summarised in Table 5.12. However, as these were the same themes highlighted during Stage 1 by the facilitator, there is a possibility that students merely regurgitated what was mentioned.

Theme	Sample Quote
Accessibility	*Accessibility, where those who normally cannot attend actual field trips can attend virtual ones.*
Efficiency	*It's time saving and we can easily go back to the part that we are interested in.*
Backup-Plan	*At times insufficient and inadequate university funding, or poorly designed class scheduling, cannot permit the opportunity of an actual field trip, this can be used as a mediocre substitute that still engages and informs students of field experiences.*

Table 5.12 Thematic analysis of benefits of using VFTs

When students were asked to reflect on whether the VFT experience helped them become more interested in the field and why, all 9 students unanimously agreed that it had. 6 of the 9 students connected this increased interest to the increased awareness of industry practices through the activity.

In my reflection, I noted how the different groups had a wide range of solutions that they brought forth to discuss and the conversations that were had, showed a depth of understanding of the scenario they were attempting and an ability to evaluate various solutions before selecting one.

5.2.4 Lessons Learnt from Iteration 1

The lessons learnt from this iteration informed the tweaks to be made to the innovation to be implemented Iteration 2. I categorised them into two categories; (1) lessons learnt relating to the activity design and (2) lessons learnt relating to student outcomes. Figure 5.11 summarises the findings and the changes to be made to the innovation for Iteration 2.

5.2.4.1 Lessons Learnt Relating to the Activity Design

From section 5.2.3.1, I concluded that the flow of stages was good, and students were able to transition from one stage to another smoothly. Thus, in Iteration 2, I maintained the same sequence of stages.

In section 5.2.3.1.4, I noted that the students were actively engaged in the group discussions but unfortunately as they did not capture their discussion points. As such, subsequent stages that built on those discussion points were hindered as the discussions had to be revisited. As such, in subsequent iterations, I decided to introduce a means of capturing their discussion points. To allow me to seamlessly use this as another means of data capture, I intend to use an online platform (Padlet) to capture the discussion points.

In section 5.2.3.1.6, I reflected on how student questions at the end of the activity were focused on the assignment. Though the insertion of the assignment was intended to ensure their engagement in the activity, it seemed to have detracted them from the activity itself. Thus, for subsequent iterations, I believe in the removal of the assignment and keeping the activity front and centre of student engagement.

From an evaluation perspective, there was no quantitative data to complement my qualitative reflections which I based my specific suggestion upon. Thus, to improve evaluation rigour, I sought for an instrument that would help me evaluate the student learning experience in all stages of the ELC which would be important in helping me tweak the activity design for subsequent iterations. Thus, the ExLSS was to be incorporated as part of the post-activity questionnaire for Iteration 2.

5.2.4.2 Lessons Learnt Relating to Student Outcomes

Reviewing the student feedback from the ELS in section 5.2.3.1.6, I concluded that there is a need to review the scenario used to engage the students in Stages 2, 4 and 5. This could be either changing the scenario entirely or perhaps tweaking it so that students could better contextualise it with the content covered in the course. This has highlighted an additional consideration to make the scenario design a focus during the pre-activity discussions with the coordinators.

In section 5.2.3.2.4, reviewing the responses from students when asked to reflect on the benefits of using VFTs, I noticed that they highlighted similar themes that were discussed during my introductory presentation in Stage 1. This made it difficult to determine if students genuinely perceived the benefits of using VFTs or if they were simply regurgitating what they had heard. Having the intention for the activity itself to inform participants of its benefits, I believe that the introductory presentation be removed in subsequent iterations.

In section 5.2.3.1.3, I had noted that during the CE stage of the activity, students adopted an individualised experience with some of them even leaving the classroom to be alone when engaging with the VFT. This potentially could have impact on the student outcomes that relies on the social engagement. As such, in subsequent iterations, I suggest the use of explicit instructions to ensure that students are aware of the option to work in groups for that stage.

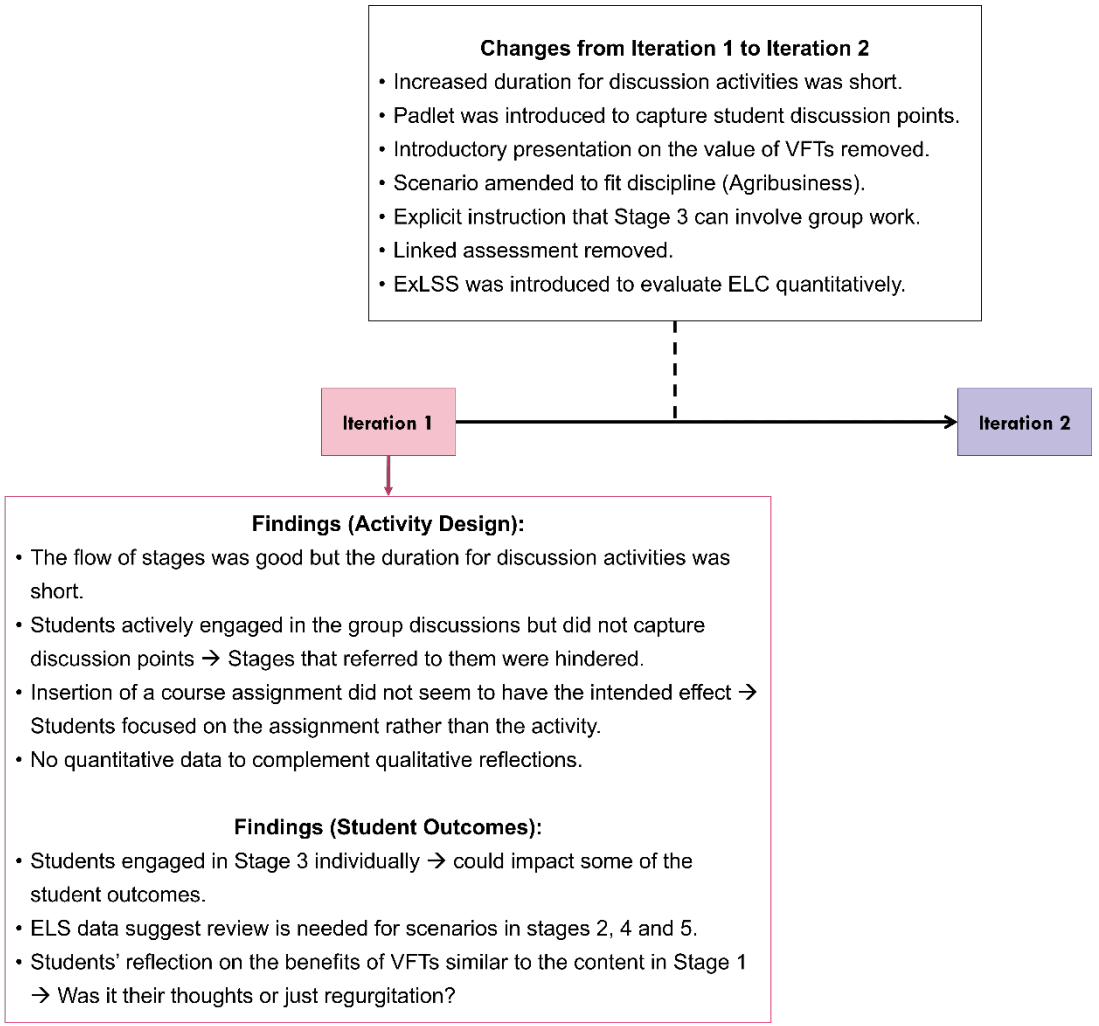


Figure 5-11 Summary of Findings from Iteration 1 and changes to be made for Iteration 2

5.3 Iteration 2: Agribusiness Planning & Management (AGRC2023)

5.3.1 Introduction

As described in section 4.3.3, Iteration 2 was conducted on Agribusiness Planning & Management (AGRC2023), a second-year undergraduate agribusiness course with an enrolment of 64 students in 2022. AGRC2023 was appropriate for Iteration 2 as the students were also in their second year of study like the students in Iteration 1 allowing us to confidently apply the lessons learnt from Iteration 1 and evaluate the revised activity design on a course from a different agricultural discipline (agribusiness) in Iteration 2.

Iteration 2 was conducted in a collaborative tutorial room like that of Iteration 1 (see Figure 5.2) though much larger in size. The larger size was particularly appropriate for AGRC2023 as its enrolment size was almost five times bigger than HORT2007 in Iteration 1. The convenient collaborative learning space allowed me to navigate the logistical aspects of getting the large group of students into their discussion groups smoothly without much impact on the duration of the activities. Similar to Iteration 1, the venue provided no capability for students to work collaboratively on Stage 3 (concrete experience). However, the larger room size did provide room for students who wanted to work collaboratively to congregate in groups around someone's laptop or iPad. As the iteration took place closer to the end of the semester, the students were very comfortable in the venue having had weekly tutorials for almost 10 weeks there at this point.

5.3.2 Activity Design

The overall activity design for Iteration 2 followed the same framework employed for Iteration 1 incorporating the three phases: the pre-activity phase, the post-activity phase, and the activity itself. From Iteration 1, I found that the sequence of stages was suitable and retained that for Iteration 2. Figure 5.13 and Table 5.13 below provide an overview of the various stages and activities involved in Iteration 2. Changes from Iteration 1 were categorised into changes

made due to lessons learnt from Iteration 1 and changes made due to the course context (i.e., AGRC2023 is an agribusiness course whereas HORT2007 was a horticultural course). The changes made due to the lesson learnt from Iteration 1 were the duration allotted for each activity stage, the removal of the introductory presentation regarding VFTs and the inclusion of group Padlet and the ExLSS.

5.3.2.1 Pre-Activity Phase

In the pre-activity discussions with the course coordinator, it was noted that of the 64 students enrolled, 38 of them were enrolled in the internal mode of study. He informed me that the course was delivered in a blended format where they had recorded lectures and a weekly 3-hour tutorial session where weekly content is reviewed before students engage in case study discussions. Attendance for the tutorial sessions was optional for the external students and as such, the coordinator asked that we focus the activity on the internal students and to fit the iteration within a 2-hour workshop.

As Iteration 2 involved a course in a different agricultural discipline, there was a need to review and revise the base scenario and its associated activities. The coordinator advised that the scenario used in Iteration 1 would not be suitable as it did not build on the concepts covered in the course. Thus, the coordinator took some time to design the scenario which tapped on not only concepts covered in the course but also concepts they could glean from the VFT application.

As the tutorial sessions were facilitated by the tutors in the course, it was once again decided that I would facilitate the session. Reflecting on feedback from the tutors, the course coordinator mentioned that the students were motivated to engage in the case study discussions. This also meant that the coordinator agreed with the suggestion derived from Iteration 1 not to incorporate an assignment tied to the activities. Figure 5.12 summarises the

key discussion points from the pre-activity discussion with the course coordinator.

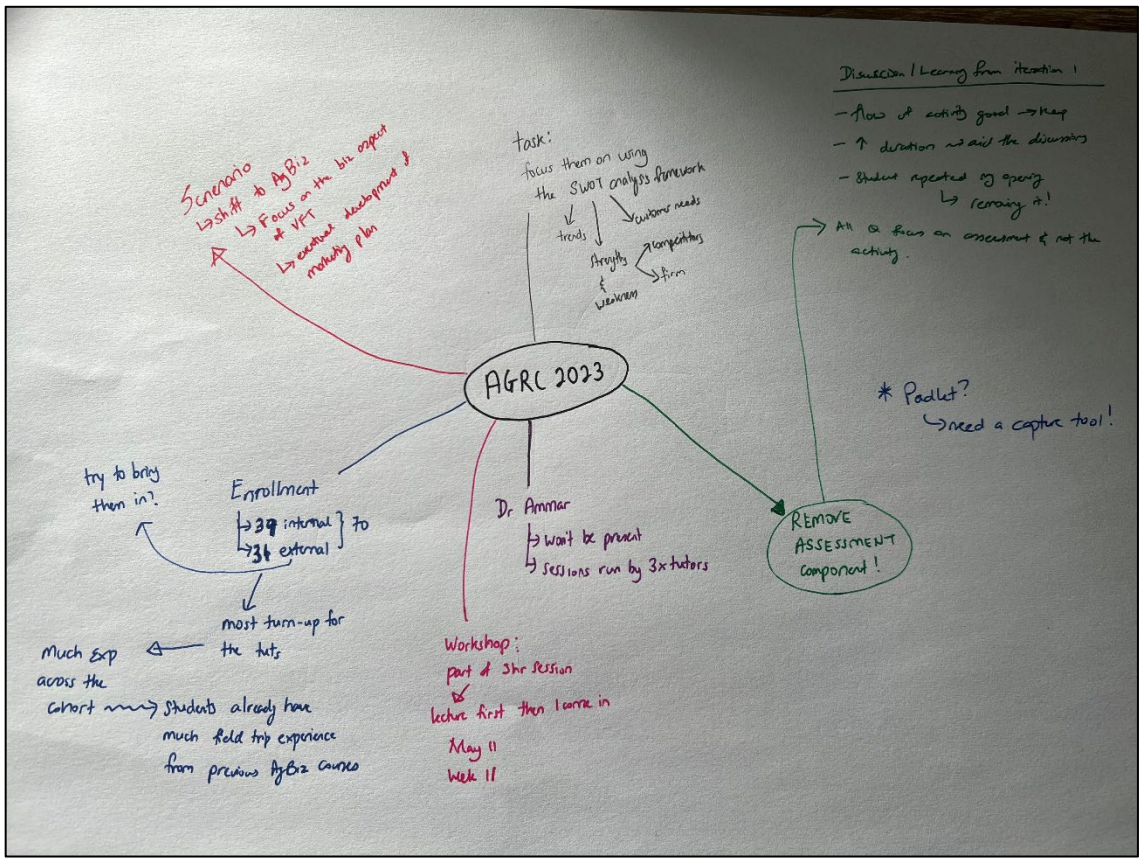
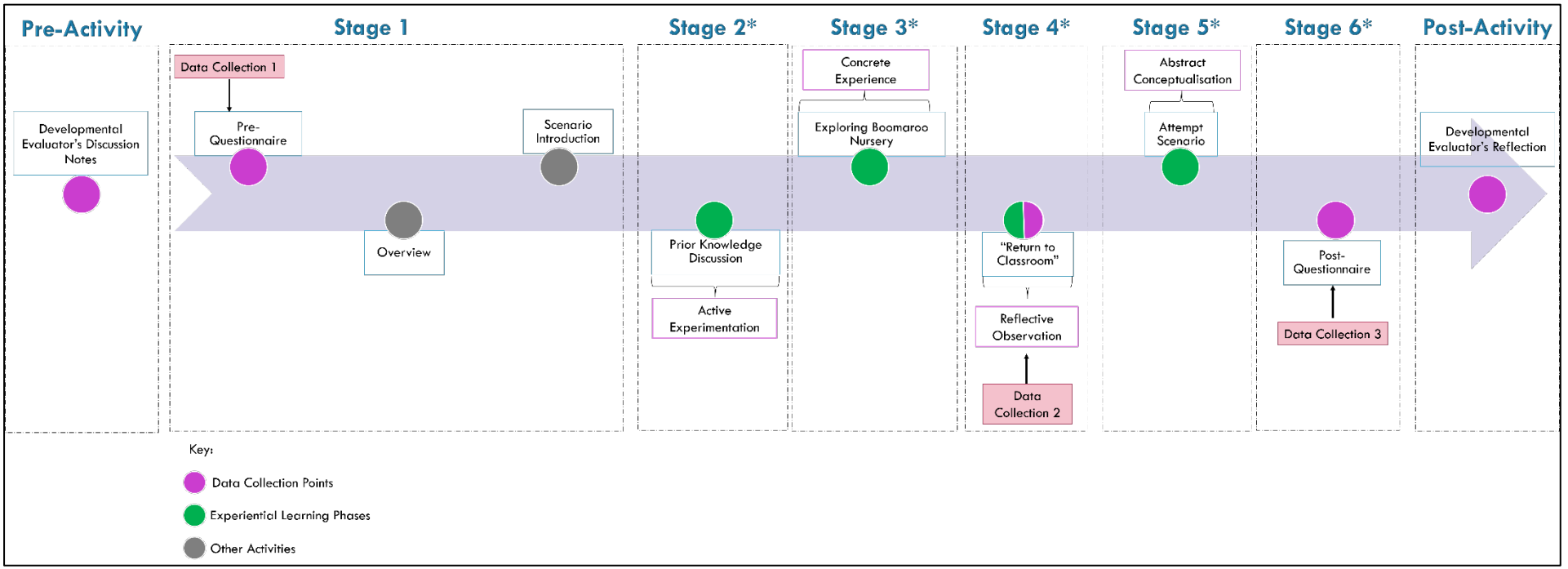


Figure 5-12 Pre-activity discussion notes for Iteration 2



Stages with * indicate Activity Changes from Iteration 1

Figure 5-13 Overview of the stages for Iteration 2 along with the data collection points

Stage	Name	Student Activity	Tools Used	Group/Individual Activity	Duration (min)	Changes from Iteration 1
1	Opening	• Respond to pre-questionnaire • Listen to briefing	Online Form	Individual	5	• Duration reduced from 15 min* • Removed introductory presentation of VFTs* • Scenario amended to fit discipline#
2	Prior Knowledge Discussion	• Explore scenario using prior knowledge • Share with groupmates	Padlet	Individual / Group	20	• Duration increased from 15 min* • Scenario amended to fit discipline# • Padlet introduced to capture data*
3	Exploring Boomaroo Nursery	• Explore the VFT location	VFT Application	Individual / Group	25	• Option to engage in activity in groups offered#
4	"Return to Classroom"	• Review prior knowledge • Share with groupmates	Online Form Padlet	Group	20	• Scenario amended to fit discipline# • Padlet introduced to capture data*
5	Attempt Scenario	• Attempt scenario • Share with class	Padlet	Group	30	• Duration increased from 15 min* • Scenario amended to fit discipline# • Padlet introduced to capture data*
6	Closing	• Respond to post-questionnaire • Listen to briefing	Online Form	Individual	10	• Duration reduced from 15 min* • Assessment component removed# • ExLSS added as additional measure*

* Changes made due to lesson learnt from Iteration 1

Changes made due to course context

Table 5.13 Summary of stages in Iteration 2

5.3.2.2 Stage 1

Stage 1 was delivered similarly as in Iteration 1 as described in section 5.2.2.1 where the session began with a brief introduction about what students would be expecting culminating in the presentation of the scenario that the activities will be based on.

The design differed from Iteration 1 in three ways as listed in Table 5.13. Based on lessons learnt from Iteration 1, I reduced the duration allocated for the stage. This was due to the removal of the introductory presentation of VFTs and the need for more time for the discussion activities in Stages 2, 4 and 5. Additionally, the scenario that was used in the iteration was updated as per the coordinator's design, shown in Figure 5.14.

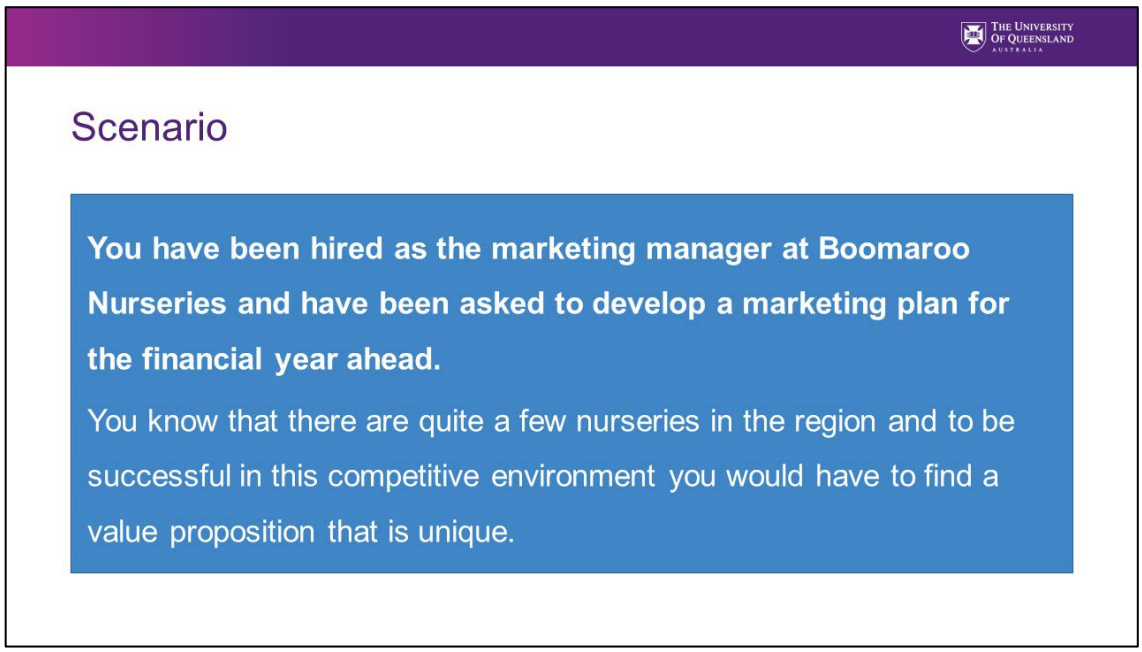


Figure 5-14 Agribusiness Scenario for Iteration 2

5.3.2.3 Stage 2

The design of this stage differed from Iteration 1 in three ways as indicated in Table 5.13. Based on lessons learnt from Iteration 1 and an increased class size, I increased the duration allocated for the stage to allow

students the opportunity to engage in deeper discussions with their group. Again, the task for the stage was redesigned as shown in Figure 5.15 where students were asked to perform a SWOT analysis which is a key concept covered in the course. Additionally, students were asked to capture their discussion points on a group Padlet.

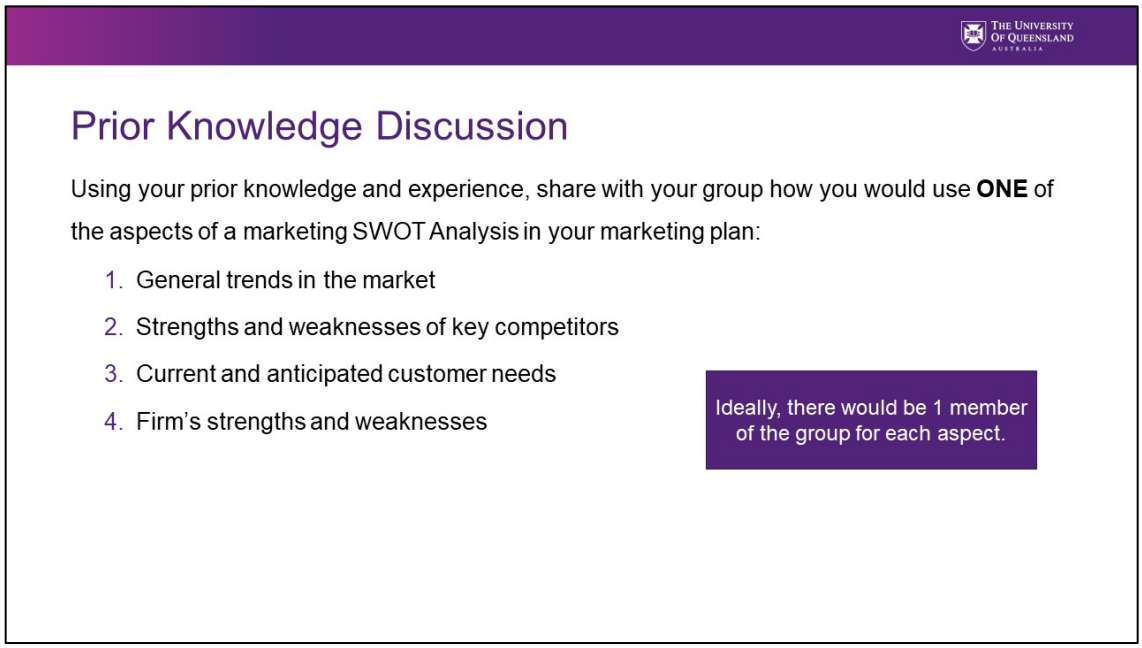


Figure 5-15 Revised activity instructions for Stage 2

5.3.2.4 Stage 3

Stage 3 was delivered as in Iteration 1, described in section 5.2.2.3, where students engaged with the VFT application. Based on lessons learnt from Iteration 1, specific instructions were given to students that they had the option to embark on the activity in groups.

5.3.2.5 Stage 4

Stage 4 was delivered similarly as in Iteration 1 as described in section 5.2.2.4 where students reviewed their responses to the task from Stage 2. The design of this stage differed from Iteration 1 as indicated in Table 5.13. Though

the class size was larger, I retained the duration allotted for the stage as I planned for students to be concise and reflect on changes to their prior knowledge as opposed to developing new ideas. Just as in Stage 2, students were asked to capture their discussion points on a group Padlet.

5.3.2.6 Stage 5

Stage 5 was designed for students to attempt the scenario task using their prior knowledge along with knowledge garnered from the VFT application. The design of this stage differed from Iteration 1 in three ways as indicated in Table 5.13. Based on lessons learnt from Iteration 1, I increased the duration allocated for the stage to allow students the opportunity to engage in deeper discussions with their group. Again, the task for the stage was redesigned as shown in Figure 5.16 where students were asked to develop a marking plan based on the 4P marketing mix and students were asked to capture their discussion points on a group Padlet.

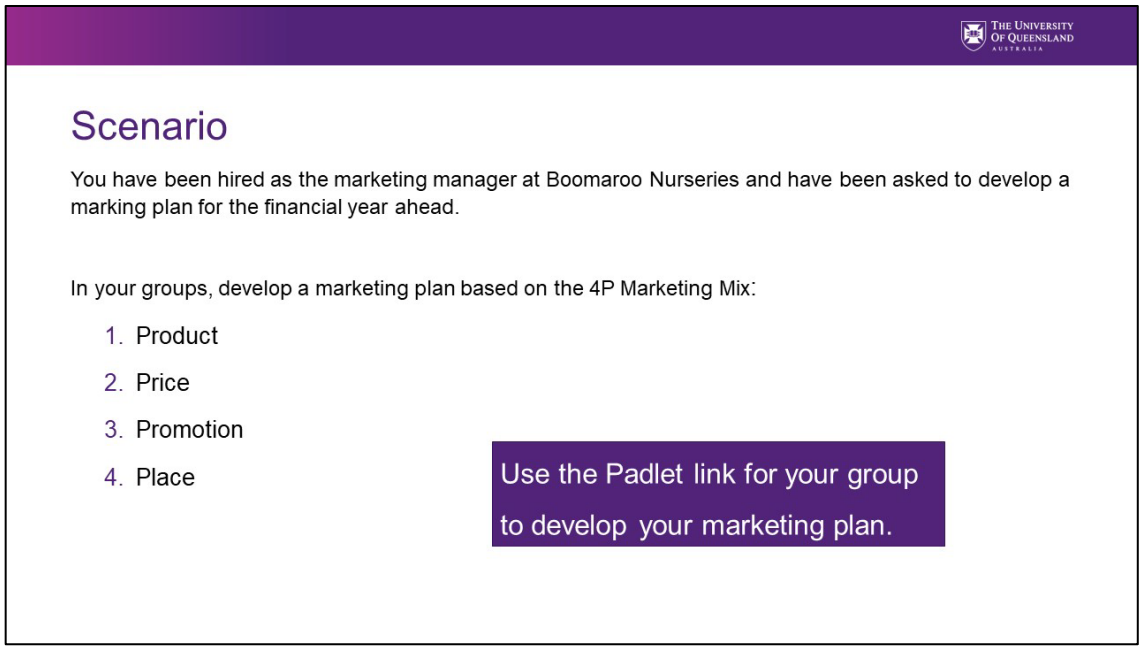


Figure 5-16 Activity instructions for Stage 5

5.3.2.7 Stage 6 - Closure

In comparison with Iteration 1, Stage 6 was delivered with three major changes. Firstly, as there was no assessment item related to the activities, students were immediately directed to the data collection activity. With that, the duration allotted for the stage was also reduced. Lastly, the post-questionnaire now included an additional section incorporating the ExLSS.

5.3.2.8 Post-Activity Phase

In the post-activity reflection, I noted observations about aspects of the activity that went well along with some aspects which did not go as well and had to improve. Aspects like the flow of activities and the student engagement observed during the group activities were positive. The revised duration worked to the students benefit. The use of the ExLSS made it easier to understand the student experience in the various stages.

Unfortunately, the technical difficulties faced when using the Padlet made it difficult to access its capabilities though the initial foray was positive. The task design for Stage 2 and 4 which was supposed to help them attempt the base scenario was also found to be generic. Figure 5.17 captures my reflection notes at the end of Iteration 2. Specific reflections are highlighted across the appropriate evaluation sections in section 5.3.3 and supported the findings from the other measures in allowing me to make conclusions and draw out lessons learnt.

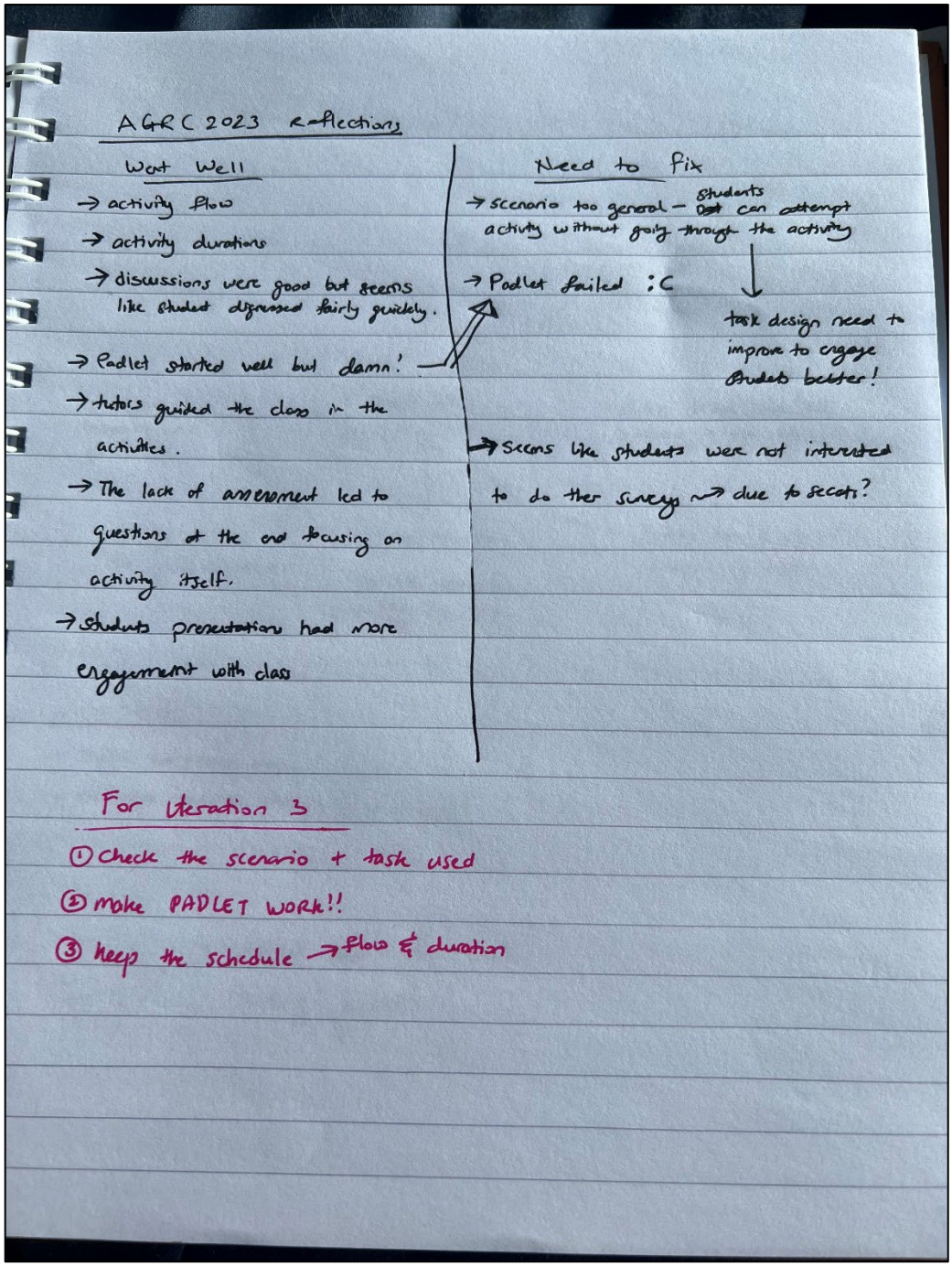


Figure 5-17 Reflection notes for Iteration 2

5.3.3 Evaluation

Like my evaluation strategy in for Iteration 1, described in section 5.2.3 data collected was categorised to inform two areas: activity design and student outcomes.

5.3.3.1 Activity Design

The analysis for the activity design was done in 2 stages. Firstly, the data were analysed according to the activity stages and secondly, data from my evaluator's reflection notes, ELVIS and ExLSS were analysed broadly to inform the overall activity design. One noteworthy element of the data collection was the number of responses at each data collection point. While the pre-questionnaire had 34 responses, the post-questionnaire and reflection only had 18 and 12 responses, respectively. This was surprising as students appeared to be engaged in responding to the questionnaires during the data collection points. Potentially the lack of responses could be due to a technical difficulty that arose during the session and the fact that the session overran the timetabled slot.

5.3.3.1.1 Stage 1

In Stage 1, student demographics was collated along with their prior experience with VFTs. Just like Iteration 1, there was an even student gender distribution with 52.9% (*n*=18) female and 47.1% (*n*=16) male, again reducing chances that there are no gender effects to the findings. As this was a 2nd year undergraduate agribusiness course and a core for all agribusiness students, we can see that 94.1% of the students came from the programme with 64.7% of them embarking on the dual offerings. The dual offerings pair different agricultural disciplines with the agribusiness programme.

As illustrated in Figure 5.18 below, a large majority (67.6%, n = 23) indicated that they *"have not used virtual field trips before this activity but am*

aware of what it is all about" with another 20.6% (n = 7) responding that they *"have not used virtual field trips before the activity and had no idea what it is all about"*. Reviewing their responses about what they think VFTs are all about, there is a clear theme that most connected VFTs to online field trips.

Conversely, there were 4 students (11.8%) who *"have used virtual field trips before this activity, and it was a pleasant experience"*. One described their experience as being amazing and informative with another describing it as an online analysis. Fortunately, like Iteration 1, we have no students who had previously used VFT and had an unpleasant experience. This distribution of students was positive as unlike Iteration 1, we now had a mix of students with prior experience and those without.

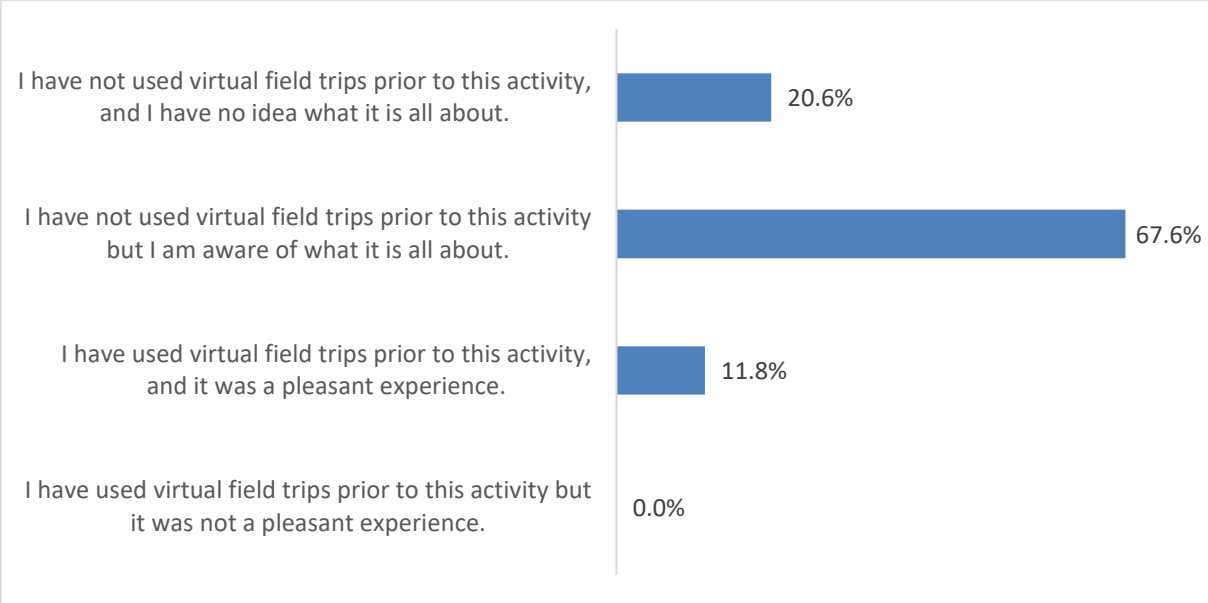


Figure 5-18 Summary of student prior experience with VFTs

5.3.3.1.2 Stage 2

In Stage 2, students were required to use their prior knowledge to attempt the task in Figure 5.15 and share this with their groups. They were asked to capture their discussion points in a Padlet created for the activity but unfortunately, the technology failed during this stage and the students were

unable to access the platform. Thus, students were asked to capture their thoughts on their devices.

"Walking around the groups, I noticed that some of them did not engage in the activity. However, when approached, they easily quoted examples to show that they were all sorted!"

-reflection notes, Iteration 2, 12/05/2022

5.3.3.1.3 Stage 3

In Stage 3, students engaged in a self-exploratory journey with the VFT application. The additional instruction given to students was that they could work in groups. was a promising idea as many students paired up to work on it together though it might have been due to the lack of resources.

"I heard students whining that they did not bring their earphones…when some students played the videos out loud on their devices, it was quite distracting…prompting many to reluctantly pair up to listen to the videos together".

-reflection notes, Iteration 2, 12/05/2022

Like what was noted in Iteration 1, different students engaged with it in diverse ways. It was however notable that the larger groups were able to complete the tour much faster than the smaller groups.

"As the video duration is fixed, with no option to speed up the video, I have a feeling that students in the large groups might have split the task of video watching amongst their members."

-reflection notes, Iteration 2, 12/05/2022

5.3.3.1.4 Stage 4

Stage 4 involved students' reflecting both individually and in their groups. Responses to the reflection question, *"What were you thinking and feeling during the learning activity?*" were analysed to understand the influence of the VFT application on the student experience which is valuable to the activity design.

Table 5.14 illustrates the two themes identified where the responses were split into those that found themselves "lost" or bored during the activity or focused their responses on what they saw during the activity.

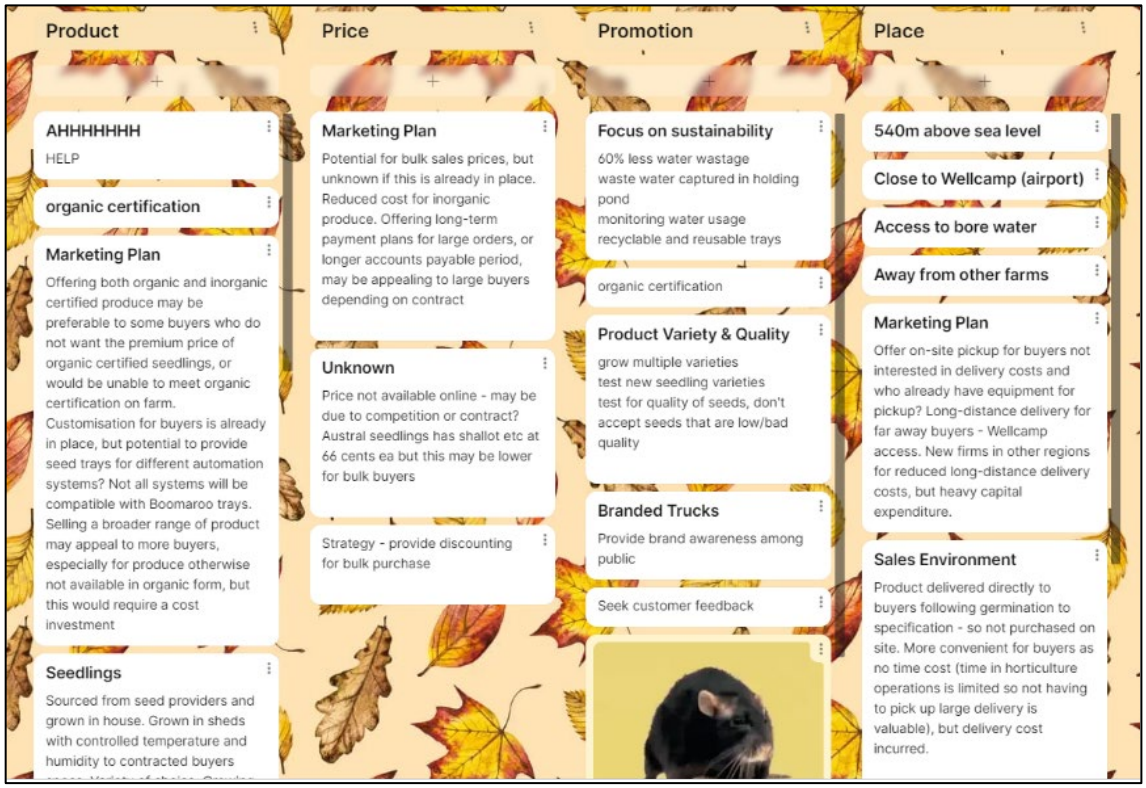
Theme	Sample Quote
Participants Found Themselves "Lost"	*I got "lost", you learned a lot, but I would have liked a specific order like someone was walking us through it.*
Participants Focused on What They Saw	• *This company explore their product in many aspects and knows its product position very well.* • *seeing how they run the facility*

Table 5.14 Thematic analysis of what students were thinking and feeling during the learning activity

With the technological challenges in Stage 2 resolved, the option to use Padlet to capture the group discussion points was made available but none of the groups took up the option, choosing instead to discuss their points verbally.

5.3.3.1.5 Stage 5

Stage 5 was designed to allow students to apply their collective aggregated knowledge in addressing the scenario task described in Figure 5.16. Students discussed the scenario and developed a marketing plan based on the 4P Marketing Mix and they captured their designs in their respective Padlet as shown in Figure 5.19. The number of posts and details in the Padlet gives a good indication of the elevated level of engagement students had in the activity. The groups were then asked to present their ideas to the group and the tutors present remarked that their plans were comprehensive and of a good standard incorporating knowledge from the course and the knowledge garnered from the VFT and peers.



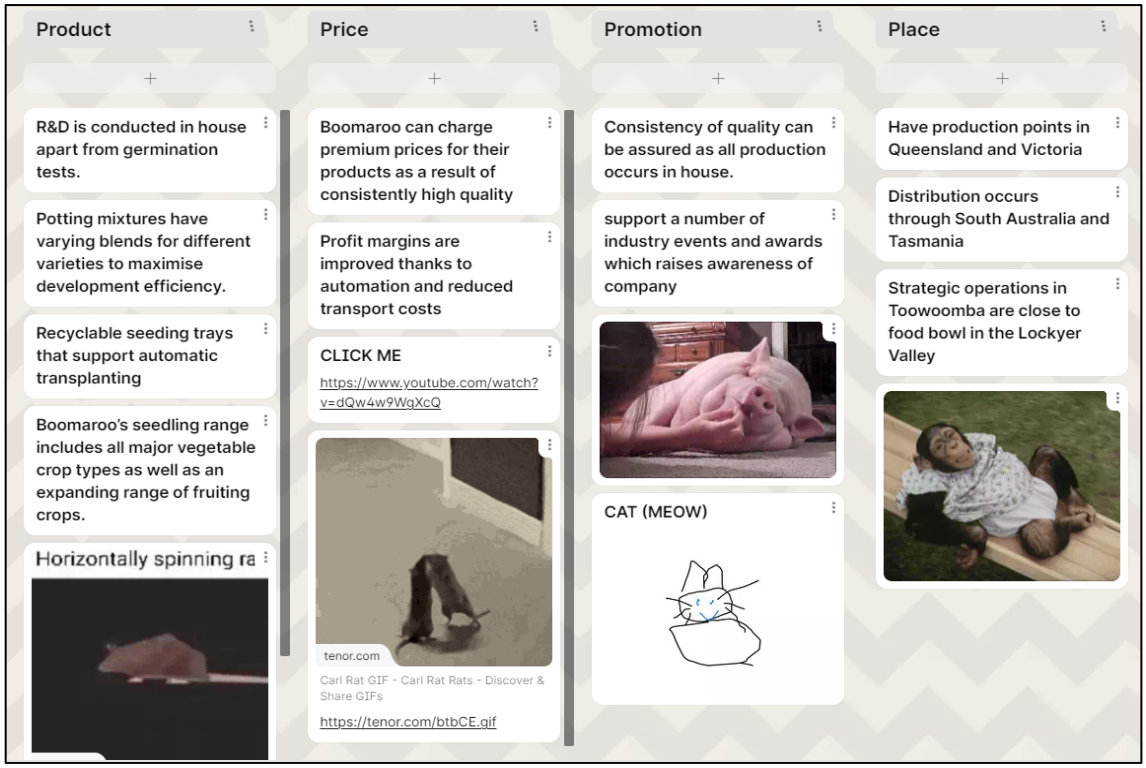


Figure 5-19 Screenshots of student Padlet from Stage 5

5.3.3.1.6 Stage 6

As we had removed the assessment component from Iteration 1, the stage was devoted to the data collection using the ELS which measured students' perception of the value of experiential learning activities and the ExLSS which captured students' perceptions of how well an experiential learning activity included each of the four phases of the ELC and their approaches to learning.

5.3.3.1.6.1 Analysis of the ELS

Table 5.15 summarises the mean values for the individual subscales from the ELS. Across all subscales, we see comparatively poorer ratings compared to Iteration 1. This was important as the scenario and task used in Iteration 2 were contextualised to the agribusiness discipline and the poorer

scores might be indicative that despite being designed for the discipline, the student experience was such that they did not see the authenticity, relevance, utility, and their active learning in the activity.

Scale	Number of Items	Mean	SD
Environment Authenticity	5	5.78	0.57
Active Learning	7	5.23	1.04
Relevance	9	5.41	0.78
Utility	7	5.22	0.79

Table 5.15 Means and SDs for ELS Subscales.

As shown in Table 5.16, there is a strong positive correlation between the relevance and active learning subscale, which was statistically significant ($r = 0.874$, $p < 0.001$), indicating that the more engaged they were with the learning material, the more relevant they found the activity. There is also a strong positive correlation between the *relevance* and *utility* subscale, which was statistically significant ($r = 0.803$, $p < 0.001$), indicating that the more students found the activity relevant, the higher the likelihood they can see it being useful in the future. Similarly, there is also a strong positive correlation between the *active learning* and *utility* subscale, which was statistically significant ($r = 0.661$, $p < 0.004$), indicating that the more engaged students were with the learning material, the higher the likelihood they can see it being useful in the future. Thus, we can see that the more engaged the students are with the learning material, there is higher the probability that they find the activity relevant and useful in the future.

There were poor positive correlations between the *environment authenticity* and *active learning* subscale ($r = 0.063$, $p = 0.809$), the *relevance* subscales ($r = 0.066$, $p = 0.801$) and *utility* subscales ($r = 0.095$, $p = 0.717$) all of which were not statistically significant. These correlations indicate that quantitatively, information was not presented in a way that students were able to deduce the intended outcome of the activity. Reviewing the scenario and

task design, I propose that they were rather generic, and the students need not have gone through the VFT application to complete the scenario successfully.

	Environment Authenticity	Active Learning	Relevance	Utility
Environment Authenticity	1	-	-	-
Active Learning	0.063	1	-	-
Relevance	0.066	0.874**	1	-
Utility	0.095	0.661**	0.803**	1

** Correlation is significant at the 0.01 level (2-tailed).

Table 5.16 ELS inter-scale correlations

5.3.3.1.6.2 Analysis of the ExLSS

Findings from the ExLSS as summarised in Table 5.17, showed that the AC phase had the highest mean score (M = 4.17, SD = 0.45) while the RO phase had the lowest (M = 3.94, SD = 0.56). Reviewing the associated items, the design of the task involved in stage 5 was appropriate in allowing them to correctly use interrelated course concepts and organise them into a meaningful format. Similarly, the items associated with the reflective observation focused on connecting personal experiences and prior knowledge with course content. As discussed above, the generality of the scenario and task used in Stage 2, may not have required students to rely on their past knowledge and hence their poorer response to the RO subscale.

Scale	# of Items	Mean	SD
Active Experimentation (AE)	3	4.11	0.44
Concrete Experience (CE)	3	4.02	0.35
Reflective Observation (RO)	3	3.94	0.56
Abstract Conceptualization (AC)	3	4.17	0.45
Deep Approach	9	7.13	1.15
Surface Approach	10	5.91	1.54

Table 5.17 Means and SDs for ExLSS Subscales

The measures for students' approaches to learning, give us an indication as to whether students could both understand the material and apply the information that was learned (*deep approach*) compared to students who focused on facts and ideas to memorize what they thought was important and what they would be required to reproduce at the end of the activity (*surface approach*). From Table 5.18, we can see that students rated their adoption of a deeper approach to learning (M = 7.13, SD = 1.15) higher than their surface approach (M = 5.91, SD = 1.54) which is preferred engaging them in experiential learning.

A successful experiential learning activity where students are actively engaged in all stages will positively correlate to a deep approach and negatively correlate to a surface approach to learning. As shown in Table 5.18, looking at the correlation of the individual stages with the *deep approach*, we see a strong positive correlation with all phases; *CE* ($r = 0.710$, $p < 0.001$), *RO* ($r = 0.732$, $p < 0.001$), *AE* ($r = 0.684$, $p = 0.002$) except the *AC*. It had a moderate positive correlation ($r = 0.467$, $p = 0.051$), though it was not significant. This was surprising as the AC stage had the highest mean score across the stages when evaluating them and involved the application of the course concepts to a scenario that lends itself seamlessly to a deep approach to learning.

Table 5.18 also shows that across the individual stages, we see a weak negative correlation of the surface approach to learning with all stages; CE ($r = -0.091$, $p = 0.721$), AC ($r = -0.068$, $p = 0.788$), AE ($r = -0.231$, $p = 0.355$) except

the RO stage which had a weak positive correlation (r = 0.098, p = 0.700), though it was not significant. The positive correlation alongside the comparatively poorer mean score for the stage could indicate that the RO stage should be tweaked to improve student engagement.

	Active Experimentation	Concrete Experience	Reflective Observation	Abstract Conceptualization	Deep Approach	Surface Approach
Active Experimentation	1					
Concrete Experience	0.741**	1				
Reflective Observation	0.708**	0.632**	1			
Abstract Conceptualization	0.628**	0.395	0.715**	1		
Deep Approach	0.684**	0.710**	0.732**	0.467	1	
Surface Approach	0.231	-0.091	0.098	-0.068		1

** Correlation is significant at the 0.01 level (2-tailed).

Table 5.18 ExLSS inter-scale correlations

5.3.3.2 Student Outcomes

Section 4.5.2 describes the intended student outcomes derived from the UQ graduate attributes and using the analysis described in that section, the attainment of intended student outcomes was determined using the quantitative and qualitative data collected at the various data collection points. Each of the following subsections represents the analysis and determination of the attainment of the respective student outcomes.

5.3.3.2.1 Student will display an understanding of social and civic responsibility

As described in section 4.5.2, to evaluate this student outcome, I looked to SLO 1 and SLO 4 from the ELSS and the reflection question, “After going through the activity, what are your thoughts about ways in which the agriculture industry needs to develop to best meet the needs of the community?”.

In the ELSS, an increase in the mean scores from the pre- to the post-activity response indicated that students had attained that SLO. SLO 1 and SLO 4 had large mean increases of 1.53 and 1.24, respectively. Table 5.19 summarises the mean scores from the pre-and post-survey results along with the *t*-test results comparing them. The paired *t*-test result for SLO 1 showed that there was a statistically significant improvement from the pre-(M = 23.29, SD = 2.29) to post-(M = 24.82, SD = 2.60) experience, $t = 3.425$, $p = 0.003$. The eta squared statistic (0.83) indicated a large effect size. The paired *t*-test result for SLO 4 showed that there was an improvement from the pre-(M = 16.35, SD = 2.60) to post-(M = 17.59, SD = 2.35) experience, $t = 1.822$, $p = 0.087$ though it was not statistically significant.

This finding was like that of Iteration 1, where the increase for SLO 1 was significant but not SLO 4. It was, however, interesting to note that SLO 4 saw a larger increase in Iteration 2 as compared to Iteration 1. In terms of the design, the key difference between the iterations was the scenarios. Perhaps the nature of the scenarios which were more open-ended and required students to pull from a range of ideas gave them more of an opportunity to develop the attributes associated with SLO 4.

	# of Items	Pre		Post		Mean Diff [Post-Pre]	t	df
		Mean	S.D.	Mean	S.D.			
SLO 1: Students will value the importance of engaged scholarship and lifelong learning.	4	23.29	2.29	24.82	2.60	1.53	3.425**	16
SLO 4: Students will engage in structured reflection as part of the inquiry process.	3	16.35	2.60	17.59	2.35	1.24	1.822	16

** $p < 0.01$

Table 5.19 Means, SDs, and *t*-test results for ELSS SLO 1 and SLO 4

When students were asked to reflect on ways in which the agriculture industry needs to develop to best meet the needs of the community, all but one student provided specific examples of areas where the industry needed to develop. The students that did not, drew reference to the videos and indicated that *"Videos did not make me think about that"*. In analysing their responses, two clear themes stood out: *involving technology* and *sustainability* (See Table 5.20 below).

Theme	Sample Quote
Involving Technology	*The agricultural industry needs to stay relevant with technology and innovation to look at the customers first.*
Sustainability	*The focus on sustainability and water conservation, as well as automation and quality management, is something that should be the goal across the industry.*

Table 5.20 Thematic analysis of ways in which the agriculture industry needs to develop to best meet the needs of the community

5.3.3.2.2 Student will display the ability to engage effectively and appropriately with information and communication technologies

To evaluate this student outcome, I looked at the quantitative aspect of the student reflection on the VFT Experience and the reflection questions, "How did you approach the learning activity and why?" and "What would you change about the virtual field trip experience to enhance it for future students?".

The responses for the "VFT interface and media" construct highlighted the high expectations that students had about the VFT application though they had reflected no prior experience with it. They deemed that the multimedia helped them engage with the VFT application (M = 4.29, SD = 0.47) and that the interface was user-friendly (M = 3.67, SD = 1.12) but appraised navigation (M = 3.76, SD = 1.09) of the application comparatively poorly just as the students in Iteration 1. Despite their belief that both VFTs and actual field trips can be useful in agricultural courses (M = 4.35, SD = 0.61), students were not as positive about experiencing a VFT as having no field trip experience (M =

3.76, SD = 1.15) and they were not as keen to see more VFTs in their courses (M = 3.76, SD = 0.83). This was different from the student responses in Iteration 1 and could be explained by the VFT application used. Much of the focus of the application was the operations conducted in Boomaroo Nurseries and less so on the business aspects of the organisation. For these agribusiness students, this might have resulted in them not seeing its potential across their courses.

Conversely, in the use of the "Learning with VFT" construct, we have a high subscale mean of 4.29. There were high mean scores for items related to the application of concepts in industry (M = 4.29, SD = 0.47) and how it allowed them to gain knowledge (M = 4.24, SD = 0.44). Additionally, the high mean score for how the VFT application added to the enjoyment of learning (M = 4.29, SD = 0.59) was pleasing from both an activity design perspective and highlights a comfort in engaging and using the application for their learning. It was thus surprising to note that they felt that they were able to accomplish the given task effectively (M = 4.35, SD = 0.49). The mean scores for the individual items and the overall subscales are summarised in Table 5.21 below.

Items [Scales in bold]	Mean	S.D.
VFT Interface and Media - 3 Items	**4.02**	**0.79**
The VFT application was easy to navigate.	3.76	1.09
The multimedia (e.g., videos and floor plans) helped me engage with the VFT application.	4.29	0.47
The interface of the VFT application was user-friendly.	4.00	1.12
Perception of VFT - 5 Items	**3.81**	**0.51**
I would rather visit an actual field site than experience a VFT.	4.53	0.87
I would rather experience a VFT than have no field trip experience.	3.76	1.15
VFTs can replace actual field trips.	2.65	1.32
I would like to see the use of more VFTs in my courses.	3.76	0.83
I think both VFTs and actual field trips can be useful in agricultural courses.	4.35	0.61
Learning with VFT - 6 Items	**4.29**	**0.42**
The VFT application enabled me to accomplish the task effectively.	4.35	0.49

Items [Scales in bold]	Mean	S.D.
The VFT application complemented the course material.	4.24	0.44
The VFT allowed me to see course concepts being used in the industry.	4.29	0.47
The VFT application provided an appropriate learning opportunity.	4.29	0.47
The VFT application added to the enjoyment of learning.	4.29	0.59
The VFT application allowed me to gain knowledge that I previously did not have.	4.24	0.56

Table 5.21 Means and SDs for VFT experience subscales

Reviewing what students reflected on, *"What would you change about the VFT experience to enhance it for future students?",* unlike Iteration 1, responses here were varied with 5 of the responses giving suggestions about the overall activity delivery rather than focusing on the application itself as summarised in Table 5.22.

Theme	**Sample Quote**
Improvement in overall activity	*Before a discussion, it would be great to have 5 or 10 minutes warm up, to let group mates know each other.*
Improvement to the VFT application	*Made it step by step/ more direction on which station to visit first.*
Improvement to content provided	*More interviews with workers based on how they conduct their jobs.*

Table 5.22 Thematic analysis of student responses to "what would you change about the VFT experience to enhance it for future students?".

The way they approached the learning activity gave us insight into how they engaged with the application. The guiding questions focused the students' responses on the path they had taken through the activity and why. There were two themes identified with some indicating that they followed a free-flowing path, and others describing a path guided by specifics as summarised in Table 5.23.

Theme	Sample Quote
Followed a free-flowing path	*I followed a free-flowing path which was what I thought was the easiest way to approach it.*
Followed a path guided by specifics	*visit the company web and follow the list on the web, also see Google map for their location*

Table 5.23 Thematic analysis of benefits of using VFTs

5.3.3.2.3 Student will display the ability to interact effectively with others to work towards a common outcome

To evaluate this student outcome, I looked to SLO 3 from the ELSS and the reflection question, “How did your relationship with your group mates influence your experience?”.

In the ELSS, an increase in the mean scores from the pre- to the post-activity response indicated that students had attained that SLO. SLO 3 had a small mean increase of 0.12. Table 5.24 summarises the mean scores from the pre-and post-survey results along with the *t*-test results comparing them. The paired *t*-test result for SLO 3 showed that there was an improvement from the pre-(M = 17.76, SD = 2.19) to post-(M = 17.88, SD = 2.03) experience, $t = 0.344$, $p = 0.735$ though it was not statistically significant.

	# of Items	Pre		Post		Mean Diff [Post-Pre]	t	df
		Mean	S.D.	Mean	S.D.			
SLO 3: Students will work collaboratively with others.	3	17.76	2.19	17.88	2.03	0.12	0.344	16

Table 5.24 Means, SDs, and *t*-test results for ELSS SLO 3

When students were asked to reflect on how the relationship with their group mates influenced their experience, 8 of the 12 responses highlighted that they engaged in the activity as a group and highlighted the benefits of group activity such as, “We *all completed the activity at the same time which made it*

enjoyable. I wasn't worried about missing information in some areas of the experience as my group mates had the same information as well" and "*It was more engaging with group mates. It allowed us to bounce ideas and interact more with the activity."* The increased engagement in groups could be due to the specific instruction given that it was an option and the lack of resources as noted in my reflection notes and highlighted in section 5.3.3.1.3.

5.3.3.2.4 Student will display the ability to identify problems, create solutions, innovate, and improve current practices

To evaluate this student outcome, I looked to SLO 2 from the ELSS and the reflection questions, "What benefits do you think there are from using VFTs in place of actual field trips?" and "Has the virtual field trip experience helped you become more interested in this field and if so, why?".

In the ELSS, an increase in the mean scores from the pre- to the post-activity response indicated that students had attained that SLO. SLO 2 had a mean increase of 2.29. Table 5.25 summarises the mean scores from the pre- and post-survey results along with the *t*-test results comparing them. The paired *t*-test result for SLO 2 showed that there was a significant improvement from the pre-(M = 32.24, SD = 3.99) to post-(M = 34.53, SD = 4.65) experience, t = 2.889, p = 0.011. The eta squared statistic (0.71) indicated a medium effect size. Compared to Iteration 1, this finding could point to the design of the scenario where students must analyse information and make judgements.

	# of Items	Pre		Post		Mean Diff [Post-Pre]	t	df
		Mean	S.D.	Mean	S.D.			
SLO 2: Students will apply knowledge, values, and skills in solving real-world problems.	6	32.24	3.99	34.53	4.65	2.29	2.889*	16

* $p < 0.05$

Table 5.25 Means, SDs, and *t*-test results for ELSS SLO 2

When students were asked to reflect on the benefits of using VFTs in place of actual field trips most students were able to link its benefits to themes of time efficiency and convenience as summarised in Table 5.26.

Theme	Sample Quote
Time Efficiency	*Virtual field trips allow for more discussion and analysis time as time is not wasted travelling.*
Convenience	*Suitable for students with extracurricular or work commitments.*

Table 5.26 Thematic analysis of benefits of using VFTs

When students were asked to reflect on whether the VFT experience helped them become more interested in the field and why, 6 of the 13 students responded with a “No”. From those who elaborated, the main reason for this is that the horticulture industry featured in the VFT is not their industry of interest. From those that responded with a “yes”, their reasoning centred on exposure to the advanced technology highlighted in the VFT.

5.3.4 Lessons Learnt from Iteration 2

Building on the lessons learnt from Iteration 1, the lessons learnt from this iteration informed the tweaks to be made to the innovation to be implemented Iteration 3. I categorised them into two categories; (1) lessons learnt relating to the activity design and (2) lessons learnt relating to student outcomes. Figure 5.20 summarises the findings and the changes to be made to the innovation for Iteration 2.

5.3.4.1 Lessons Learnt Relating to Activity Design

In the conduct of the activity, the flow of stages was good, and with the amended durations, once again students were able to transition from one stage to another smoothly. The added time given to the discussion activities was

beneficial considering the student solutions and related tutor comments. Thus, I suggest the retention of both the sequence and amended durations for the activity stages.

I had proposed the use of Padlet as an online tool to capture student discussion points, but this had mixed results due to technical difficulties which hindered its use during the activity. However, its potential in supporting the students during their activity can be inferred from the Figure 5.19 and as such, I proposed for its more extensive use in Iteration 3.

From an evaluation perspective, I introduced the ExLSS to improve evaluation rigour and help us better understand the impact of the ELC stages on student learning. With its use, we were able to break down students' perceptions of how well an experiential learning activity included each of the four phases of the ELC and its influence on student deep and surface approaches to learning. This data provided valuable information and corroborated conclusions drawn from the other instruments. As such, I maintain that it be also used in Iteration 3 to help evaluate the innovation.

5.3.4.2 Lessons Learnt Relating to Student Outcomes

Across section 5.3.3.1, we saw that the task design in Stages 2 and 4 was not effective in that students were able to give generic responses to them and it did not allow them to build on it when attempting the scenario in Stage 5. Additionally, in section 5.3.3.2, we see that the scenario in Stage 5 was generic leading to impacts on student outcomes. I recommend that in Iteration 3, the scenario should be redesigned in a manner that allows students to draw direct reference to the VFT as well as the task in Stages 2 and 4.

Learning from Iteration 1, we explicitly mentioned that working through the VFT in Stage 3 could be done as a group. Employing this is in Iteration 2 was successful and be continued for Iteration 3.

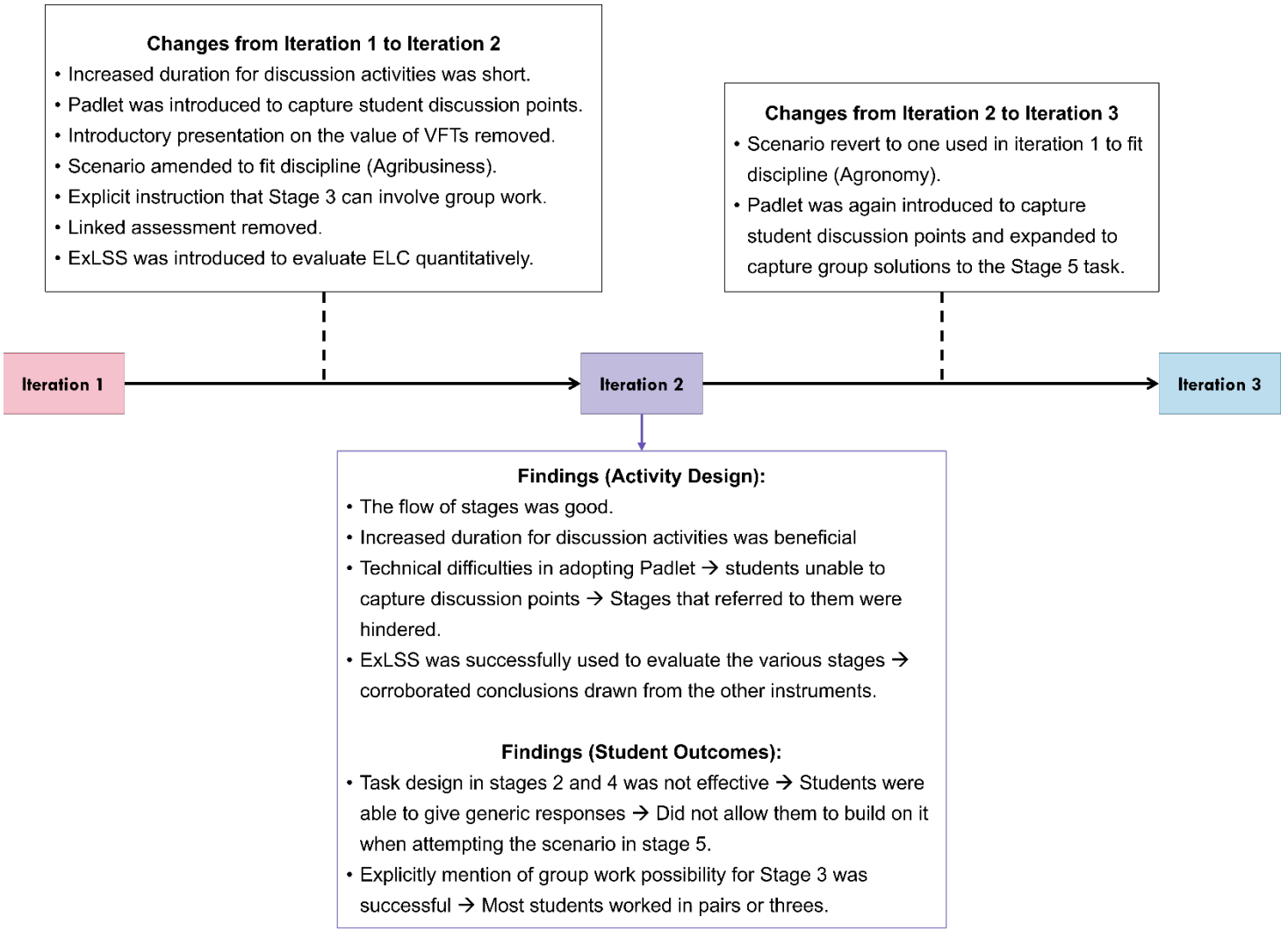


Figure 5-20 Summary of Findings from Iteration 2 and changes to be made for Iteration 3

5.4 Iteration 3: Plant Production Principles & Technologies (AGRC1024)

5.4.1 Introduction

As described in section 4.3.3, Iteration 3 was conducted on Plant Production Principles & Technologies (AGRC1024), a first-year undergraduate agronomy course with an enrolment of 53 students in 2022. As discussed in previous iterations, the planned overall course delivery made it necessary for the study to be conducted towards the end of the semester thus making it ideal for Iteration 3. With an application to a different agricultural discipline, Iteration 3 would also allow me to further refine our lessons learnt, especially looking at the connection between the scenario used and the student's perception of its usefulness in the activity and the overall course content. Furthermore, drawing inspiration from the utilization focus principle, extending the tested activity design to a first-year course (compared to iterations 1 and 2 which were second years) would provide valuable insights in making guidance for course coordinators who intend to use VFTs in their courses.

Iteration 3 was conducted in a computer annex where each student had physical access to a computer as shown in Figure 5.21. Unlike the previous iterations where the physical space allowed for seamless group discussions coupled with an enrolment of 53 students, I was apprehensive as to whether the location would pose a hindrance. This however proved to be unfounded as the sections below indicate. This could have been due to the students' familiarity with working collaboratively at the venue – something they have been doing throughout the preceding eleven weeks. This was further aided during the conduct of the iteration by the fact that only a fraction of the class attended the session in person. Another difference with the previous iterations was that the availability of computers for students to use for the collaborative activities. This was particularly useful for Iteration 3 as they were explicitly given instructions to do so for stage 3 unlike the previous iterations.

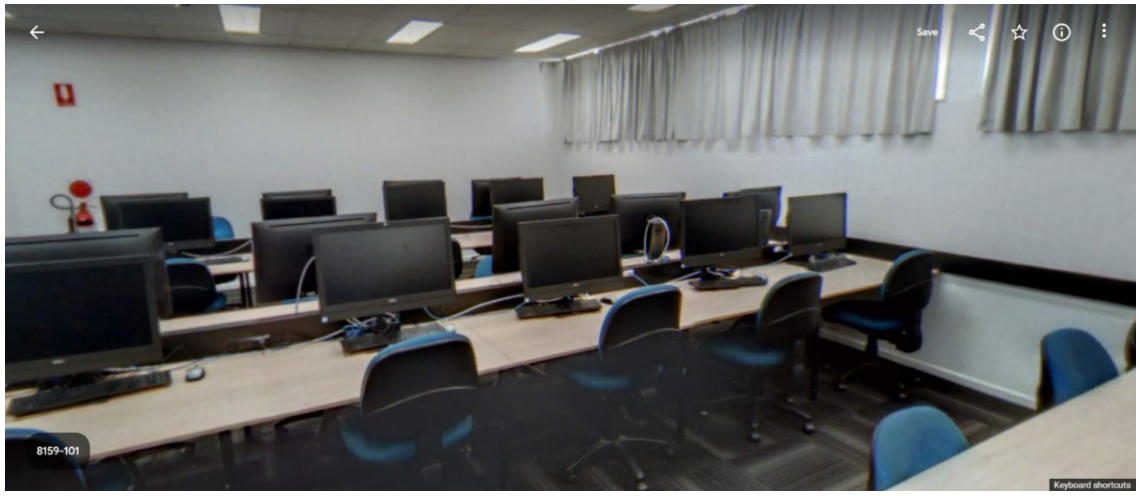


Figure 5-21 Computer annex where Iteration 3 was conducted.

5.4.2 Activity Design

The overall activity design for Iteration 3 followed the same framework employed for previous iterations incorporating the three phases – the pre-activity phase, the post-activity phase, and the activity itself. As the sequence of stages was found to be suitable in both iterations, it was retained for Iteration 3. The duration allotted for individual stages was found to be suitable in Iteration 2 and thus retained for Iteration 3. Due to the technical issues that arose in Iteration 2, the use of Padlet was limited though its success in stage 5 was positive and thus, the use of Padlet to capture the discussion points for the tasks was retained for Iteration 3. The one aspect that had to be reviewed and revised was the scenario used for Iteration 3.

5.4.2.1 Pre-Activity Phase

In the pre-activity discussions, it was noted that of the 53 students enrolled, 37 of them were enrolled in the internal mode of study. The coordinator informed me that the activity had been marketed to the students as an extension to the course content where they would see the concepts being applied in the horticulture field. Additionally, as it was close to the end of the

semester and the materials covered in the activity were not being assessed in the examination, he cautioned that attendance at the session might be poor. Figure 5.22 summarises the key discussion points from the pre-activity discussion with the course coordinator.

The scenario used in Iteration 2 was designed by the course coordinator to reflect the concepts covered in the course. Similarly, the coordinator for AGRC1024 reviewed the scenario used in both iterations and requested that we use the same scenario and task from Iteration 1 as it matched his intention for the activity and would allow students to apply some of the concepts covered in the course. Figure 5.23 and Table 5.27 below provide an overview of the various stages and activities involved highlighting any changes from Iteration 2.

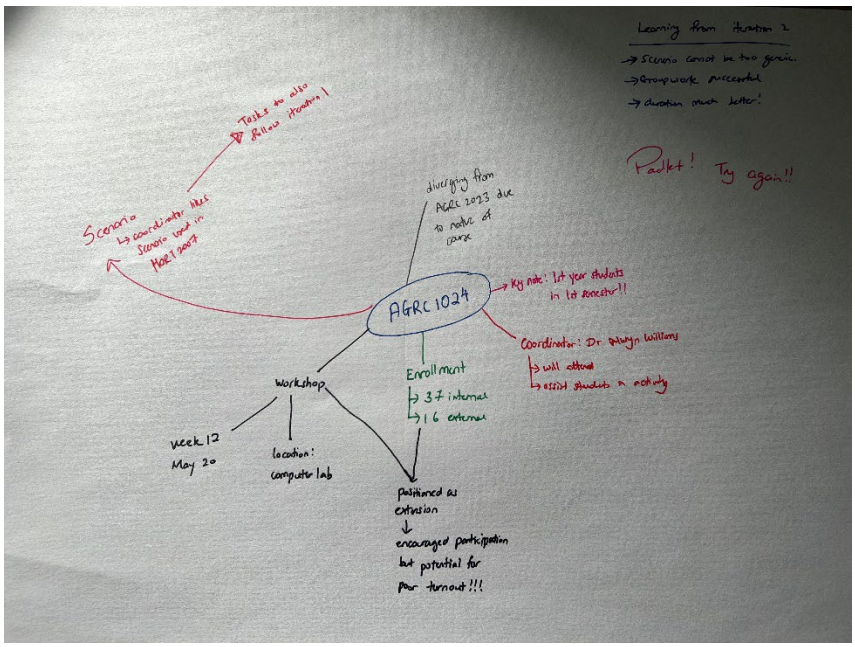
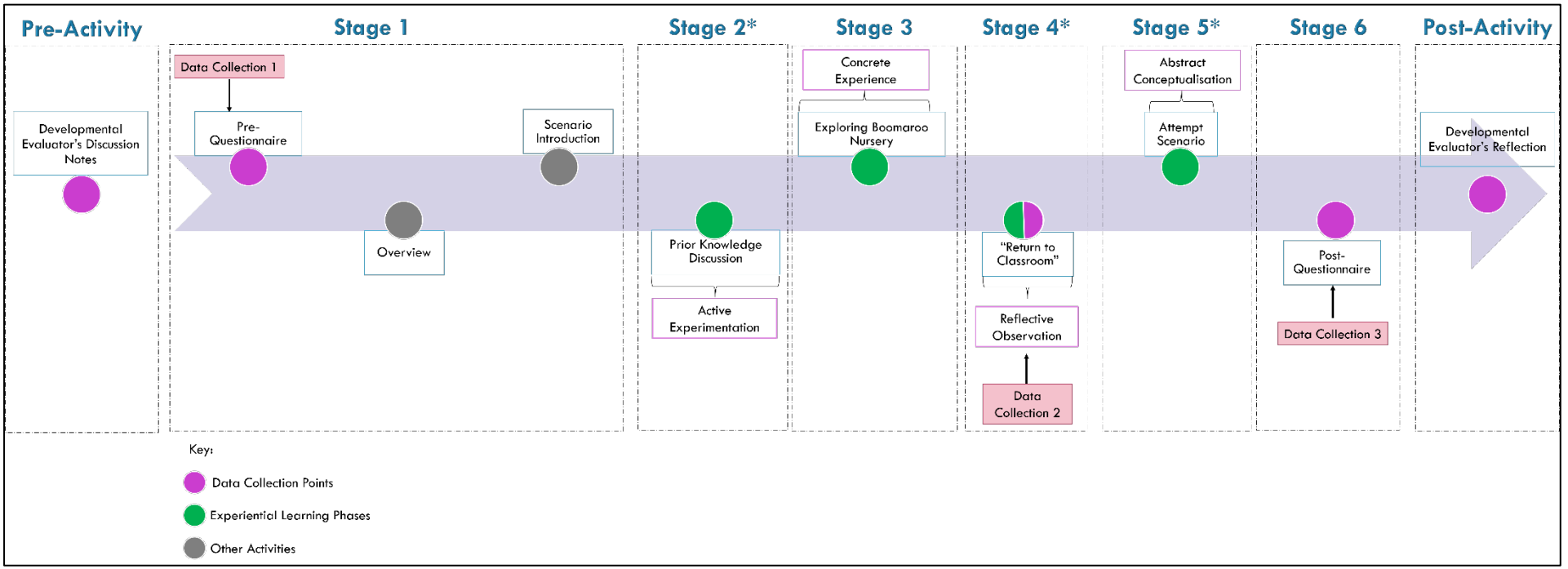


Figure 5-22 Pre-activity discussion notes for Iteration 3



Stages with * indicate activity changes from Iteration 3 based on lessons learnt from Iteration 2

Figure 5-23 Overview of the stages for Iteration 3 along with the data collection points

Stage	Name	Student Activity	Tools Used	Group/Individual Activity	Duration (min)	Changes from Iteration 2
1	Opening	• Respond to pre-questionnaire • Listen to briefing	Online Form	Individual	5	The scenario reverted to the one used in Iteration 1[#]
2	Prior Knowledge Discussion	• Explore scenario using prior knowledge • Share with groupmates	Padlet	Individual / Group	20	The scenario reverted to the one used in Iteration 1[#]
3	Exploring Boomaroo Nursery	• Explore the VFT location	VFT Application	Individual / Group	30	-
4	"Return to Classroom"	• Review prior knowledge • Share with groupmates	Online Form Padlet	Group	15	The scenario reverted to the one used in Iteration 1[#]
5	Attempt Scenario	• Attempt scenario • Share with class	Padlet	Group	30	The scenario reverted to the one used in Iteration 1[#]
6	Closing	• Respond to post-questionnaire • Listen to briefing	Online Form	Individual	10	-

[#] Changes made due to course context

Table 5.27 Summary of stages in Iteration 3 and changes from Iteration 2

5.4.2.2 Stage 1 - Opening

Stage 1 was delivered similarly to the stage in Iteration 2 including the duration and the information provided to the students. One change from Iteration 2 was the reversion of the scenario used to the one used in Iteration 1 as shown in Figure 5.24. As discussed above, this was deemed suitable by the course coordinator and additionally provided a means of comparing the impact of the scenario on student outcomes.

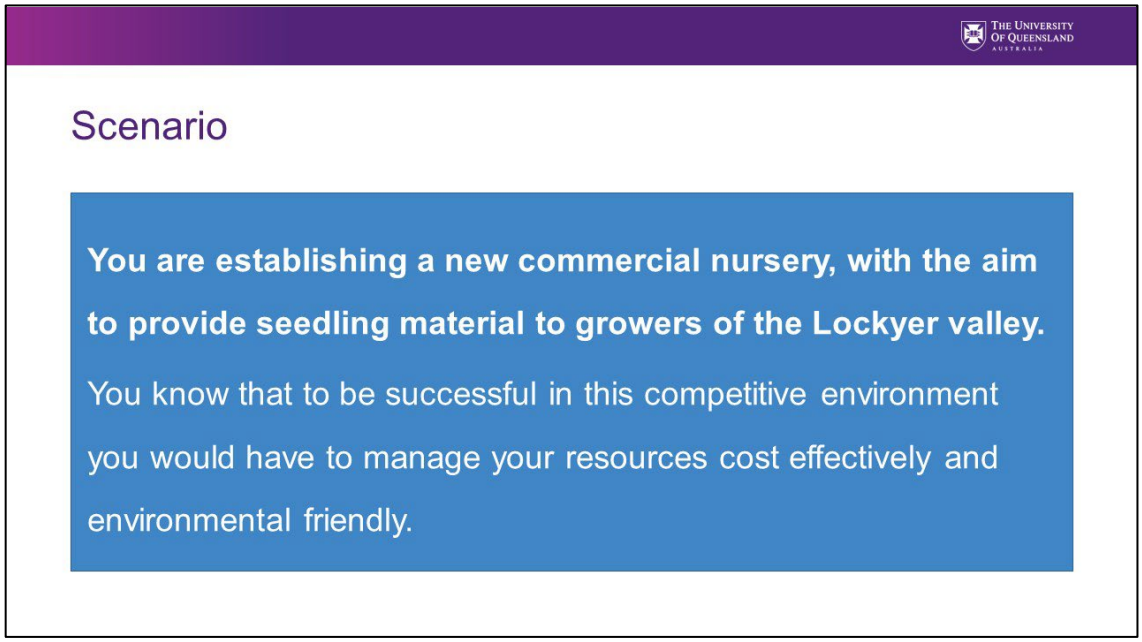


Figure 5-24 Scenario for Iteration 3

5.4.2.3 Stage 2 - Prior Knowledge Discussion

The design of Stage 2 was like Iteration 2 where students were asked to attempt a task using their prior knowledge. The duration for the activity mirrored that of Iteration 2 and once again they were instructed to capture their discussion points in a group Padlet. The task used however was revised to the one used in Iteration 1 as shown below in Figure 5.25.

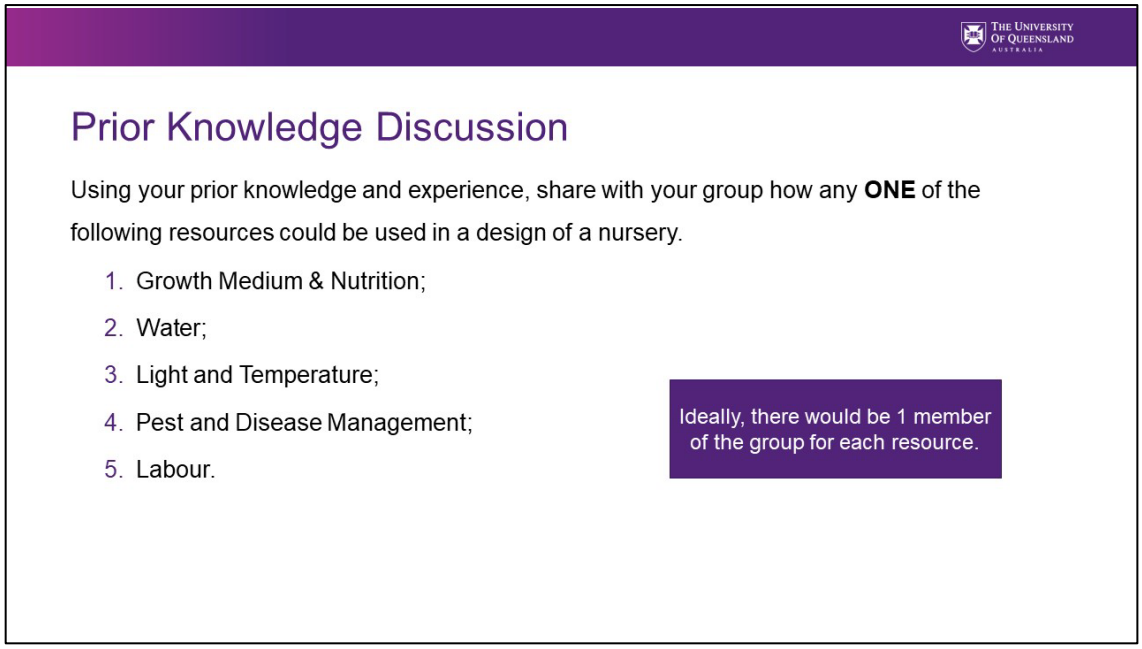


Figure 5-25 Activity instructions for Stage 2

5.4.2.4 Stage 3 - Exploring Boomaroo Nursery

Across all iterations, Stage 3 was largely conducted similarly and in Iteration 3, it was conducted exactly as in Iteration 2 including specific instructions given to students that they could choose to embark on the activity in their groups.

5.4.2.5 Stage 4 - "Return to Classroom"

In Stage 4, students were asked to review their responses provided for the task in Stage 2. This activity was conducted just as in Iteration 2 and students were asked to capture their thoughts on the group Padlet.

5.4.2.6 Stage 5 - Attempt Scenario

Stage 5 was delivered using the revised scenario shown in Figure 5.26. The delivery and the use of Padlet here were as Iteration 2.

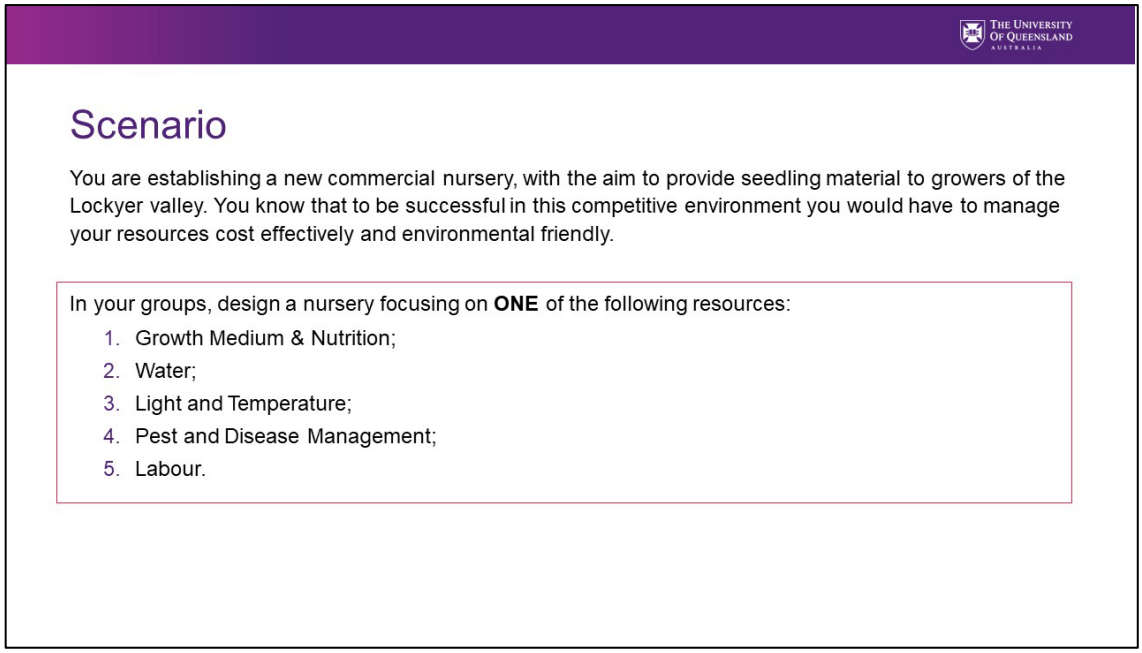


Figure 5-26 Activity instructions for Stage 5

5.4.2.7 Stage 6 - Closure

With the lesson learnt from Iteration 2, stage 6 was delivered exactly as how it was done in Iteration 2.

5.4.2.8 Post-Activity Phase

In the post-activity reflection, I noted my observations about aspects of the activity that went well such as the flow of activities and the student engagement observed during the group activities and importantly the use of Padlet to capture their discussion points. Conversely, the lack of data capture during those discussions and the short duration afforded to them had to be improved. Figure 5.27 captures my reflection notes at the end of Iteration 1. Specific reflections are highlighted across the appropriate evaluation sections in section 5.2.3 and support the findings from the other measures in allowing me to make conclusions and draw out lessons learnt.

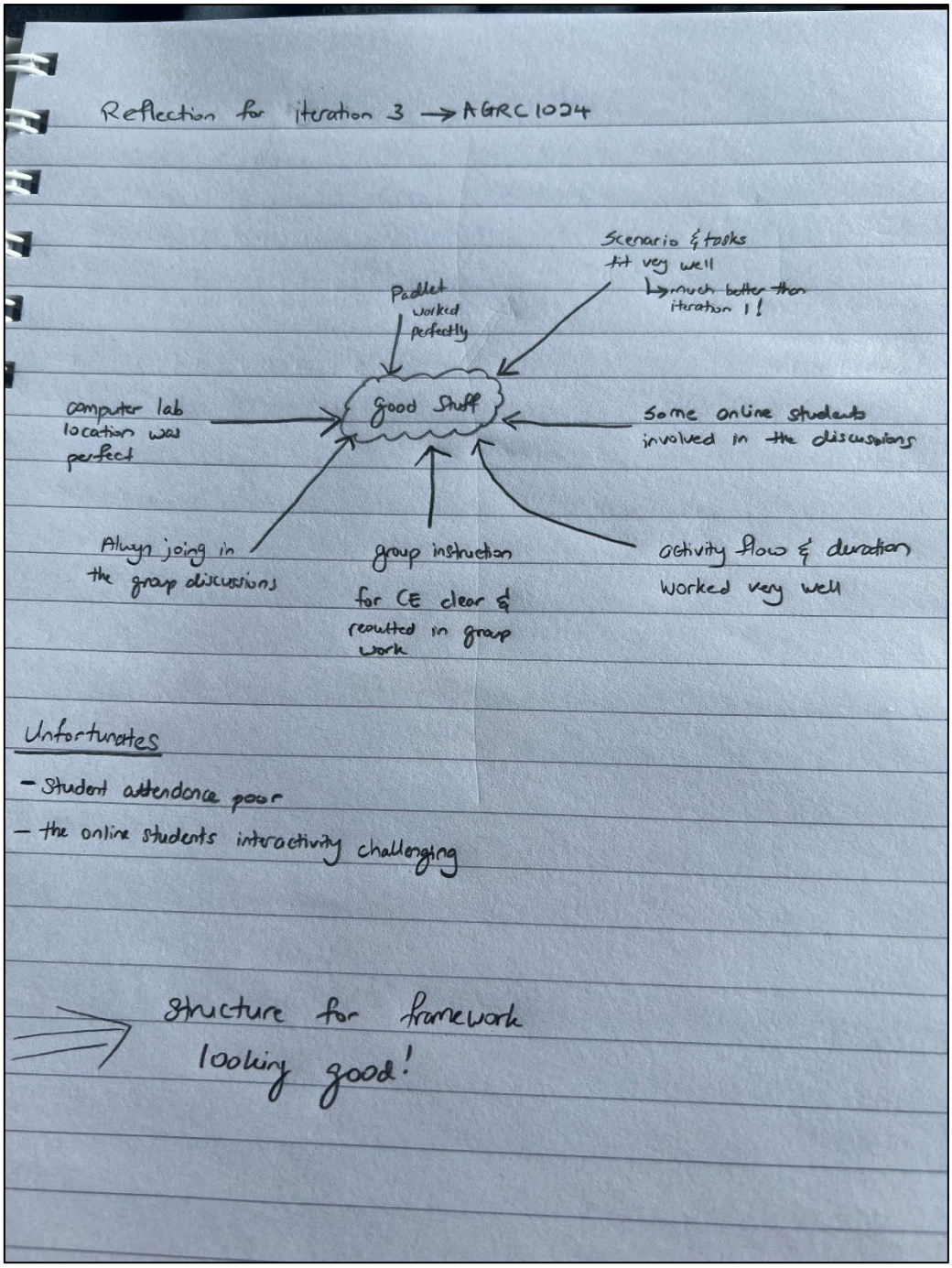


Figure 5-27 Reflection notes for Iteration 3

5.4.3 Evaluation

The same evaluation strategy adopted for Iteration 1 and Iteration 2 was once again adopted allowing me to categorise the data collected into two categories: the activity design and student outcomes and evaluate them accordingly.

5.4.3.1 Activity Design

Adopting a similar approach to the previous iterations, the analysis was done in 2 stages. As predicted by the course coordinator, a small number of students attended the session though all attendees including students who participated in the online mode responded to the questionnaires. Unfortunately, some of the students joining the activity via the online mode joined in midway and left before all activities were completed. Hence, the pre-and post-questionnaires had fewer respondents compared to the reflective exercises.

5.4.3.1.1 Stage 1

In Stage 1, student demographics was collated along with their prior experience with VFTs. Unlike the previous iterations, there were a large majority of female students 77.8% (*n* = 7). The impact of the unbalanced gender distribution was not conclusive as the small number of male students 22.2% (*n* = 2) was not sufficient for a comparative analysis to be performed. 44.4% of the students hailed from the Bachelor of Agricultural Science programme majoring in agronomy. Another 33.3% were embarking on the dual offering with agribusiness and the last two (22.2%) were majoring in horticulture and the bachelor of sustainable agriculture programme.

As illustrated in Figure 5.28 below, a large majority (88.9%, n = 8) indicated that they *"have not used virtual field trips before this activity but am aware of what it is all about"* with another 11.1% (n = 1) responding that they

"have not used virtual field trips before the activity and had no idea what it is all about". Reviewing their responses about what they think VFTs are all about, there is a clear theme most connected VFTs to being able to experience a field trip without being there. This distribution was surprising as the cohort of students had much of their high school experience shifting online due to COVID-19 and I had incorrectly assumed that they would have some VFT experience before enrolling in the course.

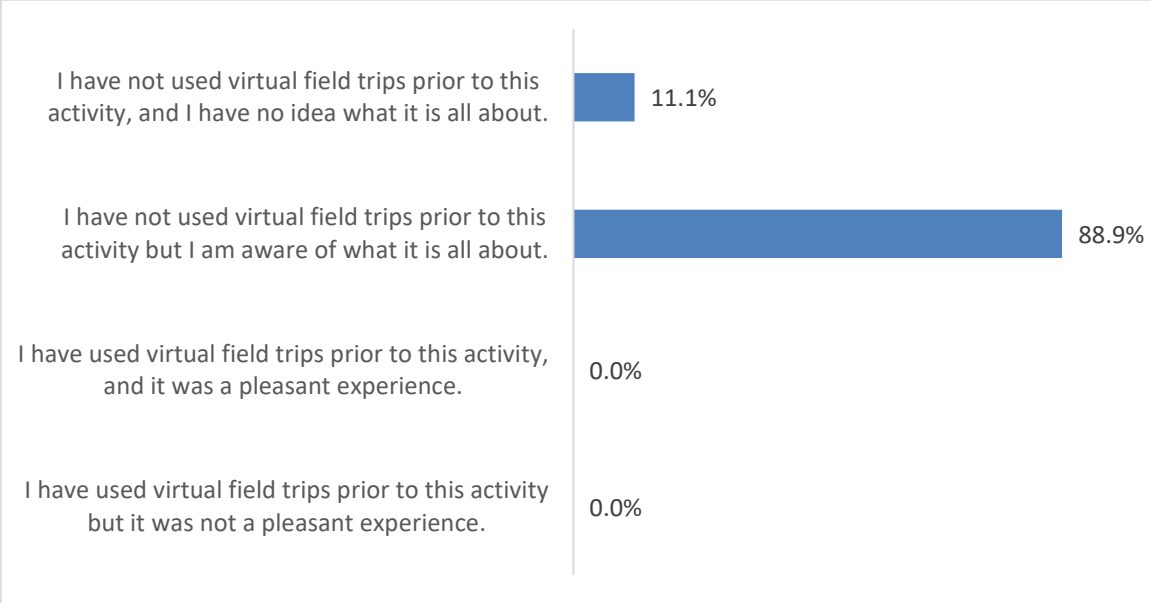


Figure 5-28 Summary of student prior experience with VFTs

5.4.3.1.2 Stage 2

In Stage 2, students had to use their prior knowledge to attempt the task shown in Figure 5.19 and share this with their groups. They were asked to capture their points in a group Padlet created for the activity. Figure 5.29 shows a screenshot of the points captured by the groups in the activity. The level of detail captured is indicative of the elevated level of engagement that students had during the activity.

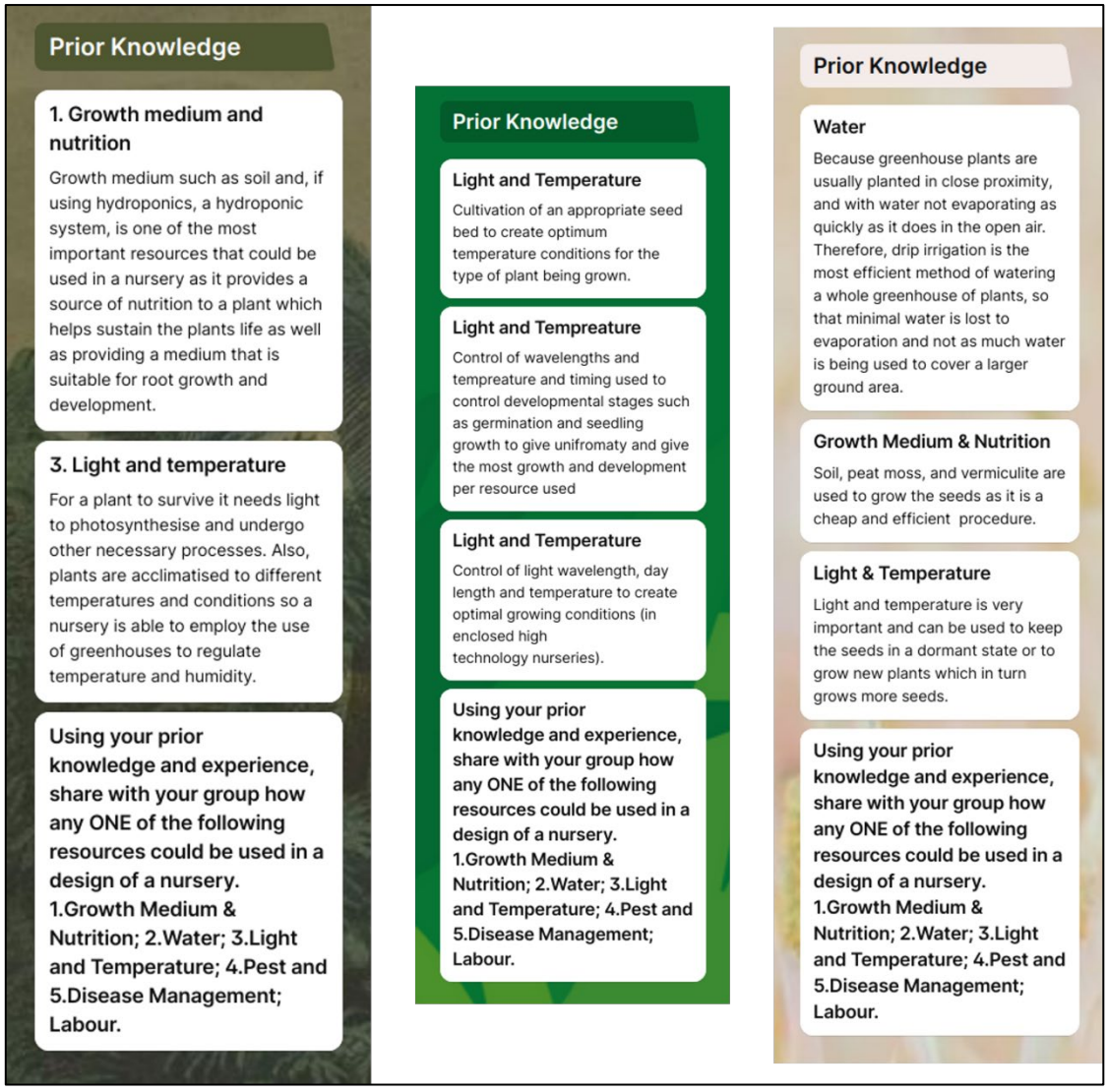


Figure 5-29 Screenshot of group Padlet showing discussion points from Stage 2

5.4.3.1.3 Stage 3

In Stage 3, students engaged in a self-exploratory journey with the VFT application. As the activity was conducted in a computer lab, the students looked at the group at central computers and worked through the videos together.

"I noticed a few groups taking opportunities to discuss things they saw in the videos and also tended to ask each other for preferences before embarking on a path."

-reflection notes, Iteration 3, 21/05/2022

5.4.3.1.4 Stage 4

Stage 4 involved students' reflecting both individually and in their groups. As in the previous iterations, responses to the reflection question, *"What were you thinking and feeling during the learning activity?*" were analysed to understand the influence of the VFT application on the student experience which is valuable to the activity design. 9 of the 12 respondents indicated positive experience, with the word "interesting" appearing in 7 of those responses referring to Boomaroo and their application of technology. The other students reflected a negative experience connecting the limited interaction and video buffering to be the reason for that. One noteworthy response was, "*I've never been to an actual nursery so it's nice to see what it's like. I don't like online learning and virtual experiences much however and I dread the thought of real field trips being replaced by virtual ones"* giving potential insight into student perception of how their views might be taken.

On a positive note, the students were engaged in the discussion activity where they reflected on their prior knowledge. As seen in Figure 5.30, the various groups were able to add much detail to their previous discussion reflecting information that they have garnered through the activity.

Figure 5-30 Screenshot of student Padlet from Stage 4

5.4.3.1.5 Stage 5

Stage 5 allowed students to apply their knowledge towards the scenario in Figure 5.26. Students collaborated on the scenario and proposed a nursery design focusing on a resource selected from a list provided and captured their designs in group Padlet as shown in Figure 5.31. The groups presented their ideas to the class and had open discussions with others about their design. Though the screenshot provides images from just two of the groups, it illustrates how their thoughts flowed from the activities in Stages 2 and 4 into this stage.


Prior Knowledge
1. Growth medium and nutrition
Growth medium such as soil and, if using hydroponics, a hydroponic system, is one of the most important resources that could be used in a nursery as it provides a source of nutrition to a plant which helps sustain the plants life as well as providing a medium that is suitable for root growth and development.
3. Light and temperature
For a plant to survive it needs light to photosynthesise and undergo other necessary processes. Also, plants are acclimatised to different temperatures and conditions so a nursery is able to employ the use of greenhouses to regulate temperature and humidity.
Using your prior knowledge and experience, share with your group how any ONE of the following resources could be used in a design of a nursery. 1.Growth Medium & Nutrition; 2.Water; 3.Light and Temperature; 4.Pest and 5.Disease Management; Labour.
After Boomaroo
1. growth medium and nutrition
Trimming the seedlings once a week keeps the nutrition in the plant allowing it to keep growing and remain healthy without fertiliser
1. Growth medium and nutrition
Boomaroo used soil as the growth medium for there seedlings, that is formulated by them by using peat and other beneficial resources that supply the plant with the correct specifications of nutrients that they are looking for, for optimal growth of their seedlings.
3. Light and temperature
Boomaroo has a greenhouse system for their seedlings, which was expected, however once the seedlings have established they are moved to an outside area to undergo a 'harding process' which allows the seedlings to adapt to the typical conditions that they will face when they are planted into a production system.
How has the virtual field trip to Boomaroo changed your thoughts about how your chosen resources could be used in a design of a nursery?
Design your Nursery
3. Light and temperature
In our nursery, the greenhouse system used would allow the plants to grow in an environment that utilises the outside climate, light and temperature, which allows it to save on energy, making it more environmentally friendly and reduces production costs for the producer and in turn lowering the price of seedlings for the farmer to purchase. Then, when required, when conditions are not ideal, the greenhouse can be closed to create a controlled climate that is ideal for the seedlings to grow in. Harnessing the natural processes of climate, light and temperature is capitalised on to be more environmentally friendly.
You are establishing a new commercial nursery, with the aim to provide seedling material to growers of the Lockyer valley. You know that to be successful in this competitive environment you would have to manage your resources cost effectively and environmental friendly. In your groups, design a nursery focusing on ONE of the resources.

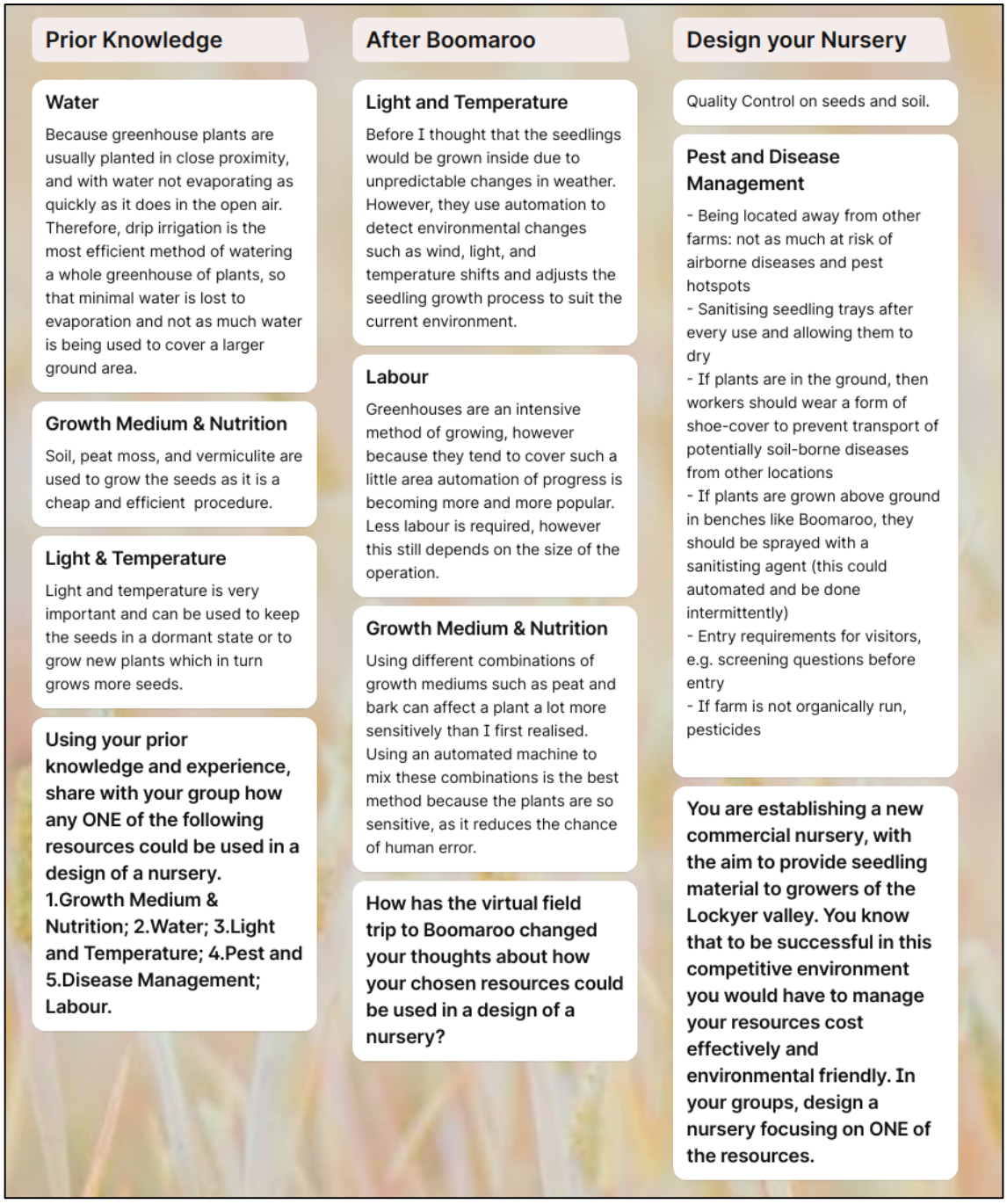


Figure 5-31 Screenshot of student Padlet from Stage 5

5.4.3.1.6 Stage 6

This stage was again devoted to the data collection process and the analysis was performed as done in Iteration 2.

5.4.3.1.6.1 Analysis of the ELS

Table 5.28 summarises the mean values for the individual subscales from the ELS which showed ratings comparable to that of Iteration 1. The revised scenario had a positive impact with three of the four subscales scoring higher than Iteration 2, with two of them (*active learning* and *utility*) scoring higher than both Iteration 1 and 2.

Scale	Number of Items	Mean	SD
Environment Authenticity	5	5.44	1.02
Active Learning	7	5.53	1.08
Relevance	9	5.98	0.81
Utility	7	5.56	0.80

Table 5.28 Means and SDs for ELS subscales.

Table 5.29 illustrates the strong positive correlations between all the various subscales indicating that the activity was effectively designed for experiential learning. The strongest correlation was between the *relevance* and *utility* subscale ($r = 0.971$, $p < 0.001$) which was statistically significant. The *relevance* subscale was also strongly correlated with the *active learning* ($r = 0.795$, $p = 0.006$) subscale which also strongly correlated to the utility subscale ($r = 0.757$, $p = 0.011$). The *environment authenticity* subscale was also strongly correlated to the *active learning* ($r = 0.772$, $p = 0.009$), *relevance* ($r = 0.751$, $p = 0.012$) and *utility* subscales ($r = 0.639$, $p = 0.047$).

As the scenario used in Iteration 3 was the only change made from Iteration 2, these finding highlights the importance of the scenario in the activity design. The course content covered concepts in the agronomy discipline while the VFT application featured a business that is centred on horticultural aspects. The scenario here required students to employ both agronomy and horticultural knowledge and connect them to address the task. This meant they could see the implication of what they are learning on another agricultural discipline and its impact in real-world situations.

	Environment Authenticity	Active Learning	Relevance	Utility
Environment Authenticity	1	0.772**	0.751*	0.639*
Active Learning	-	1	0.795**	0.757*
Relevance	-	-	1	0.971**
Utility	-	-	-	1

** Correlation is significant at the 0.01 level

* Correlation is significant at the 0.05 level

Table 5.29 ELS inter-scale correlations

5.4.3.1.6.2 Analysis of the ExLSS

The finding from the ELS above was backed up by findings from the ExLSS as summarised in Table 5.30, showing all four stages of the ELC having high mean scores with the RO phase having the highest mean score (M = 4.23, SD = 0.67). This was positive as a reflection that all four stages were well received by the students and indicative of them being well designed.

Scale	Number of Items	Mean	SD
Active Experimentation (AE)	3	4.10	0.69
Concrete Experience (CE)	3	4.10	0.72
Reflective Observation (RO)	3	4.23	0.67
Abstract Conceptualization (AC)	3	4.17	0.84
Deep Approach	9	7.98	1.50
Surface Approach	10	4.26	1.20

Table 5.30 Means and SDs for ExLSS subscales.

The measures for students' approaches to learning, give us an indication as to whether students could both understand the material and apply the information that was learned (*deep approach*) compared to students who focused on facts and ideas to memorize what they thought was important and what they would be required to reproduce at the end of the activity (*surface approach*). From Table 5.30, we can see that students rated their adoption of a deeper approach to learning (M = 7.98, SD = 1.50) higher than their surface approach (M = 4.26, SD = 1.20) which is preferred in experiential learning. Compared to Iteration 2, this showed how the activity design better supported them in adopting a deeper approach to learning.

A successful experiential learning activity, where students are actively engaged in all stages, will positively correlate to a *deep approach* to learning, and negatively correlate to a *surface approach* to learning. As summarised in Table 5.31, we see a strong significant positive correlation between the *deep approach* to learning subscale with all ELC phases; CE ($r = 0.905$, $p < 0.001$), RO ($r = 0.892$, $p < 0.001$), AC ($r = 0.924$, $p < 0.001$) and AE ($r = 0.908$, $p < 0.001$) with the *deep approach* to learning. We also see a strong significant negative correlation for the *surface approach* to learning with all ELC phases; CE ($r = -0.753$, $p = 0.012$), RO ($r = -0.685$, $p = 0.029$), AC ($r = -0.802$, $p = 0.005$) and AE ($r = -0.674$, $p = 0.033$) with the *surface approach* to learning.

	Active Experimentation	Concrete Experience	Reflective Observation	Abstract Conceptualization	Deep Approach	Surface Approach
Active Experimentation	1					
Concrete Experience	0.951**	1				
Reflective Observation	0.860**	0.895**	1			
Abstract Conceptualization	0.808**	0.851**	0.875**	1		
Deep Approach	0.908**	0.905**	0.892**	0.924**	1	
Surface Approach	-0.674*	-0.753*	-0.685*	-0.802**	-0.719*	1

** Correlation is significant at the 0.01 level

* Correlation is significant at the 0.05 level

Table 5.31 ExLSS inter-scale correlations.

5.4.3.2 Student Outcomes

As the intended student outcomes for Iteration 3 were the same as that of the previous two iterations, the same evaluation framework described in section 4.5.2 was used to evaluate their attainment. Each of the following subsections represents the analysis and determination of the attainment of the respective student outcomes.

5.4.3.2.1 Student will display an understanding of social and civic responsibility

To evaluate this student outcome, I looked to SLO 1 and SLO 4 from the ELSS and the reflection question, “After going through the activity, what are your thoughts about ways in which the agriculture industry needs to develop to best meet the needs of the community?”.

In the ELSS, an increase in the mean scores from the pre- to the post-activity response indicated that students had attained that SLO. SLO 1 had large mean increase of 3.11 while SLO 4 had a small mean increase of 0.11. Table 5.32 summarises the mean scores from the pre-and post-survey results

along with the *t*-test results comparing them. The paired *t*-test result for SLO 1 showed that there was a statistically significant improvement from the pre-(M = 23.00, SD = 2.83) to post-(M = 26.11, SD = 2.52) experience, $t = 3.855$, $p = 0.005$. The paired *t*-test result for SLO 4 showed that there was a small improvement from the pre-(M = 17.33, SD = 2.40) to post-(M = 17.44, SD = 3.88) experience, $t = 0.175$, $p = 0.865$ though it was not statistically significant.

This finding was like that of Iteration 1, where the increase for SLO 1 was significant but not SLO 4. It was interesting to see that the increasing SLO 4 was more comparable to that of Iteration 1. In terms of the design, the key difference between the iterations was the scenarios used in Stages 2, 4 and 5. Comparing the scenarios, I determined that the open-ended nature of the scenario used in Iteration 2 required students to pull from a range of ideas giving them more opportunity to develop the attributes associated with SLO 4. Thus, reverting to a scenario that allows them to draw specific references from the course, as done for Iteration 1 and now Iteration 3, we similarly see a slight increase in SLO 4 which was not statistically significant.

	#	Pre		Post		Mean Diff	t	df
	of Items	Mean	S.D.	Mean	S.D.	[Post-Pre]		
1: Students will value the importance of engaged scholarship and lifelong learning.	4	23.00	2.83	26.11	2.52	3.11	3.855**	8
4: Students will engage in structured reflection as part of the inquiry process.	3	17.33	2.40	17.44	3.88	0.11	0.175	8

** $p < 0.01$

Table 5.32 Means, SDs, and *t*-test Results for ELSS SLO 1 and SLO 4

When students were asked to reflect on ways in which the agriculture industry needs to develop to best meet the needs of the community, the response showed a larger diversity in how students believed the industry

needed to develop. In analysing their responses, 3 clear themes stood out: technology and automation, biosecurity, and sustainability (see Table 5.33).

Theme	Sample Quote
Technology & Automation	*ways in which the agriculture industry needs to develop to best meet the needs of the community is in technology and automation, as this ensures more consistency and fewer human and natural errors*
Biosecurity	*systems like irrigation with a collection of the water that drips down are also useful, as is integrated pest management with biocontrol options such as predation are a good option.*
Sustainability	*The Ag industry needs to consider every aspect of production to be sustainable and contribute positively to the community*

Table 5.33 Thematic analysis of ways in which the agriculture industry needs to develop to best meet the needs of the community

5.4.3.2.2 Student will display the ability to engage effectively and appropriately with information and communication technologies

In evaluating this student outcome, I looked to the quantitative aspect of the student reflection on the VFT Experience and the reflection questions, “How did you approach the learning activity and why?” and “What would you change about the virtual field trip experience to enhance it for future students?”.

The responses for the “VFT interface and media” construct highlighted the high expectations that students had about the VFT application though they had reflected no prior experience with it. They deemed that the multimedia helped them engage with the VFT application (M = 4.22, SD = 0.44) and that the interface was user-friendly (M = 4.11, SD = 0.93) but appraised navigation (M = 4.22, SD = 0.83) of the application higher than students in either of the previous iterations. As there were no changes made to the navigation, I put this

down to two reasons. Firstly, as they belong to the “COVID-cohort” where their pre-university experiences are largely online, would have been made up of a range of resources of varying degrees of sophistication. With that experience behind them, they might have rated the application through a comparative lens. The students in iterations 2 and 3 however, already had one year of university experience and were found in other internal studies conducted to want more from the online resources provided for them. Secondly, I believe that the overall positive experience with the activities and collaborating with their peers could have positively influenced their responses.

Despite their belief that both VFTs and actual field trips can be useful in agricultural courses (M = 4.44, SD = 0.73), students were not as positive about experiencing a VFT as having no field trip experience (M = 3.22, SD = 1.72) and they were not as keen to see more VFTs in their courses (M = 3.33, SD = 1.32). I believe this is due to the experiences that the students had in their semester rather than specifically about their experience with the VFT itself. As they return to on-campus lessons, coordinators for various courses have found ways to incorporate multiple field trips to locations close to campus. As mentioned, being their first semester at university after having much of their later high school years online, the field trips may be a unique experience and now, they may not want an online activity to disrupt that.

Conversely, in the use of the “learning with VFTs” construct, we have a high subscale mean of 4.32 across all 6 items related to their learning experience. There were high mean scores for items related to the application of concepts in industry (M = 4.56, SD = 0.53) and how it allowed them to gain knowledge (M = 4.33, SD = 0.71). However, the comparatively lower mean score for how the VFT application added to the enjoyment of learning (M = 3.78, SD = 0.97) was interesting as students in the previous iterations had rated it highly. Again, I believe the comparative experience with other courses might have played a part here. Despite that, they reported that they felt that they were able to accomplish the given task effectively (M = 4.44, SD = 0.53). The mean scores for the individual items and the overall subscales are summarised in Table 5.34 below.

Items [Scales in bold]	Mean	S.D.
VFT Interface and Media - 3 Items	**4.19**	**0.63**
The VFT application was easy to navigate.	4.22	0.83
The multimedia (e.g., videos and floor plans) helped me engage with the VFT application.	4.22	0.44
The interface of the VFT application was user-friendly.	4.11	0.93
Perception of VFT - 5 Items	**3.49**	**0.44**
I would rather visit an actual field site than experience a VFT.	4.33	0.87
I would rather experience a VFT than have no field trip experience.	3.22	1.72
VFTs can replace actual field trips.	2.11	1.05
I would like to see the use of more VFTs in my courses.	3.33	1.32
I think both VFTs and actual field trips can be useful in agricultural courses.	4.44	0.73
Learning with VFT - 6 Items	**4.32**	**0.57**
The VFT application enabled me to accomplish the task effectively.	4.44	0.53
The VFT application complemented the course material.	4.44	0.73
The VFT allowed me to see course concepts being used in the industry.	4.56	0.53
The VFT application provided an appropriate learning opportunity.	4.33	0.71
The VFT application added to the enjoyment of learning.	3.78	0.97
The VFT application allowed me to gain knowledge that I previously did not have.	4.33	0.71

Table 5.34 Means and SDs for VFT experience subscales.

Reviewing what students reflected on, *"What would you change about the VFT experience to enhance it for future students?",* like Iteration 2, student responses gave suggestions about the overall activity delivery rather than focusing on the application itself as summarised in Table 5.35.

Theme	Sample Quote
Improvement in overall activity	*The questions given should be a bit clearer as they were a bit confusing at times on what we were supposed to be discussing.*
Improvement to the VFT application	*I went through it backwards and missed some things so numbered sites would be nice.*
Improvement to content provided	*More discussion about each part and the machinery used*

Table 5.35 Thematic analysis of student responses to “What would you change about the VFT experience to enhance it for future students?”.

The way they approached the learning activity gave us insight into how they engaged with the application. The guiding questions focused the students' responses on the path they had taken through the activity and why. There were three themes identified with some indicating that they followed a free-flowing path, and others describing a path guided by specifics as summarised in Table 5.36. Interestingly, there were a few responses that connected their approach with having an open mind.

Theme	Sample Quote
Followed a free-flowing path	*I followed a free-flowing path to see if I could see how all the sections fit in together and work together.*
Followed a path guided by specifics	*I didn't know what it was going to be like, so I followed the pathway in order of production as much as possible*
Referred to their approach to having an open mind	*I approached it with an open mind as I realised that each business is different, and this business may do things better than other businesses I’ve seen.*

Table 5.36 Thematic analysis of benefits of using VFTs

5.4.3.2.3 Students Would Display an Ability to Interact Effectively with Others to Work Towards a Common Outcome

To evaluate this student outcome, I looked to SLO 3 from the ELSS and the reflection question, “How did your relationship with your group mates influence your experience?”.

In the ELSS, an increase in the mean scores from the pre- to the post-activity response indicated that students had attained that SLO. The paired *t*-test result for SLO 3 showed that there was a significant improvement from the pre-(M = 18.22, SD = 1.86) to post-(M = 19.22, SD = 2.15) experience, $t = 2.874$, $p = 0.021$. Table 5.37 summarises the mean scores from the pre-and post-survey results along with the *t*-test results comparing them. This was surprising as similar instructions for the group activities were given in the previous iteration and Iteration 2, specific information about group engagement in Stage 3 was also provided though both saw no significant increase in SLO 3. This finding was more surprising when analysing student responses to how their group mates influenced their experience. Again, as in previous iterations, the focus of the responses was on their experience with the VFT application where 8 out of the 12 responses indicated that the group had little to no effect on their experience. The individual items under SLO 3 gave some possible explanations for this finding. The items centre around respecting one another’s ideas and offering relevant questions and comments within a group setting. I believe that as first-year students, they had not established deep bonds with one another and were generally impressed by the knowledge offered by their groupmates and were more mindful of respecting one another’s views and perspectives.

	# of Items	Pre		Post		Mean Diff [Post-Pre]	t	df
		Mean	S.D.	Mean	S.D.			
SLO 3: Students will work collaboratively with others.	3	18.22	1.86	19.11	2.15	0.89	2.874*	8

* $p < 0.05$

Table 5.37 Means, SDs, and *t*-test results for ELSS SLO 3

5.4.3.2.4 Students would Display an Ability to Evaluate Opinions, Make Decisions and Reflect Critically on the Justifications for Decisions.

To evaluate this student outcome, I looked to SLO 2 from the ELSS and the reflection questions, “What benefits do you think there are from using VFTs in place of actual field trips?” and “Has the virtual field trip experience helped you become more interested in this field and if so, why?”.

In the ELSS, an increase in the mean scores from the pre- to the post-activity response indicated that students had attained that SLO. SLO 2 had a mean increase of 3.00. Table 5.38 summarises the mean scores from the pre- and post-survey results along with the *t*-test results comparing them. The paired *t*-test result for SLO 2 showed that there was a significant improvement from the pre-(M = 34.00, SD = 5.17) to post-(M = 37.00, SD = 5.07) experience, $t = 3.530$, $p = 0.008$. Compared to the previous iterations, this finding highlights the importance of the scenario in the activity design. As discussed above, the scenario here, though the same as used in Iteration 1, required them to employ both agronomy and horticultural knowledge and connect them to address the task. This meant they could see the implication of what they are learning on another agricultural discipline and its impact in real-world situations.

	# of Items	Pre		Post		Mean Diff [Post-Pre]	t	df
		Mean	S.D.	Mean	S.D.			
2: Students will apply knowledge, values, and skills in solving real-world problems.	6	34.00	5.17	37.00	5.07	3.00	3.530**	8

* $p < 0.01$

Table 5.38 Means, SDs, and *t*-test Results for ELSS SLO 2

When students were asked to reflect on the benefits of using VFTs in place of actual field trips most students were able to link its benefits to being

more reliable and the convenience it affords to students as summarised in Table 5.39.

Theme	Sample Quote
Reliability	*You could go to places far away, or still go if the trip were cancelled*
Student Convenience	*All students receive the same information and can look back on the recordings at any time, rather than relying solely on memory. All the information is already collated for you to use.*

Table 5.39 Thematic analysis of benefits of using VFTs

When students were asked to reflect on whether the VFT experience helped them become more interested in the field and why, 5 of the 8 students responded with a “yes”, centring their reasoning on how the VFT has opened them up to a new side of the horticultural industry that they did not know of. For students who responded with a “No”, they elaborated that it was because they were already interested in the field.

5.4.4 Lessons Learnt from Iteration 3

As Iteration 3 was the last iteration of the study, the lessons learnt informed the part of the guidance made for other educators. I categorised them into two categories; (1) lessons learnt relating to the activity design and (2) lessons learnt relating to student outcomes.

5.4.4.1 Lessons Learnt Relating to Activity Design

Building on the lessons learnt from Iteration 2, the durations for the individual stages were retained as shown in Table 5.27. Once again students were able to transition from one stage to another smoothly. The added time given to the discussion activities was beneficial and the depth of engagement can be seen

in the screenshot of students' Padlet in Figure 5.31. The use of the Padlet itself to capture student discussion points and their attempt at the scenario was positive giving evidence of their level of engagement. Using the ExLSS again in the evaluation process was beneficial in allowing me to make conclusions about the individual stages and their contribution to the overall activity design and student outcomes.

5.4.4.2 Lessons Learnt Relating to Student Outcomes

Learning from Iteration 2, we explicitly mentioned that working through the VFT in Stage 3 could be done as a group and in my reflection, I noted how most students worked in pairs.

Across section 5.4.3, we see that the scenario which was designed for Iteration 1 was a good fit for Iteration 3 and this is seen through their responses in the various questionnaires and the level of engagement seen during the session. The tasks used in Stage 2 and Stage 4 allowed students to build on their discussions in their attempt to address the scenario in Stage 5.

5.5 Conclusion

Figure 5.32 summarises the findings and lesson learnt across all three iterations. Overall, the iterative process undertaken to refine the innovation yielded valuable insights into both activity design and student outcomes. Across the three iterations, several key findings emerged, shedding light on areas of success and areas requiring further refinement. The insights gained from this process not only contribute to the understanding of effective virtual learning methodologies but also provide valuable guidance for future iterations and adaptations of similar educational interventions.

In terms of activity design, adjustments such as increased duration for discussion activities and the introduction of Padlet for capturing discussion points were implemented based on earlier feedback. While these changes were generally beneficial, technical difficulties with Padlet in Iteration 2 posed

challenges in capturing discussion points, affecting stages reliant on this information. However, the reinstatement of Padlet in Iteration 3 proved effective, facilitating robust documentation of student interactions and contributing to a smoother flow of activities. Moreover, the incorporation of the ExLSS provided quantitative data to complement qualitative reflections, enhancing the evaluation process. This quantitative data corroborated conclusions drawn from other assessment instruments, lending greater validity to the findings.

Regarding student outcomes, iterative refinements resulted in notable improvements. The explicit mention of group work possibilities in Stage 3 proved successful, with most students opting to collaborate in pairs or small groups. Additionally, revisiting the scenario from Iteration 1 in Iteration 3 proved to be a wise decision, as it elicited more substantive responses and heightened engagement from students. However, challenges persisted in certain areas, particularly in task design for stages 2 and 4, which sometimes yielded generic responses that hindered students' ability to effectively address the scenario presented in Stage 5. Despite these challenges, the iterative process allowed for incremental improvements, culminating in tasks that better facilitated student learning and engagement.

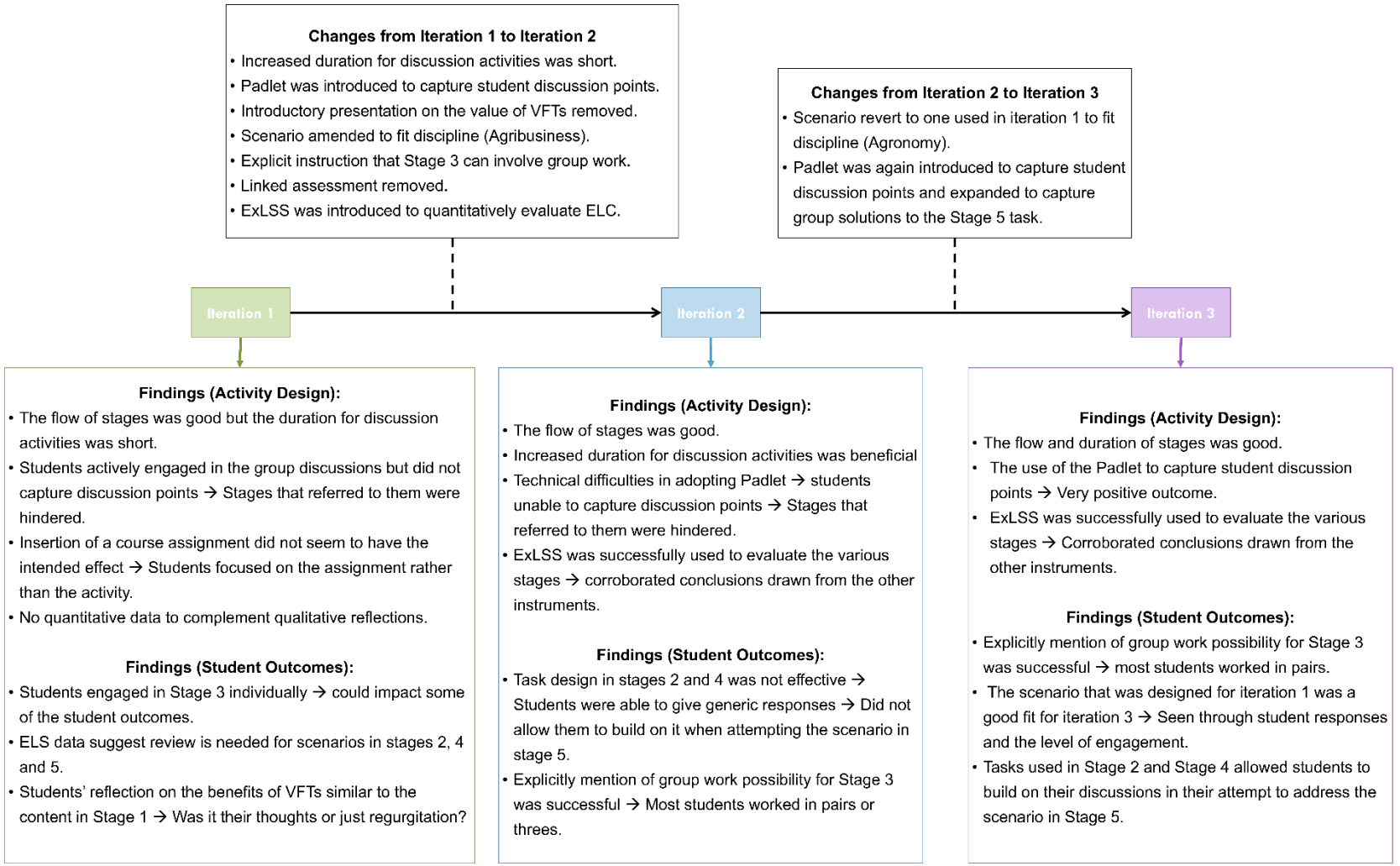


Figure 5-32 Lessons learnt across all three iterations

Chapter 6: Discussion

6.1 Introduction

The purpose of this chapter is to bring together the methodological approach and findings from the previous chapters and situate them within the broader literature. The chapter starts with an introduction to *VirtualVoyageVista* an activity design framework developed through the lessons learnt across the three iterations, anchored on experiential learning pedagogy coupled with pre- and post-activity stages. I delineate its conceptual underpinnings and practical implications, elucidating its potential to enrich pedagogical practices and student outcomes. Moreover, the chapter examines the study's contributions to pedagogical considerations, evaluation methodologies, and student outcomes within the context of VFTs in higher education. In the second part of the chapter, I will illustrate my project's contribution to the literature following the three themes - *pedagogical considerations*, *evaluation approaches* and *student outcomes* - discussed in Chapter 2 and frame the relevancy of my findings around them. By contextualizing the study within the broader literature and elucidating its implications for educational practice, I offer valuable insights for scholars, educators, and practitioners seeking to harness the transformative power of VFTs in contemporary learning environments.

6.2 VirtualVoyageVista – Activity Design Framework

6.2.1 Introducing VirtualVoyageVista

VirtualVoyageVista is an activity design framework that uses an integrated VFT activity to support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education. VirtualVoyageVista is a playful and imaginative term that combines several key concepts:

- *Virtual*: Relating to something that is simulated, replicated, or experienced through technology, often in a digital environment.
- *Voyage*: A journey, adventure, or expedition, typically involving travel or exploration.

- *Vista*: A view, scene, or panorama, often implying a wide or comprehensive perspective. In this framework, it refers to a comprehensive understanding of the outcomes and insights gained from the virtual journey.

As such, *VirtualVoyageVista* could be interpreted as a journey of exploration and discovery within a virtual environment, leading to a comprehensive and panoramic view of the outcomes and insights gained from the experience. *VirtualVoyageVista* as illustrated in Figure 6.1 below draws inspiration from the three iterations described in Chapter 5, bringing together lessons learnt from them along with learnings from the literature.

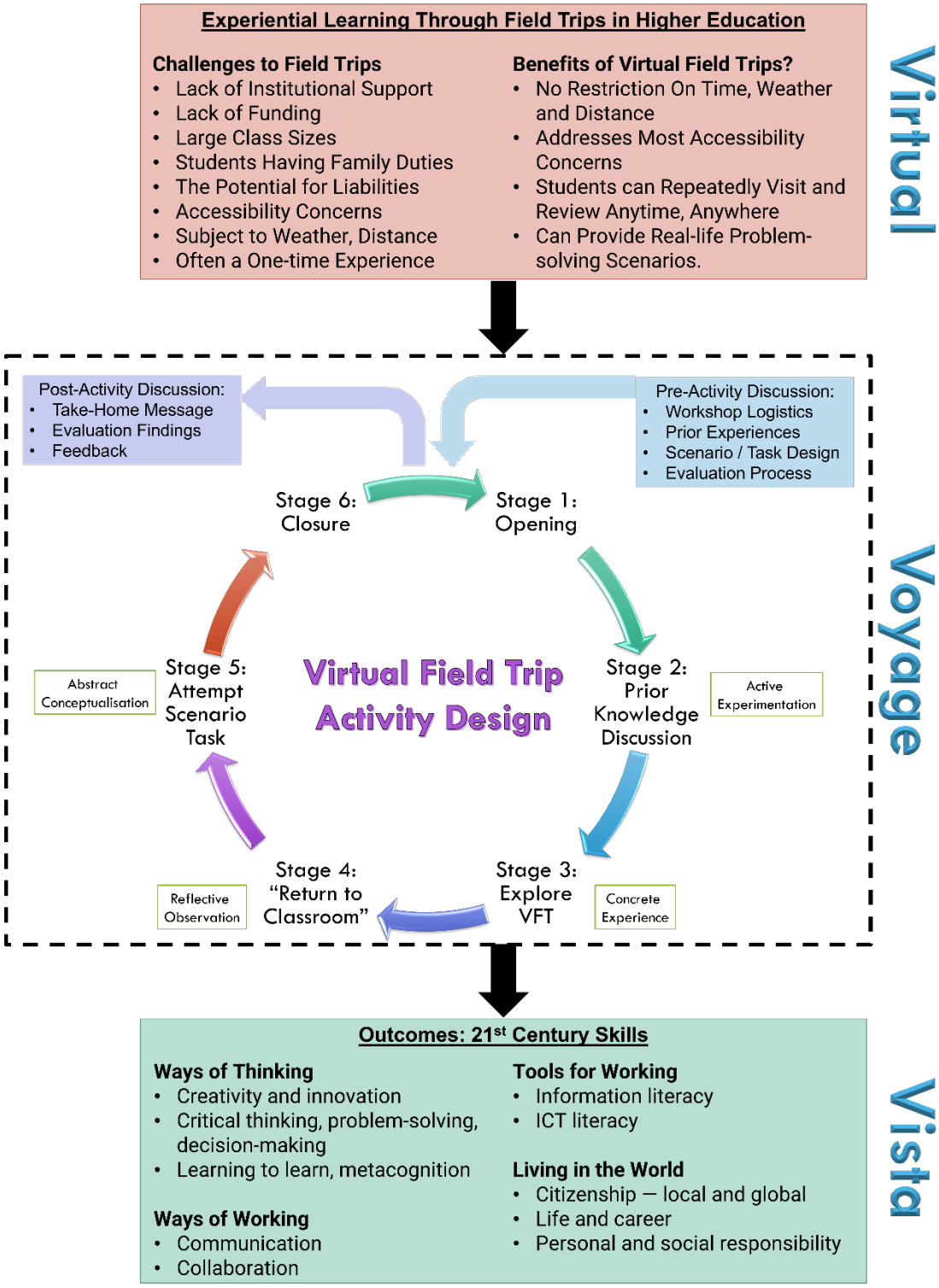


Figure 6-1 Pictorial representation of *VirtualVoyageVista*

6.2.2 Core Beneficiaries of *VirtualVoyageVista*

The *VirtualVoyageVista* framework, as illustrated in Figure 6.1 is an innovative activity design model that prioritizes educators as primary

stakeholders. It aims to enhance their pedagogical practices and experiential learning with targeted student outcomes using a VFT-integrated activity. This framework puts a strong emphasis on providing educators with a versatile tool to connect theoretical concepts with real-world experiences. They are guided in designing and implementing a structured experiential learning activity within their instructional contexts that aligns with their desired learning objectives.

The *VirtualVoyageVista* framework is designed to be multi-functional for educators interested in using it. The framework gives them the tools to design the activities with advisories for each stage informed by lessons learnt. It also guides them on how to structure and implement those activities. Through its use, they can also manage the activity sequence and ensure it adheres to the principles of the ELC. The framework also lays out possible student outcomes that educators can evaluate in their implementations. Section 6.3 below describes the advisory for users of the framework.

In using the *VirtualVoyageVista* framework, educators can be confident in employing a framework that is backed by both research and evidence-based practices, utilizing the benefits of experiential learning and virtual technologies to overcome the challenges of conducting in-person field trips and attain broader student outcomes such as the 21st-century skills which include critical thinking skills, information literacy along with communication and collaboration skills.

6.2.3 Advisory for Users of the *VirtualVoyageVista* Framework

Tracing the framework from the top, about the orange box in Figure 6.1, before engaging in VFTs, educators should be aware of the potential benefits (Klemm & Tuthill, 2003) of employing them about the challenges that exist (Jones & Washko, 2021) in organising in-person field trips in the current higher education climate. When choosing to employ an integrated VFT activity for experiential learning, the *VirtualVoyageVista* framework suggests the adoption of a 6-stage activity design where four of the stages are mapped directly to four

phases of the ELC (Kolb & Kolb, 2019). Those four stages are bookended by an *opening* and *closure* stage and supported by a *pre-activity discussion* and a *post-activity discussion*.

In the *pre-activity discussion* (see blue box in Figure 6.1), it is important to develop an understanding of the class particularly regarding aspects that have a bearing on the successful delivery of the activity. From the lessons learnt, the *workshop logistics* must be carefully managed especially the duration and location of the session including the estimated enrolment numbers. These were logistics that had an impact across the three iterations of the study as illustrated in Figure 5.32. An understanding of the groups' *prior experiences* is a critical aspect of the activity's success. As many of the activities require students to build upon their prior experiences, it would be ideal if this expertise could be distributed across different groups. If the distribution is skewed, then a situation like Iteration 1 where the group discussion is dominated by a few individuals to the potential detriment of the group learning experience.

Additionally, one key element to be discussed and developed at this juncture is the *scenario and task design*. The impact of a poorly designed task design was illustrated in Iteration 2 where students did not benefit from the scaffolding that the tasks were supposed to provide. Similarly, when the same scenario and tasks were used in Iteration 1 and Iteration 3, students in Iteration 1 did not seem to find it as useful as those in Iteration 3. This is also the segment where discussion on the *evaluation process* including methods and measures should be conducted if evaluation of the implementation is intended.

At the beginning of the activity, the *opening stage* is important in setting the scene for the rest of the activities. This includes introducing the base scenario that forms the basis of the activity tasks. In this stage, students are provided with an overview of the activities along with expectations. Across the iterations, where the rationale for the activity was shared with the students. However, educators must take care to ensure the information shared during this stage does not influence student perception or learning. As I learnt in Iteration 1, this leaves an ambiguity in determining the success of the activity with

intended student learning. This is also where data collection processes can be inserted to collect “pre-“ data and establish any preconceptions students might have that might affect their engagement in the activity.

As mentioned above, the main chunk of the activity comprises four stages mapped to the four phases of the ELC, illustrated by the four white boxes with pink outlines (Stages 2 – 5). *Stage 2 (Prior Knowledge Discussion*) should be designed around a task that requires students to draw on their prior knowledge. With this stage being mapped to the *Active Experimentation* phase of the ELC, attempting this task in groups allows students to not only see how their prior knowledge can address the scenario but also how the collective prior knowledge allows a variety of solutions to be derived. In particular, the task must be designed such that students would be able to revisit this task in *Stage 4* before attempting *Stage 5* – the criticality of the task design here positions the subsequent stages for success. Figure 6.2 below revisits two of the tasks used in the iterations where the task design for Iteration 2 (right task) proved to be generic and did not adequately support the students for *Stage 5*. Additionally, consider the use of online tools such as Padlet to capture the discussion points that students raise in attempting this task.

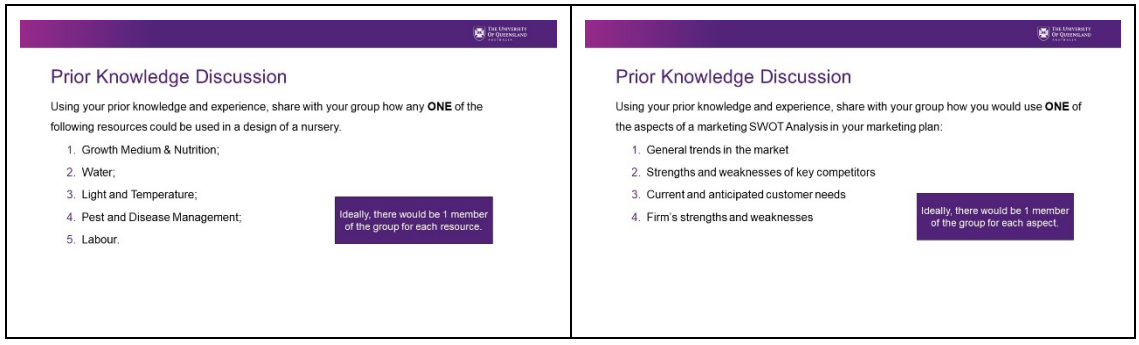


Figure 6-2 Tasks designed for *Stage 2* in Iteration 1 and 3 (left) and Iteration 2 (right)

Stage 3 (Explore VFT) is where students engage with the VFT application and are mapped to the *Concrete Experience* phase of the ELC. The VFT application used in the activity serves as a window to the real world where

they can see their course concepts being applied in industry. One lesson learnt across the iterations for *Stage 3* is that students must be given explicit instructions as to whether this stage is to be embarked on as a group. When embarking on in-person field trips, this social element is often a given (Friess et al., 2016; Palaigeorgiou, Malandrakis, & Tsolopani, 2017) but using a VFT can be an individual activity considering the required attention span having to engage with the media used. When comparing my observations from Iteration 1 to Iteration 3, it was clear that when no explicit instructions were given, students preferred to engage with the VFT individually which limited the opportunity for them to communicate with one another and engage in discussions apart from those structured in the various stages.

Stage 4 ("Return to Classroom") should be designed around a revisit to the task in *Stage 2* allowing students to reconcile the difference between what they already knew and what they learnt in the VFT and is mapped to the *Reflective Observation* phase of the ELC. However, to maximise the benefits of the reflection process, students should be allowed to reflect on their learning individually before sharing their reflections with the group. In my project, this was by providing the students with reflection questions to consider as they engage with the VFT application in Stage 3. This structured reflection would also allow them to demonstrate their thought processes and engagement with the task and their groupmates towards all four intended student outcomes. Figure 6.3 below shows the individual reflection questions and group reflection activity used in Iteration 1.

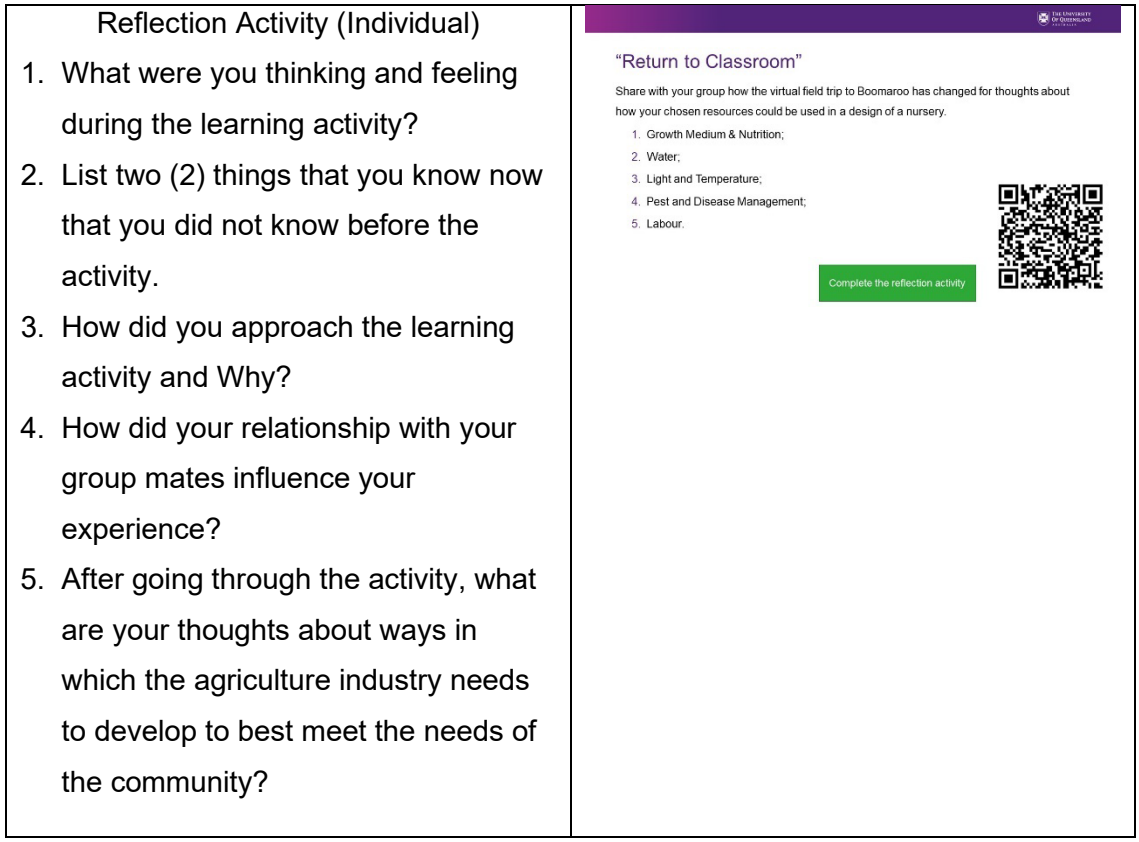


Figure 6-3 Individual reflection questions (left) and group reflection (right) task used in Iteration 1

Stage 5 (Attempt Scenario Task) is mapped to the *Abstract Conceptualisation* phase of the ELC. In using their aggregate knowledge from the activity tasks in the preceding stages and their prior knowledge, attitudes and skills, students attempt to apply them to resolve a given scenario task. This scenario is presented to them in *Stage 1* and is important in terms of helping students see the point of the entire activity. If they are not able to incorporate the learnings from the tasks in *Stages 2* and *4*, they might find the entire activity a waste of time. However, *Stage 5* also brought the complex idea of *uncertainty* to the forefront of my mind as the task on the left of Figure 6.4 was specifically designed for the horticulture students in HORT2007 (Iteration 1) but was found to be more suitable for the agronomy students in AGRC1024 (Iteration 3) for some reason!

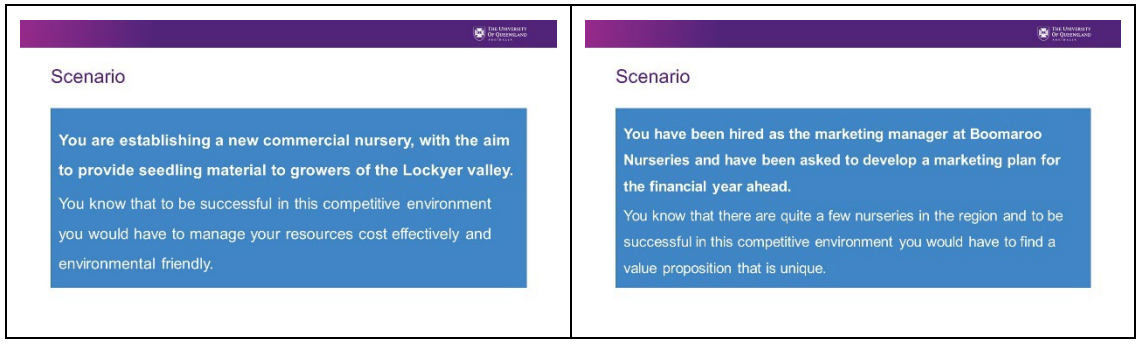


Figure 6-4 Tasks designed for *Stage 5* in Iteration 1 and 3 (left) and Iteration 2 (right)

At the end of the activity, the *closure stage* is essential towards anchoring the activity and cementing student learning. In this stage, students are provided feedback on their proposed solution about the concepts covered in the course. It should be used as an opportunity to help students see other elements or aspects of note that might not have been discussed. The closure stage is also where data collection processes can be inserted to determine student learning gains from engaging with the activity.

In the *post-activity discussion* (see purple box in Figure 6.1), the educator needs to reflect on the activity. This is important as reflection encourages insight into the activity's impact, efficacy, challenges, and potential improvements. These are usually informed by *evaluation findings* and *feedback* from students or fellow educators. These can then form the *take-home messages* that the educator takes into the next iteration of where the activity is implemented

The development and attainment of student outcomes, such as those listed in the green box in Figure 6.1, come across various stages. The activity in *Stage 2* helps them develop *"ways of thinking"* and the incorporation of group work is key towards the attainment of *"ways of working"*. More importantly, it also provides the opportunity for them to develop skills associated with *"tools for working"*. In *Stage 3*, the activity provides them an opportunity to develop an ability to engage effectively and appropriately with information and communication technologies (*"tools for working"*). Within the design of the application, students can be allowed to develop social and civic responsibility (*"living in the world"*). In *Stage 5*, their active engagement allows students to

demonstrate a combination of the categories of outcomes as they pool their collective expertise and communication skills to develop and present their proposed solution to the scenario.

In summary, the implementation of the *VirtualVoyageVista* framework underscores the importance of meticulous planning and thoughtful execution in integrating VFTs for experiential learning. Pre-activity discussions are pivotal for understanding prior experiences, optimizing workshop logistics, and refining scenario and task designs. The opening stage sets the activity's tone, while the main chunk of the activity, mapped to the ELC, fosters student engagement and reflection. Effective facilitation of each stage, from drawing on prior knowledge to applying learnings in scenario tasks, influences student outcomes and learning gains. Post-activity reflection informs iterative improvements, ensuring continual enhancement of the academic experience.

6.3 Contributions to the literature

Upon reviewing the existing literature (see Chapter 2), several noteworthy discoveries emerged regarding pedagogical considerations, evaluation methods, and student outcomes within the context of VFTs in Higher Education. It was noted that there was no consistent pedagogical model across the literature, despite the prevalent emphasis on providing students with an experiential learning environment. While some articles referenced pedagogical models, the connection between these models and activity design was often unclear. Although there was diversity in the use of ELC or ELT in projects, this pedagogical consideration did not consistently translate into activity design.

Regarding evaluation approaches, the literature showed that evaluations of VFTs tended to be summative and focused on achieving outcomes rather than informing the innovation being evaluated. Evaluation measures were inflexible, and few articles used lessons learned from evaluations to inform subsequent iterations of their innovations.

Lastly, concerning student outcomes, findings indicated positive levels of student satisfaction and perception with VFTs, highlighting the importance of addressing these aspects to ensure a positive learning experience. However, there was an opportunity missed to measure broader educational outcomes beyond satisfaction and knowledge gain, particularly at higher cognitive levels.

Against this backdrop of findings, my study aimed to contribute to these themes by:

- proposing an activity design framework that explicitly embraces the ELT and operationalises it by leveraging the four phases of the ELC.
- adopting the Development Evaluation (DE) approach. Through this, I could:
    - demonstrate the effectiveness of an evaluation approach that is integrated with the innovation being evaluated allowing me to draw evidence from various sources and data points.
    - leverage the eight guiding principles of DE to design an iterative approach that is flexible responsive, and process focused.
- Highlighting and evaluating student outcomes aligned to the UQ graduate outcomes encompassing desired skills and attributes such as problem-solving, collaborative skills, engagement with technology and a developing understanding of student social and civic responsibility.

The following sub-sections detail those contributions within each identified theme.

6.3.1 Contributing to the theme of 'Pedagogical Considerations'

My project's contribution to this theme is the *illustration of the design principles of experiential learning in using VFTs*. I did this by developing the *VirtualVoyageVista* framework (described in section 6.2) which lays out an activity design that incorporates VFTs as part of an experiential learning activity that was explicitly underpinned by ELT. I operationalised the ELT using the ELC ensuring each phase of the ELC formed a specific activity stage. This is a valuable contribution as "*experience*" is a key reason why many researchers embarked on their research into VFTs as either a replacement or supplementary component to in-person field trips. However, as described in Chapter 2, the literature does not illustrate a consistent pedagogical model, despite the prevalent emphasis on providing students with an experiential learning environment. While some articles referenced pedagogical models, the connection between these models and activity design was often unclear. Although there was diversity in the use of ELC or ELT in projects, this pedagogical consideration did not consistently translate into activity design

In the *VirtualVoyageVista* framework, the main activity stages were mapped to the four phases of the ELC, and specific activities were designed to bring out the essence of the phase. Section 6.3.3 details the different activities and how lessons learnt to form the three iterations shaped the activity design. Table 6.1 summarises how VFTs relate to each phase of the ELC.

Utilizing the ELC to design the VFT-based activities has proven invaluable in providing a structured framework for integrating theory with practice, fostering deeper engagement, and learning among students. Scholars invested in enhancing educational experiences through VFTs should consider this approach, as it offers a systematic methodology for optimizing learning outcomes and ensuring meaningful student engagement in virtual environments. Integrating the ELC into the activity design not only enhances pedagogical effectiveness but also paves the way for innovative and impactful educational practices in diverse learning contexts.

Stage	Name	Mapping to ELC	Student Activity	How VFTs Relate to Each Phase of ELC
1	Opening	-	-	-
2	Prior Knowledge Discussion	Active Experimentation	• Explore scenarios using prior knowledge. • Share with groupmates	In group tasks designed around prior knowledge, students actively experiment with applying their existing understanding to real-world scenarios. By collaborating and generating diverse solutions, students not only deepen their understanding but also refine their problem-solving skills, preparing them for future challenges. Though this phase doesn't specifically involve the VFT, the real-world scenario takes reference from the VFT.
3	Exploring Boomaroo Nursery	Concrete Experimentation	• Explore the VFT location	VFTs serve as a concrete experience where students directly engage with real-world applications of course concepts. Through interactive simulations and virtual environments, students gain first-hand exposure to industry contexts, enhancing their understanding and connection to theoretical concepts.
4	"Return to Classroom"	Reflective Observation	• Review prior knowledge. • Share with groupmates	After exploring the VFT, students return to the classroom to reflect on their experiences. Structured reflection activities, such as individual reflection questions, allow students to analyse and evaluate their learning process, bridging the gap between prior knowledge and new insights gained from the VFT.

Stage	Name	Mapping to ELC	Student Activity	How VFTs Relate to Each Phase of ELC
5	Attempt Scenario	Abstract Conceptualisation	• Attempt scenario with groupmates	Students utilize their aggregate knowledge from the VFT experience to solve scenario-based tasks. By abstracting their learnings and applying them to unfamiliar contexts, students develop higher order thinking skills and demonstrate their ability to transfer knowledge to practical situations.
6	Closing	-	-	-

Table 6.1 Illustrating how the VFT relates to each phase of the ELC

6.3.2 Contributing to the theme ‘Evaluation Approaches’

One of my project’s biggest contributions to the literature is the *demonstration of the DE methodology*, using it in a completely new context and scale, specifically in agricultural education for a single learning activity and in an iterative manner and in doing so, make 3 contributions.

Firstly, the use of DE and in particular the adherence to the *developmental purpose principle* focused my evaluation on the process of *how* the innovation was implemented rather than pre-empting a desired outcome. It is this process-focus lens that allowed me to focus on the student experience in designing and evaluating an experiential learning activity sequence. This was important in developing the framework illustrated in section 6.2 above. Using DE allowed me to study individual activity stages in-depth and build an understanding of how each activity fitted together. This in turn was critical when reflecting on the implementation and drawing lessons from it. In being able to understand the role each activity stage played in the overall design; it ensured that any adjustments recommended had a purpose informed by the process. For example, through the observations and the data collected, we understood that the development and attainment of the student outcome: the *ability to engage effectively and appropriately with information and communication technologies* could be better with the incorporation of additional educational technologies and better instructions given to students. Attempting to incorporate Padlet in Iteration 2 and being successful in Iteration 3, we were able to continually improve student attainment of that student outcome from iteration to iteration.

Secondly, in adhering to the evaluation rigor principle - in using rigorous evaluative thinking and situationally appropriate rigorous evaluation methods - I was able to employ an integrated approach where evaluative elements tightly fitted across various stages in the activity design within and across iterations. I started with a pre-activity questionnaire and concluded with the post-activity questionnaire. This provides me with insight into the effectiveness of the activities. Within the activities, data collected from discussions in Stages 2, 4

and 5 of the activity design shed light on the depth of discussions reflecting student engagement. The reflection exercises provide an opportunity to understand the student experience and thought process when engaging with the VFT. This integrated approach allowed me to draw evidence from various sources and data points when seeking to understand the student experience at each stage of the learning activity and when making conclusions about the intended student outcomes. Adherence to the evaluation rigour principle also meant that I could actively tweak the evaluation measures to make sure that the necessary information was collected for the continued development of the innovation. For example, in evaluating Iteration 1, I realised that I was unable to adequately understand the student experience in the four phases of the ELC. I seamlessly introduced the Experiential Learning Stages Survey (ExLSS) (Young, Caudill, & Murphy, 2008) for subsequent iterations which allowed me to tweak stages 2, 3, 4 and 5 appropriately. This is advantageous when compared to the evaluation approaches adopted in the literature which tended to be summative looking back at various aspects of their implementation (Friess et al., 2016; Fung et al., 2019; Mathews, Andrews, & Luck, 2012). Due to the summative nature, they would have to make conclusions and subsequently guidance for improvements which could be clouded by the overall success of the implementation.

Thirdly, in my project, I employed DE in an iterative manner which allowed me to evaluate my activity design and allow guidance made from its findings to be retested and continually improved upon across the three subdisciplines of horticulture, agribusiness, and agronomy with minimal contextualisation. The importance here is that, if I had only evaluated Iteration 1 in the same vein as much of the literature, I would have concluded that my activity design would only lead to student attainment of one outcome rather than the three outcomes demonstrated when the revised activity design was used in Iteration 3. As discussed in section 2.4, evaluations of VFTs tended to be summative and focused on achieving outcomes rather than informing the innovation being evaluated and evaluation measures were often inflexible. In adopting an iterative approach embracing the DE principles, I was able to overcome this perceived deficiency.

6.3.3 Contributing to the theme 'Student Outcomes'

My project's contribution to this theme is to *highlight the potential of attaining broader educational outcomes through a VFT integrated experiential learning ac*tivity. Specifically, in my project, I evaluated student outcomes aligned to the UQ graduate outcomes encompassing desired skills and attributes such as problem-solving, collaborative skills, engagement with technology and a developing understanding of student social and civic responsibility. Evaluating the broader student-graduate outcome is important as higher education is an important pathway to the working world and in the agricultural context, this is even more so as the students' ability to assimilate their knowledge and apply it to real-life scenarios is key to their success. Student graduate outcomes illustrate the knowledge, attitudes, and skills that students should attain through their respective programmes. It is however noteworthy that course-level student outcomes tend to have a focus on the *cognitive* elements and this is what we see in the literature where many of the studies look at the *knowledge gain* students embark on VFTs (Hurst, 1998; Mead et al., 2019; Meezan & Cuffey, 2012). Jones and Washko (2021) summarised that the purpose of engaging with field trips is to be able to *(1) integrate active learning, (2) co-create knowledge through collaborative, problem-based activities, (3) provide place-based learning that provides real-world context, and (4) allow rapid feedback between peers and instructors*. In focusing on just the *knowledge gain*, however, researchers have missed the opportunity to measure the *affective* aspect of student learning considering that one of their purposes in exploring VFTs was to either replace or complement in-person field trips.

Through my project, across the three iterations, I was able to evaluate four student outcomes:

1. Student will display an understanding of social and civic responsibility.
2. Student will display the ability to engage effectively and appropriately with information and communication technologies.

3. Student will display the ability to interact effectively with others to work towards a common outcome.
4. Student will display the ability to identify problems, create solutions, innovate, and improve current practices.

The *VirtualVoyageVista* framework illustrated in section 6.2 allows students to develop and demonstrate achievement of the first three student outcomes measured through both quantitative and qualitative means. Student Outcome 4 was not demonstrated quantitatively though observations made by the course coordinators, tutors and I during the iterations reflected that students were innovative in developing strategies to address the scenarios posed. Future work could investigate improving the framework to enable students to develop and demonstrate their achievement of that student outcome.

6.4 Conclusion

In summary, this chapter presented the insights and contributions drawn from the study, underscoring the significance of integrating VFTs into experiential learning activity designs. The introduction of the *VirtualVoyageVista* framework marks a pivotal advancement, offering educators a structured approach to seamlessly integrate VFTs into undergraduate agricultural education. This framework, informed by the ELC, not only enhances pedagogical practices but also fosters deeper student engagement and learning outcomes alignment.

Through the meticulous application of the Development Evaluation (DE) methodology, the study exemplifies a novel approach to evaluating educational innovations. By focusing on the process rather than predefined outcomes, the DE methodology allows for iterative refinement of activity designs, informed by data-driven insights and student experiences. This iterative evaluation approach, coupled with rigorous evaluative thinking, ensures continuous improvement and optimization of the *VirtualVoyageVista* framework across diverse learning contexts. Furthermore, the study sheds light on the broader

educational outcomes attainable through VFT-integrated experiential learning activities. By evaluating student outcomes aligned with graduate attributes, such as problem-solving skills, collaborative abilities, and technological proficiency, the study underscores the transformative potential of VFTs in preparing students for real-world challenges. This comprehensive evaluation of student outcomes enriches our understanding of the multifaceted impact of VFTs on student learning experiences.

In essence, the *VirtualVoyageVista* framework, coupled with the DE methodology and a focus on broader student outcomes, represents a paradigm shift in educational practice. Scholars and educators alike are encouraged to consider and integrate these innovative approaches into their pedagogical frameworks, fostering a culture of continuous improvement and enhancing student learning experiences in the digital age. As the educational landscape continues to evolve, embracing VFTs and experiential learning methodologies will be essential in preparing students for success in an increasingly complex and interconnected world. The next chapter will conclude the research study revisiting and summarising key aspects of the project.

Chapter 7: Conclusion

7.1 Introduction

The purpose of this concluding chapter is to close my project by looking back at my project through a reflective lens and sharing my reflection before summarising my project findings. I follow this by reflecting on its limitations and revising its contributions to extant literature. I close the chapter with a brief discussion of the implications to policy, practice, and future research.

7.2 Personal Reflection

In section 1.2 I set out my motivation in embarking on this project. I shared how this project, sprung from an initial disappointment but then evolved to fit a gap that arose when we had to transition all teaching to an online delivery mode while still addressing some pedagogical priorities in the disciplinary context. Beyond obviously achieving a successful outcome for the project, I had a few personal objectives that I hoped to achieve. Firstly, I aimed to present a case where a pedagogy-informed activity design could result in a single resource being reused across courses and disciplines. Through this, I wanted to expand my school colleagues' view of educational technology beyond that of video lectures. For the research community, I hoped to shed light on the capabilities of using VFTs for experiential learning and for attaining broader student outcomes. At the same time, I hoped to exemplify how the DE approach can be adopted with a novel scope and scale.

At the end of this project, I feel a deep sense of achievement. Throughout the project, I had the opportunity to interact with the different course coordinators to discuss the potential of VFTs and had the opportunity to demonstrate its capabilities in courses across different disciplines. As the coordinators engaged in the design process with me, they also remarked on the complexities of designing activities to maximise student outcomes. As previously mentioned in section 1.2, at the time of writing, new VFTs are being incorporated into the system and some courses have adopted my proposed

framework for using VFTs for experiential learning. I was disappointed to be unable to explore this work across other disciplines in the school such as animal science and soil science. Unfortunately, the ACDS grant discussed in section 4.3.2 was only sufficient to develop a VFT for just one location and with Boomaroo Nurseries on board, I was unable to have another animal centric VFT built for the study.

For the research community, I feel proud to be able to highlight how DE can be harnessed for the successful implementation of an innovation of such a type. DE projects in the literature tend to be on a larger scale both in terms of duration and scope but since my exposure to its principles, I have been a huge proponent of its use for course design in Higher Education. Before this project, I had successfully used DE in various projects, transforming courses with traditional deliveries to one that adopted either a flipped or blended approach. As those projects spanned consecutive deliveries, they were often done over one to two years but through this project, I was able to show that the DE approach could be harnessed for work across multiple iterations within a single semester.

Reflecting on my journey through the project, I find myself having become more meticulous, and more conscious of the complexities of educational research and have also become more aware of my strengths and weaknesses as a researcher. I am glad that I have embarked on this journey, and it has reinforced my decision to be an academic in this field. I do feel that my project is the beginning when it comes to VFTs and their potential in the educational space which I point to in the section on future research below.

7.3 Research Findings

My research findings are presented across Chapter 5 and Chapter 6. Chapter 5 detailed the process in which I employed the DE approach in my project across three iterations. In each iteration, I evaluated the quantitative and qualitative data learning lessons to revise and improve the overall activity design as well as specifically the experiential learning components within it to

aid in the attainment of student outcomes. Figure 7.1 summarises the findings and subsequent changes made based on those findings across the three iterations.

In Chapter 6, I synthesised the lessons learnt across the three iterations and devised the *VirtualVoyageVista,* an activity design framework that uses an integrated VFT activity to support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education. Figure 7.2 presents the framework that was introduced in section 6.2 along with a detailed advisory for users of the framework in section 6.2.3.

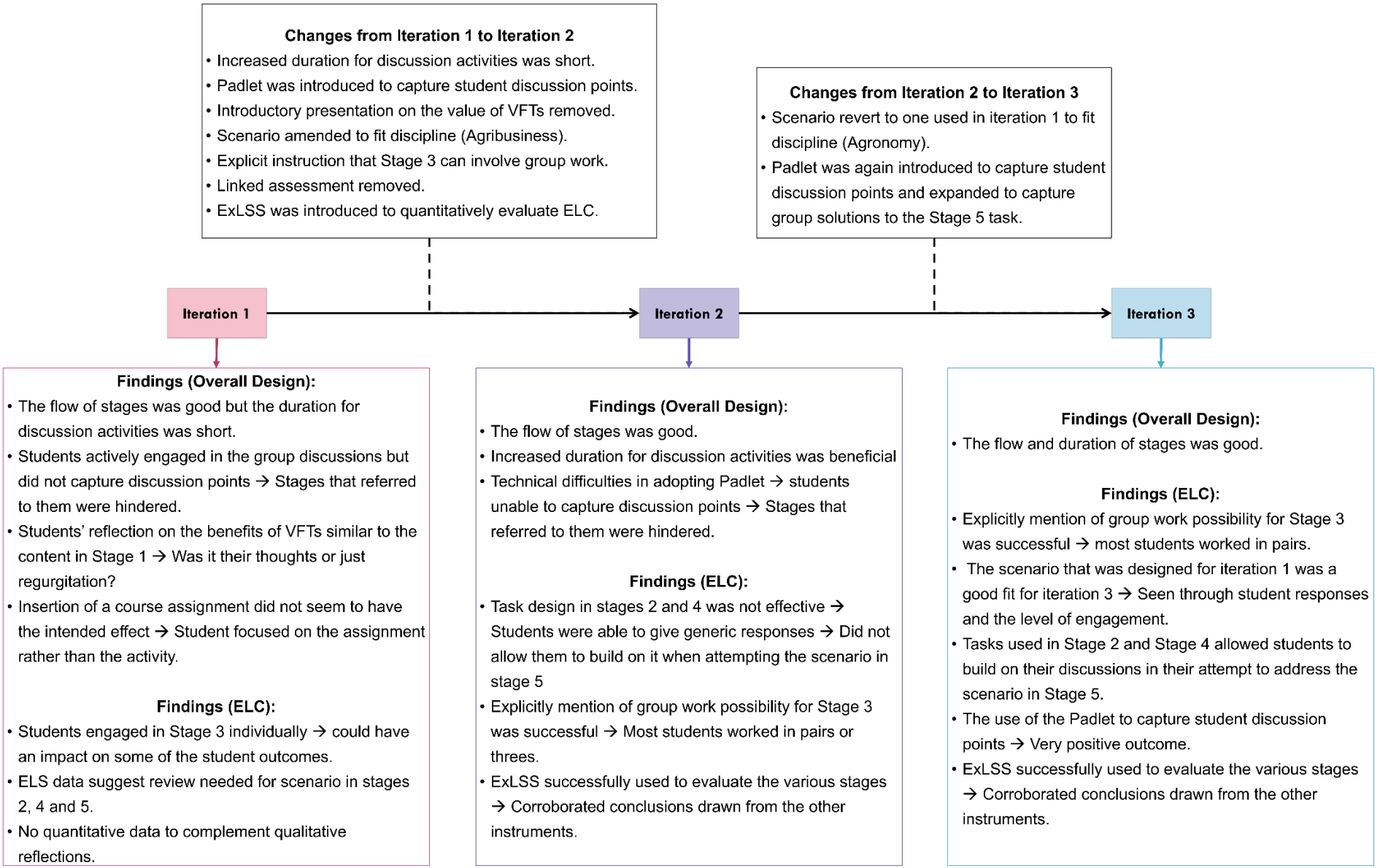


Figure 7-1 Summary of findings and changes made based on those findings for each iteration.

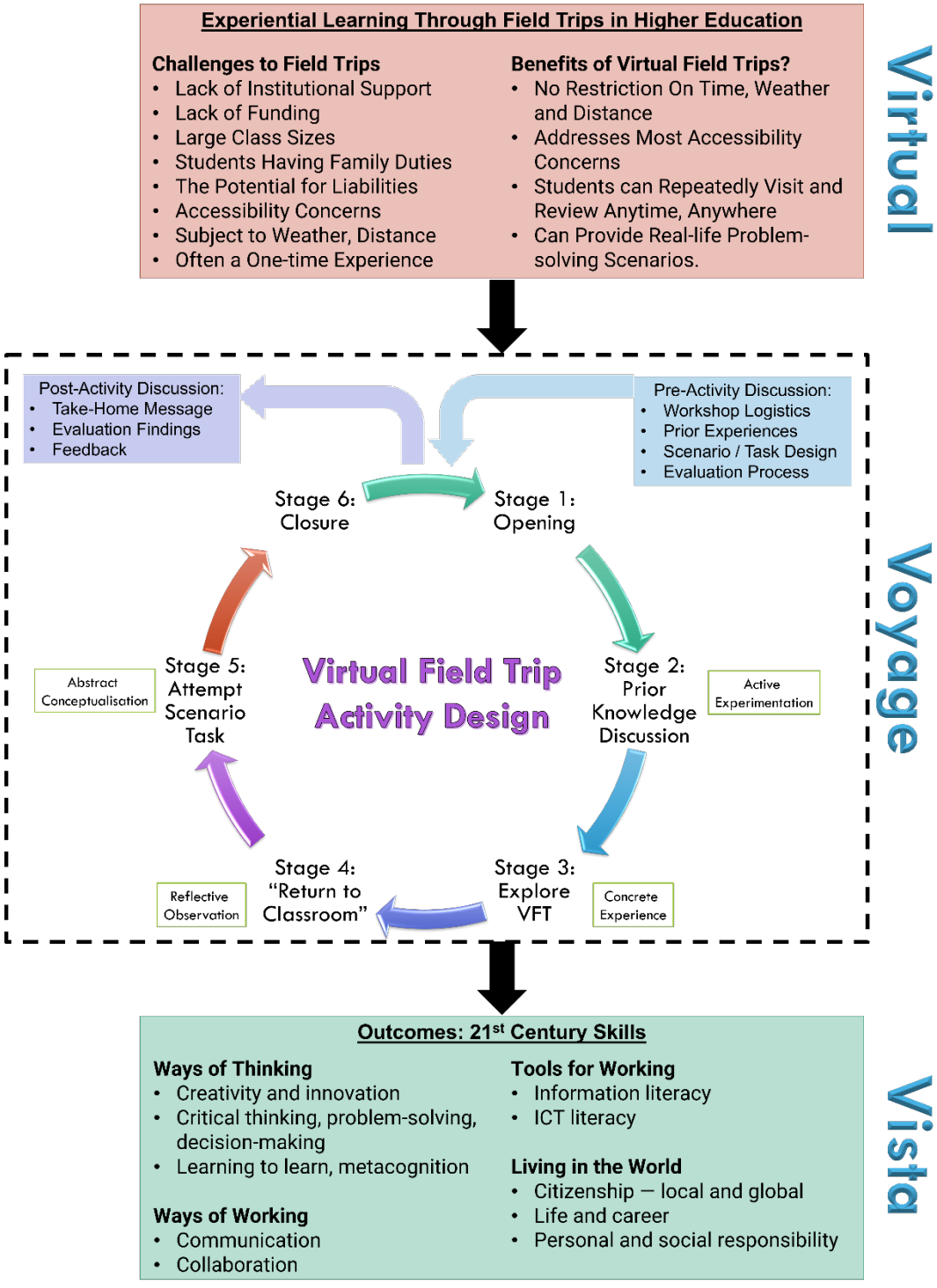


Figure 7-2 *VirtualVoyageVista* Framework as presented in Chapter 6

Another aspect of my project that has been key is the use of DE in a novel manner which was discussed in section 3.4. In the literature, there have been various examples where DE has been used across various areas

including exploring the impact of lesson study (Godfrey et al., 2018), curriculum innovation in professional education (Leonard, Fitzgerald, & Riordan, 2015), communities of practice (van Winkelen, 2016), reframing a degree in a new school (Ahonen & Lacey, 2017) and supporting a change in sex education policy (Fagen et al., 2011). The scale of those projects can be seen to be larger as compared to my project where I adopted it for the design at an activity level. Furthermore, the shortest duration for those projects was nine months with most of them ranging between one and four years. In my project, I used it within a tight 13-week (1 semester) duration using three iterations across three subdisciplines. How I have adopted the approach had not been previously reported.

As described in sections 3.4 and 4.2, the key to using the DE approach, is the adherence to the eight principles as set out by Patton (2016a) with an importance on the contextual understanding and application of the innovation. Despite this emphasis on the adherence to all eight of the DE principles, there were three principles that I found to be critical to the conduct and success of a DE evaluation project specifically. This is because there are some principles which lend themselves to various evaluation approaches.

The first key principle is the developmental purpose principle which I found to be the most important. Its importance lies in the fact that it underpinned the entire project. Attending to this principle encouraged me to ensure that all stakeholders had a common understanding of what was being evaluated and ensured that all instruments allowed relevant data that informed the innovation to be collected. Utilizing this principle also helped me focus on establishing that the required information were collect at the appropriate time to make conclusions about the innovation. To me this principle was a critical one as it kept the entire project team on point that the innovation was not the VFT itself but rather the activity design that incorporated it with the ELC.

Another two principles that are, in my opinion, intrinsically linked are the complexity perspective and system thinking principles. Educational research is fundamentally a field of social science research involving individuals each with their own perceptions, values and ideologies which can affect methodologies,

findings and conclusions drawn. A range of formative and summative evaluative approaches often have implicit understanding of what success looks like. However, DE prides itself on adhering to more specific complexity principles such as *nonlinearity* and *uncertainty*.

Reviews of literature on the topic of innovations in higher education seldom refer to contexts and the interplay between external influences (Major et al., 2020) though it is interesting that previous work from Fischer (2016) raised notion that “institutional culture” was important in pedagogical innovations. DE reminds us that innovations do not take place in isolation and that we should pay attention to the interrelationships, perspectives and boundaries between the innovation and the context where it is applied (*systems thinking principle*). Together these two principles ensure that innovation evaluation is not conducted with a pre-conceived notion of what success is but rather allows the data to guide conclusions and adjustments made to the innovation.

Furthermore, they ensured that the evaluation was approached in a systematic manner resulting in me being able to leverage various data sources to make clear conclusions. Table 4.1 summarised the DE principles and how they were adhered to within the project context while Table 7.1 presents my reflections at how successful I was, from the point of view of having finished the project and reflecting.

DE Principle	**Definition** (Patton, 2016a)	**Contextualisation and Operationalisation in my Project**	**Reflection**
Developmental Purpose	"Illuminate, inform and support the innovation by identifying the nature and patterns of development along with the implications and consequences of those patterns"	• My Purpose: Evaluating the innovative use of an integrated VFT activity design to support a process that links experiential learning to appropriate student outcomes in undergraduate agriculture education. • Ensured that all course coordinators and I (evaluator) were on the same page of understanding the purpose of the evaluation. • Ensured that the activity design for each iteration employed the ELC incorporating VFT. • Established the information required to make conclusions about the innovation and ensured that the right instruments were employed at the appropriate time. • Ensured included the incorporation of data collection from a range of sources to ensure a holistic view of the student experience. • Ensured that the data collected drove the conclusions despite our preconceived notions (e.g. using an inductive approach for thematic analysis).	• In ensuring that my approach adhered to this principle, I clearly defined the project's evaluation objectives and engaged the course coordinators to ensure that the evaluation was relevant and meaningful to them. • As illustrated via the *VirtualVoyageVista* framework in Chapter 6, I successfully incorporated the VFT within the activity design based on the ELC. • Chapter 5 evidenced how I successfully planned for and collected data from a range of sources including how I embraced this principle in my data analysis. • Looking back at the project, the adherence to this principle was successfully done although it became repetitious to keep reminding the course coordinators that the innovation was not the VFT itself but rather the activity design that incorporated it with the ELC.

DE Principle	**Definition** (Patton, 2016a)	**Contextualisation and Operationalisation in my Project**	**Reflection**
Evaluation Rigor	"Use rigorous evaluative thinking and situationally appropriate rigorous evaluation methods"	• Mapped individual activity stages to the ELC phases and developed student activities to ensure that the essence of the phases is leveraged for the student experience. • Embedded data collection processes within the activity stages to maximise response rates and collect as much of the required data as possible. • The data collected from students was thus limited to questionnaires. • Adopted a mixed approach using quantitative questionnaires, qualitative reflections, and observations to corroborate our findings and conclusions. • Employed a combination of standardised measures alongside specifically designed measures for the project.	• In ensuring that our approach adhered to this principle, I mapped the activity stages to the phases of the ELC as illustrated via the *VirtualVoyageVista* framework in Chapter 6. • Figure 4.3 illustrates the successful embedding of data collection processes withing the activity stages. • Section 4.4 describes how I successfully adopted a mixed approach using quantitative questionnaires, qualitative reflections, and observations to corroborate our findings and conclusions. • I also successfully employed a combination of standardised measures (e.g. ELVIS, ExLSS) alongside reflections and questionnaires specifically designed for the project. • Looking back at the project, the adherence to this principle was successful although it could be improved by including an academic perspective of the activities and potentially data analytic measures as well .

DE Principle	**Definition** (Patton, 2016a)	**Contextualisation and Operationalisation in my Project**	**Reflection**
Utilization Focus	"Focus on the intended use by intended users from beginning to end"	• Coordinators were actively engaged in the design process giving direction on the type of scenario used and the activity instructions the students were given. • Coordinators actively shared what they would like to find out about the implementation shaping choices of measures and qualitative questions. • Between iterations, coordinators were engaged in discussion regarding the findings and any observations made which would influence the activity design. • The *VirtualVoyageVista* framework was developed in consultation with the coordinator bringing together learning points from across the three iterations.	• In ensuring that our approach adhered to this principle, as described across Chapter 5, I actively engaged and involved course coordinators in the activity design, choice of evaluation measures and interpreting iteration findings. • Looking back at the project, the adherence to this principle was potentially the most successful although the student perspective as a potential end-user could be explored further.
Innovation Niche	"Elucidate how the change process involves innovation and adaptation"	• established the innovation: how an integrated VFT activity design to support a process that links experiential learning to appropriate student outcomes specifically in undergraduate agriculture education.	• In ensuring that our approach adhered to this principle, as described in Chapter 3.4.4 and 4.2.4, I actively emphasised that the innovation is the integrated VFT activity that is designed to support a process that links experiential learning

DE Principle	**Definition** (Patton, 2016a)	**Contextualisation and Operationalisation in my Project**	**Reflection**
		• Adapted the ELC, often used for in-person field trips to develop the VFT integrated activity design. • Adapted the contextualised scenarios from one iteration to the other as an adaptation of the innovation from one context (e.g. horticulture) to another context (e.g. agribusiness). • Used lessons learnt from each iteration allowed me to revise the innovation and make adaptations appropriately.	to appropriate student outcomes which resulted in *VirtualVoyageVista* framework in Chapter 6 • The adaptation aspects were framed as the adaptation of the ELC to the VFT realm as well as from each iteration to the next. However, looking back, perhaps this view of *adaptation* was perhaps limited and not as accurately established in the project.
Complexity Perspective	"Understand and interpret the development through the lens of complexity and to conduct the evaluation accordingly"	• Embraced the idea of *nonlinearity* and sought to complete the DE iterations across a tight timeframe. • Embraced an *uncertainty* mindset to appreciate that what worked in one iteration may not work as well in another. • Embraced an *emergent* and *adaptive* view, allowed the findings from each iteration to guide the innovation and subsequent evaluations.	• Embracing the four ideas of complexity was key to being flexible in approaching the evaluation for each iteration. • My understanding of the complexity perspective and systems thinking principle were often interlinked and though I can find specific examples to highlight where the complexity ideas were embraced, I feel like more clarity for me between them would have been beneficial to the project.

DE Principle	**Definition** (Patton, 2016a)	Contextualisation and Operationalisation in my Project	Reflection
Systems Thinking	"Think systematically through the entire evaluation paying attention to the interrelationships, perspectives and boundaries between the innovation and the context where it is applied"	• I sought to capture data to help me understand the various factors that can influence a successful student activity experience to help contextualise the findings. • When deciding the appropriate measures, I ensured that various aspects of the student experience would be measured to give me a holistic understanding of their overall experience. • I approached the evaluation of each iteration from in systematic manner by collating the findings from different measures and instruments through the lens of the activity design and student outcomes rather than a measure-by-measure analysis.	• Systematically approaching the evaluation proved to be advantageous as it allowed me to leverage various data sources to make clear conclusions about student outcomes. • As discussed in the complexity perspective principle, I feel like more clarity for me between them would have been beneficial to the project.
Co-Creation	"Develop the innovation and evaluation together so that the DE becomes part of the change process"	• This principle underpinned the decision to involve the course coordinators (who are also the end-users) in decisions related to the innovation, its implementation, evaluation, and subsequent adaptations. ○ Before the iterations, the coordinators provide information about the class	• In ensuring that our approach adhered to this principle, as described in Chapter 5, I actively engaged the course coordinators across the different segments of the project. • However, the challenge faced in adhering to this principle was that having a different coordinator for each iteration meant that from the view of

DE Principle	**Definition** (Patton, 2016a)	**Contextualisation and Operationalisation in my Project**	**Reflection**
		involved in the iteration and provide their expertise in designing the scenario and activities for each activity stage. o They also provided an insight into what information would be key in helping them evaluate the implementation. In analysing the data collected, they are once again consulted to make sense of the data along with contextualising the conclusions that are made. o They support the conclusion made regarding the activity design and where appropriate suggest improvements to the evaluation process. • This cycle of consultation and implementation was repeated across all three iterations albeit with different coordinators.	that stakeholder, they only saw this from the lens of individual iterations and only I (as the evaluator) saw the three iterations as a whole.
Timely Feedback	"Time the feedback process in a manner that appropriately informs the innovation rather than only predetermined times"	• With the three iterations, it was critical that each iteration had to completed promptly so that lessons could be drawn and used in the subsequent iteration.	• Chapter 5 illustrates how I was able to successfully incorporate three data collection phases for each iteration – the pre-activity phase, the post-activity phase and during the activity itself.

DE Principle	Definition (Patton, 2016a)	Contextualisation and Operationalisation in my Project	Reflection
		• I ensured that all data collected was in a "just in time" manner just after or during the activity stages → three data collection phases – the pre-activity phase, the post-activity phase and during the activity itself. • Focusing all data collection within the conduct of the iteration meant no waiting time between collection and analysis. • Though a mixed method was employed, a large proportion of the data collected was quantitative in nature allowing for quicker analysis and for conclusions to be drawn in a shorter time.	• All evaluations were completed in time for the lessons learnt to be incorporated into the subsequent iteration which is evidence for my successful adherence to this principle.

Table 7.1 Reflecting on the eight DE principles and my project contextualisation

7.4 Limitations

With the descriptions of the findings in section 7.3 above, it is important to reflect on the limitations of the project and in this section, I will highlight three of the more pertinent ones.

The first is a limitation arising from the small sample sizes across my 3 iterations. The student participant numbers across my 3 iterations were 9, 34 and 9 respectively totalling 52 participants. This became a bigger problem in Iteration 2 where many of the students did not complete the post-surveys and in Iteration 3 where students did not turn up to the class. Though the low turnout was anticipated, steps taken to encourage their attendance failed. The small sample size could have an impact on both the quantitative and qualitative analysis in that it raises the risk of several types of bias in research and the impact on the statistical power of the finding, which can compromise the validity of the study findings. Despite this, I believe it is important to consider that though the numbers are small, they represent almost 50% of the total enrolment in these courses with Iteration 1 having 64.3% of the enrolment being involved. More importantly, Ahrens and Zaščerinska (2014) acknowledged that sample size is dependent on external and internal perspectives which for my project's context is the courses that are eligible for the student – specifically their learning activity plans, the students enrolled in the course and the timeframe that I bounded the project by.

Secondly, the project centred around the use of a VFT application which was developed as part of the 2021 ACDS Teaching and Learning Grant. This posed a resource limitation in that any findings related to making improvements to the application itself whether it was important to student learning were unable to be actioned on due to the lack of further funding from the project. In understanding the student experience with VFTs during the iterations, I asked them to reflect on how they used the application and what they would change about the experience to enhance it for future students. Though I sought feedback on the user interface and navigation, these were not amended from iteration to iteration. Unfortunately, the impact of the VFT quality on the student

experience was not adequately addressed raising a question if they would have had a better experience if the suggested changes were made appropriately. However, it was interesting to note that the ratings for the VFT interface and media and learning with the VFT scale improved from iteration to iteration despite the decreasing perception of the VFT rating. This reinforced my perception that a better student experience is more important to a successful learning activity than the quality of the technology employed.

Lastly, in this project, I have employed the DE approach in a novel manner both in terms of its scale and context in the agricultural realm. As there has not been prior work of a similar nature to guide the methodological approach and considerations to be taken, many of the decisions and directions taken were based on my experience and continued use of the DE approach in various other research projects. In the literature, the eight guiding principles as laid out by Patton (2016a), guide DE evaluators in adopting best practices when engaging in the DE methodology. Across various publications, he gives examples of how the principles can be adopted and adapted to various projects (Patton, 2011, 2016b). He does note that a contextual understanding of the project and what is to be achieved is important towards a successful implementation. However, the scale at which I have adopted it is not what can be termed as “traditional”. Hence, despite the “successful” implementation, the principles could have been incorrectly applied thus leaving the entire methodological approach without a solid foundation to rest on.

7.5 Contributions to the literature

As discussed in Chapter 2, reviewing the literature relevant to VFTs illustrated that we have a lot to learn about implementing them with a sound pedagogical grounding and achieving broader, holistic student outcomes. The three themes in the literature to which my project contributes are pedagogical considerations, evaluation approaches and student outcomes. In Chapter 2, I have set out my projects’ contribution to the literature in some detail. Table 7.2

below summarizes this alongside the major reflections from the literature review.

Themes	Main Reflection from Lit Review	Project Aims	My Project's Contribution to Literature
Pedagogical Considerations	• Across the literature there is no consistent pedagogical model. • Though the dominant rhetoric is centred on the importance of providing students with an *experience* → most researchers do not explicitly employ the ELT or ELC in their implementation. • Articles that explicitly mention a pedagogical model underpinning their work, the connection between that model and their activity design was mixed. • Articles that discussed the ELT or ELC, show a diversity in how it is employed in the projects. In each case, this pedagogical consideration did not follow through into their activity design. • There is increasing acknowledgement that not all aspects of an in-person field trip can be replicated by a VFT.	My project aims to propose an activity design framework that explicitly embraces the ELT and operationalises it by leveraging the four phases of the ELC.	• My project's contribution to this theme is the *illustration of the design principles of experiential learning in using VFTs*. • I did this by developing the *VirtualVoyageVista* framework (described in section 6.2) which lays out an activity design that incorporates VFTs as part of an experiential learning activity that was explicitly underpinned by ELT. • In the *VirtualVoyageVista* framework, the main activity stages were mapped to the four phases of the ELC, and specific activities were designed to bring out the essence of the phase. • This is a valuable contribution as "experience" is a key reason why many researchers embarked on their research into VFTs as either a replacement or supplementary component to in-person field trips.

Themes	Main Reflection from Lit Review	Project Aims	My Project's Contribution to Literature
Evaluation Approaches	• The evaluations could be categorised as evaluating a single implementation, a comparative study, or an on-going iterative study. • The evaluations conducted were always summative, the approaches do not seamlessly allow for the researchers to investigate the granularity of their innovation as the students had to look back at their experience when engaging with the measures. • Though these evaluations provided lessons to be learnt, only 4 of the articles reviewed adopted the lessons learnt and reevaluated the innovation in subsequent iteration(s). • One commonality across all the evaluations is that they are outcome-focussed with an emphasis on achieving that outcome rather than informing the innovation being evaluated.	• My project aims to adopt the Development Evaluation approach. • I aim to demonstrate the effectiveness of an evaluation approach that in integrated with the innovation being evaluated allowing me to draw evidence from various sources and data points. • I aim to leverage the eight guiding principles to design an iterative approach that is flexible and responsive, and process focussed.	• My project's contribution to this theme is the *demonstration of the DE methodology*, using it in a completely new context and scale, specifically in agricultural education for a single learning activity and in an iterative manner and in doing so, make 3 contributions. • In adhering to the developmental purpose principle focused my evaluation on the process of how the innovation was implemented rather than pre-empting a desired outcome. It is this process-focus lens that allowed me to focus on the student experience in designing and evaluating an experiential learning activity sequence. • In adhering to the evaluation rigor principle, I employed an integrated approach where evaluative elements tightly fit across various stages in the experiential learning activity design within and across iterations. This

Themes	Main Reflection from Lit Review	Project Aims	My Project's Contribution to Literature
	• Approaches have an element of rigidity in choice of evaluation measures.		integrated approach allowed me to draw evidence from various sources and data points when seeking to understand the student experience at each stage of the learning activity and when making conclusions about the intended student outcomes. • In my project, I employed DE in an iterative manner which allowed me to evaluate my activity design and allow guidance made from findings to be retested and continually improved upon. This iterative approach was valuable in the varied lessons learnt from Iteration 3 as compared to Iteration 1.
Student Outcomes	• Student outcomes were broadly categorised as either being a measure of student satisfaction/perception or that of knowledge gain. • In using VFTs, student satisfaction and perception levels were positive → The	My project aims to contribution to this theme by evaluating student outcomes aligned to the UQ graduate outcomes encompassing desired skills and attributes such as problem-solving, collaborative skills, engagement with technology and a	• My project's contribution to this theme is to *highlight the potential of attaining broader educational outcomes through a VFT integrated experiential learning ac*tivity.

Themes	Main Reflection from Lit Review	Project Aims	My Project's Contribution to Literature
	importance of looking into student satisfaction or perception with VFTs as educational technology can easily lead to a poor learning experience and become a barrier to learning. • In using VFTs, students demonstrated increased knowledge gain though findings were mixed at higher cognitive outcomes. • Researchers missed the opportunity to measure broader educational outcomes.	developing understanding of student social and civic responsibility.	• Through my project, across the three iterations, I was able to evaluate four student outcomes: 1. Student will display an understanding of social and civic responsibility. 2. Student will display the ability to engage effectively and appropriately with information and communication technologies. 3. Student will display the ability to interact effectively with others to work towards a common outcome. 4. Student will display the ability to identify problems, create solutions, innovate, and improve current practices.

Table 7.2 Summary of projects' contribution to the literature

7.6 Implications for Policy

In section 1.3, I set out my project's policy context within the Australian setting. Firstly, though there are many policies on field trips, they focus primarily on providing guidelines and resources to schools and educational institutions to help them plan and conduct safe and effective field trips rather than having clear educational objectives that tie in with intended student outcomes. Secondly, it came across clearly that in the schooling context (up to year 12) there was explicit mention of "field work" across learning outcomes from different learning units. However, when we look at the threshold learning outcomes, for higher education, in disciplines like geography and Agriculture, there is barely any mention of it. We do see educational outcomes connected to 21st-century skills like communication and working in teams.

My project's implications for policy arise from my findings of how VFT can be incorporated into an experiential learning activity and its ability to help students attain those very 21st-century skills. Firstly, being able to conduct these activities within the confines of a classroom would allow for policy development with a focus on the educational objectives of a field rather than just a focus on safety and risk management processes. Though those elements are critical to in-person field trips, a subset of field trip policy could be developed for the use of VFTs.

Secondly, my findings show the ability of VFTs to help students attain 21st-century skills like communication and working in teams emphasise the enduring importance of field trips as a learning experience. Though currently, the schooling curriculum emphasizes field trips as a hands-on experience, the lack of its mention in higher education policies, especially in Agriculture, is a concern. However, with my findings, if policies were to be reviewed, the importance of field trips could be highlighted as part of threshold learning outcomes in line with the intended student outcomes.

7.7 Implications for Practice

Findings from my project have implications for practice at two levels. Firstly, fellow educators who are interested in using VFTs for their teaching have a tested activity design framework that they can use to deliver their lessons. With the framework in tow, they would be able to ascertain that they are delivering an experiential learning experience and that students would have an opportunity to attain broader educational outcomes.

Additionally, the DE approach adopted in the manner that I have exemplifies a means of introducing and evaluating an educational technology innovation within the higher education setting. The approach of using it iteratively also exemplifies how innovations can be infused into multiple courses and programmes within a short period. Considering the dynamic environment of higher education, This is important as described in section 3.4 in situations where university courses are run only in one semester and consecutive runs are almost 30 weeks later.

For my local practice, the inception of my project and completion of the iterations have had longer-term implications at the School of Agriculture and Food Sustainability. Firstly, the activity design framework and associated VFT have become a mainstay in the curriculum of HORT2007 and AGRC1024 which were the courses for Iteration 1 and Iteration 3. Since the iteration of the project, it has now been used in 2023 and is slated for use in the upcoming semester.

Secondly, the success of the project laid the foundations for another funding success where the ACDS project team, briefly mentioned in section 4.3.2, applied for and received funding under the 2022 UQ Faculty of Science teaching and learning grants scheme to further improve the VFT platform (*Faculty of Science - Past teaching and learning grant recipients* 2024). The intention behind these further improvements to the platform was to make it easier for academics to build their VFTs or connect existing VFTs to the same platform.

Thirdly, at the time of writing, there are four other VFTs connected through the platform being used by courses particularly those in the animal science and food science disciplines – who missed out on my project reported in this thesis due to the nature of the VFT I used. Though not all of them employ the activity design framework I proposed in my thesis, course coordinators' willingness to explore VFTs as another form of educational technology beyond that of just video lectures was a personal win.

7.8 Implications for Future Research

The successful completion of the project satisfied many if not all my initial motivations for undertaking it. Finding a need at the school during a challenging time and being able to meet it has been a personal achievement. The project has successfully placed VFTs at the forefront of educational technology options at the school. As I reflected upon the project, I found areas for future research. As the project was developed and evaluated across the horticulture, agronomy and agribusiness fields in a rural campus, the activity design should also be evaluated across different disciplines and schools potentially even looking across different institutions, though in each of these potentials, they would need different VFTs.

Another aspect of the project I have not explored is the differing views between the academic staff and the students in using the VFTs. The activity design was presented and discussed with course coordinators before each implementation. I hypothesised that the academics would have differing views of whether the VFT works for their course and achieves the intended outcomes. As such, I had an initial intention to compare the experiences of the academics with that of the students. However, my decision to be the facilitator for the sessions meant that that comparison was not conducted and now stands as a potential for future research.

During the initial discussions with course coordinators about the potential use of VFT in their courses, an idea was mooted that did not fall within the scope of this project but was nonetheless interesting. The idea was to

investigate ways to use VFTs in the assessment space. Since its inception (Harden & Gleeson, 1979), the use of Objective Structured Clinical Examinations (OSCE) for student competence to be assessed as a whole has grown and now found home across the healthcare discipline in medicine (Carraccio & Englander, 2000), dentistry (Majid, Alikutty, & Rahaman, 2017), psychology (Yap et al., 2021) and nursing assessment (Mitchell et al., 2009). The key to a successful OSCE strengthening its validity, reliability and practicality as described in Harden and Gleeson (1979) is in the selection of a suitable patient and it is also recommended that a simulated patient could be used. Here is where I see VFTs being a powerful tool. It would present the visit consistently every time and offer a unique interdisciplinary potential where students could be assessed at the programme level. Specific to the Bachelor of Agricultural Science programme at my school, different course coordinators could come together to design the assessment and students would have to pull together knowledge and skills from a suite of those courses in attempting it.

Glossary and/or List of abbreviations

ACDA	Australian Council of Deans of Agriculture
ACDS	Australian Council of Deans of Science
AGFS	School of Agriculture and Food Sustainability
DE	Developmental Evaluation
ELC	Experiential Learning Cycle
ELS	Experiential Learning Survey
ELSS	Experiential Learning Student Survey
ELT	Experiential Learning Theory
ELxSS	Experiential Learning Stages Survey
UQ	The University of Queensland
VFT	Virtual Field Trip

Chapter 8: References

Abdulwahed, M., & Nagy, Z. K. (2009). Applying Kolb's Experiential Learning Cycle for Laboratory Education. *Journal of Engineering Education*, *98*.

Acuña, T. B., Able, A., Kelder, J.-A., Bobbi, P., Guisard, Y., Bellotti, B., McDonald, G., Doyle, R., Wormell, P., & Meinke, H. (2014). *Learning and Teaching Academic Standards Statement for Agriculture*. Sydney, Australia

Agricultural Science - General Senior Syllabus. (2019).

Ahn, J.-H. (2008). Application of the Experiential Learning Cycle in Learning from a Business Simulation Game. *E-Learning and Digital Media*, *5*(2), 146-156. https://doi.org/10.2304/elea.2008.5.2.146

Ahonen, E. Q., & Lacey, S. E. (2017). Undergraduate Environmental Public Health Education. *New Solut*, *27*(1), 107-123. https://doi.org/10.1177/1048291117697110

Ahrens, A., & Zaščerinska, J. (2014). Factors That Influence Sample Size in Educational Research. *Education in a Changing Society*, *1*(0). https://doi.org/10.15181/atee.v1i0.659

Alsaqqaf, A., & Li, F. (2019). Conceptual Framework for Virtual Field Trip Games. In *Immersive Learning Research Network* (pp. 43-55). https://doi.org/10.1007/978-3-030-23089-0_4

Annetta, L., Klesath, M., & Meyer, J. (2009). Taking Science Online: Evaluating Presence and Immersion through a Laboratory Experience in a Virtual Learning Environment for Entomology Students. *Journal of College Science Teaching*, *39*(1).

Arrowsmith, C., Counihan, A., & McGreevy, D. (2005). Development of a multi-scaled virtual field trip for the teaching and learning of geospatial science. *International Journal of Education and Development using Information and Communication Technology*, *1*(2).

Arsoy, A., & Özad, B. E. (2004). The experiential learning cycle in visual design. *The Turkish Online Journal of Educational Technology*, *3*(2).

Association for Experiential Education. (2021). https://www.aee.org/

Atchison, J., & Kennedy, J. (2020). Being on Country as Protest: Designing a Virtual Geography Fieldtrip Guided by Jindaola. *Journal of University Teaching & Learning Practice*, *17*(4).

Australian Council of Deans of Science (ACDS). (n.d.). *National Regulation*. Retrieved 25/2/24 from https://www.acds.edu.au/teaching-learning/science-threshold-learning-outcomes-tlos/national-regulation/

Australian Learning and Teaching Council. (2010). *Geography Learning and Teaching Academic Standards Statement*.

Bailie, J., Laycock, A. F., Peiris, D., Bainbridge, R. G., Matthews, V., Cunningham, F. C., Conte, K. P., Abimbola, S., Passey, M. E., & Bailie, R. S. (2020). Using developmental evaluation to enhance continuous reflection, learning and adaptation of an innovation platform in Australian Indigenous primary healthcare. *Health Res Policy Syst*, *18*(1), 45. https://doi.org/10.1186/s12961-020-00562-4

Barber, S., Hallein, E., Shallcross, D., Weston, J., Jacobson, C., Bramley, E., Celi, P., & McGowan, M. (2016). *Development of 4D farms to improve student learning and safety* Australian Government Office for Learning and Teaching.

Behrendt, M., & Franklin, T. (2014). A Review of Research on School Field Trips and Their Value in Education *International Journal of Environmental & Science Education*. https://doi.org/10.12973/ijese.2014.213a

Boomaroo Nurseries. (2022). https://boomaroo.com/about-us/who-we-are/

Bradford, T., Hock, G., Greenhaw, L., & Kingery, W. (2019). Comparing experiential learning techniques and direct instruction on student knowledge of agriculture in private school students. *Journal of Agricultural Education*, *60*(3). https://doi.org/10.5032/jae.2019.03080

Buckley, S. J., Howell, J. A., Naumann, N., Pugsley, J., Vanbiervliet, J., Ringdal, K., Lewis, C., Tong, B., & Chmielewska, M. (2022). *Virtual Field Trips: Experience from a Global Pandemic and Beyond* SPE Norway Subsurface Conference,

Bursztyn, N., Pederson, J., Shelton, B., Walker, A., & Campbell, T. (2015). Utilizing geo-referenced mobile game technology for universally accessible virtual geology field trips. *International Journal of Education in Mathematics, Science and Technology*, *3*(2).

Çaliskan, O. (2011). Virtual field trips in education of earth and environmental sciences. *Procedia - Social and Behavioral Sciences*, *15*, 3239-3243. https://doi.org/10.1016/j.sbspro.2011.04.278

Carraccio, C., & Englander, R. (2000). The objective structured clinical examination. A step in the direction of competency-based evaluation. *154*(7).

Centre for Research and Development in Learning. (2018). Cradle Highlights. In Nanyang Technological University (Ed.), (Vol. 1).

Chan, C. K. Y. (2023). *Assessment for Experiential Learning*. Routledge.

Cirillo, M., Berk, D., LaRochelle, R., Bieda, K. N., & Arbaugh, F. (2022). Undergraduate Students' Perceptions of Features of Active Learning Models for Teaching and Learning to Teach Mathematics. *International Journal of Research in Undergraduate Mathematics Education*, *10*(1), 172-200. https://doi.org/10.1007/s40753-022-00191-y

Clem, J. M., Mennicke, A. M., & Beasley, C. (2014). Development and Validation of the Experiential Learning Survey. *Journal of Social Work Education*, *50*(3), 490-506. https://doi.org/10.1080/10437797.2014.917900

Cliffe, A. D. (2017). A review of the benefits and drawbacks to virtual field guides in today's Geoscience higher education environment. *International Journal of Educational Technology in Higher Education*, *14*(1). https://doi.org/10.1186/s41239-017-0066-x

Coker, J. S., Heiser, E., Taylor, L., & Book, C. (2016). Impacts of Experiential Learning Depth and Breadth on Student Outcomes. *Journal of Experiential Education*, *40*(1), 5-23. https://doi.org/10.1177/1053825916678265

Delivering Ag2030. (2022). Department of Agriculture, Water and the Environment. https://www.agriculture.gov.au/sites/default/files/documents/delivering-ag2030-april-2022.pdf

Djonko-Moore, C. M., & Joseph, N. M. (2016). Out of the Classroom and Into the City. *SAGE Open*, *6*(2). https://doi.org/10.1177/2158244016649648

Dolphin, G., Dutchak, A., Karchewski, B., & Cooper, J. (2019). Virtual field experiences in introductory geology: Addressing a capacity problem, but finding a pedagogical one. *Journal of Geoscience Education*, *67*(2), 114-130. https://doi.org/10.1080/10899995.2018.1547034

Evelpidou, N., Karkani, A., Komi, A., Giannikopoulou, A., Tzouxanioti, M., Saitis, G., Spyrou, E., & Gatou, M.-A. (2022). GIS-Based Virtual Field Trip as a Tool for Remote Education. *Geosciences*, *12*(9). https://doi.org/10.3390/geosciences12090327

Faculty of Science - Past teaching and learning grant recipients (2024). https://intranet.sharepoint.uq.edu.au/sites/Science/awardsgrants/SitePages/Past%20teaching%20and%20learning%20grant%20recipients.aspx

Fagen, M. C., Redman, S. D., Stacks, J., Barrett, V., Thullen, B., Altenor, S., & Neiger, B. L. (2011). Developmental evaluation: building innovations in

complex environments. *Health Promot Pract*, *12*(5), 645-650. https://doi.org/10.1177/1524839911412596

Ferrer, J., Ringer, A., Saville, K., A Parris, M., & Kashi, K. (2020). Students' motivation and engagement in higher education: the importance of attitude to online learning. *Higher Education*, *83*(2), 317-338. https://doi.org/10.1007/s10734-020-00657-5

Fischer, A. (2016). Why Culture Matters in Pedagogical Innovation: A Look at Higher Education. *The International Journal of Interdisciplinary Educational Studies*, *9*.

Friess, D. A., Oliver, G. J. H., Quak, M. S. Y., & Lau, A. Y. A. (2016). Incorporating "virtual" and "real world" field trips into introductory geography modules. *Journal of Geography in Higher Education*, *40*(4), 546-564. https://doi.org/10.1080/03098265.2016.1174818

Fung, F. M., Choo, W. Y., Ardisara, A., Zimmermann, C. D., Watts, S., Koscielniak, T., Blanc, E., Coumoul, X., & Dumke, R. (2019). Applying a Virtual Reality Platform in Environmental Chemistry Education To Conduct a Field Trip to an Overseas Site. *Journal of Chemical Education*, *96*(2), 382-386. https://doi.org/10.1021/acs.jchemed.8b00728

Garner, L. C., & Gallo, M. A. (2005). Field Trips and Their Effect on Student Achievement and Attitudes: A Comparison of Physical versus Virtual Field Trips to the Indian River Lagoon. *Journal of College Science Teaching*, *34*(5).

Geography - General Senior Syllabus. (2019).

Ghaffarzadegan, N., Larson, R., & Hawley, J. (2017). Education as a Complex System. *Syst Res Behav Sci*, *34*(3), 211-215. https://doi.org/10.1002/sres.2405

Godfrey, D., Seleznyov, S., Anders, J., Wollaston, N., & Barrera-Pedemonte, F. (2018). A developmental evaluation approach to lesson study: exploring the impact of lesson study in London schools. *Professional Development in Education*, *45*(2), 325-340. https://doi.org/10.1080/19415257.2018.1474488

Goertzen, J. R., Fraser, A. D., Stasiewicz, M. E., & Grinman, M. N. (2020). Applying the eight principles of developmental evaluation: Complex Care Hub as a case example. *Evaluation*, *27*(2), 251-270. https://doi.org/10.1177/1356389020969714

Grosser, P. F., Xia, Z., Alt, J., Ruppel, U., & Schmalz, B. (2023). Virtual field trips in hydrological field laboratories: The potential of virtual reality for conveying hydrological engineering content. *Educ Inf Technol (Dordr)*, *28*(6), 6977-7003. https://doi.org/10.1007/s10639-022-11434-5

Habib, M. K., Nagata, F., & Watanabe, K. (2021). Mechatronics: Experiential Learning and the Stimulation of Thinking Skills. *Education Sciences*, *11*(2). https://doi.org/10.3390/educsci11020046

Hai Chien Pham, Nhu-ngoc Dao, Akeem Pedro, Quang Tuan Le, Rahat Hussain, Cho, S., & Park, C. S. (2018). Virtual Field Trip for Mobile Construction Safety Education Using 360-Degree Panoramic Virtual Reality. *International Journal of Engineering Education*, *34*(4).

Hallein, E., Shallcross, D., Dalvean, J., Celi, P., McGowan, M., Jacobson, C., Bramley, E., Weston, J. F., & Barber, S. (2024). Collaborative Development of a Farm Systems Learning Platform “4D Virtual Farm”. *Journal of Veterinary Medical Education*. https://doi.org/10.3138/jvme-2023-0023

Harden, R. M., & Gleeson, F. A. (1979). Assessment of clinical competence using an objective structured clinical examination (OSCE). *Medical Education*, *13*(1), 39-54. https://doi.org/10.1111/j.1365-2923.1979.tb00918.x

Harkess, R. L., Kuehny, J. S., Evans, M. R., Greer, L., & Cavins, T. (2007). *Virtual Field Trips: Expanding the Greenhouse Classroom* XXVII International Horticultural Congress - IHC2006: International Symposium on Horticultural Plants in Urban and Peri-Urban Life,

Hautamäki, A. (2020). Relativism and Realism in the Philosophy of Science (M. Mamane, Trans.). In O. Bueno (Ed.), *Viewpoint Relativism A New Approach to Epistemological Relativism based on the Concept of Points of View* (Vol. 419, pp. 149 - 166). Springer Nature.

Healey, M., & Jenkins, A. (2007). Kolb's Experiential Learning Theory and Its Application in Geography in Higher Education. *Journal of Geography*, *99*(5), 185-195. https://doi.org/10.1080/00221340008978967

Higgins, N., Dewhurst, E., & Watkins, L. (2012). Field trips as short-term experiential learning activities in legal education. *The Law Teacher*, *46*(2), 165-178. https://doi.org/10.1080/03069400.2012.681231

Hirsch, P., & Lloyd, K. (2005). Real and Virtual Experiential Learning on the Mekong: Field Schools, e-Sims and Cultural Challenge. *Journal of Geography in Higher Education*, *29*(3), 321-337. https://doi.org/10.1080/03098260500290892

Holden, E., & Weeden, E. (2003). The impact of prior experience in an information technology programming course sequence. CITC03: CITC 4 - '03 - Conference on Information Technology Curriculum 2003, Lafayette Indiana USA

Hood Cattaneo, K. (2017). Telling Active Learning Pedagogies Apart: from theory to practice. *Journal of New Approaches in Educational Research*, *6*(2), 144-152. https://doi.org/10.7821/naer.2017.7.237

Howard, N.-J. (2020). Navigating blended learning, negotiating professional identities. *Journal of Further and Higher Education*, *45*(5), 654-671. https://doi.org/10.1080/0309877x.2020.1806214

Hurst, S. D. (1998). Use of “virtual” field trips in teaching introductory geology. *Computers & Geosciences*, *24*(7).

Jacobson, A. R., Militello, R., & Baveye, P. C. (2009). Development of computer-assisted virtual field trips to support multidisciplinary learning. *Computers & Education*, *52*(3), 571-580. https://doi.org/10.1016/j.compedu.2008.11.007

Jolley, A., Kennedy, B., Reyna, N., Stahl, T., Hampton, S., Sommerville, P., Wilson, T., Brogt, E., Pedley, K., Davidson, J., Dawood, M., Ashwell, P., Hersey, S., & Davies, A. (2018). *Virtual Field trips in tertiary science*.

Jones, J. C., & Washko, S. (2021). More than fun in the sun: The pedagogy of field trips improves student learning in higher education. *Journal of Geoscience Education*, *70*(3), 292-305. https://doi.org/10.1080/10899995.2021.1984176

Jose, S., Patrick, P. G., & Moseley, C. (2017). Experiential learning theory: the importance of outdoor classrooms in environmental education. *International Journal of Science Education, Part B*, *7*(3), 269-284. https://doi.org/10.1080/21548455.2016.1272144

Kayes, A. B., Kayes, D. C., & Kolb, D. A. (2016). Experiential learning in teams. *Simulation & Gaming*, *36*(3), 330-354. https://doi.org/10.1177/1046878105279012

Kenna, J. L., & Potter, S. (2019). Experiencing the World From Inside the Classroom: Using Virtual Field Trips to Enhance Social Studies Instruction. *The Social Studies*, *109*(5), 265-275. https://doi.org/10.1080/00377996.2018.1515719

Kingston, D. G., Eastwood, W. J., Jones, P. I., Johnson, R., Marshall, S., & Hannah, D. M. (2012). Experiences of using mobile technologies and virtual field tours in Physical Geography: implications for hydrology education. *Hydrology and Earth System Sciences*, *16*(5), 1281-1286. https://doi.org/10.5194/hess-16-1281-2012

Kirnan, J. P., & Luce, C. (2016). Using Indirect vs. Direct Measures in the Summative Assessment of Student Learning in Higher Education. *Journal of the Scholarship of Teaching and Learning*, *16*(4), 75-91. https://doi.org/10.14434/josotl.v16i4.19371

Klemm, B. E., & Tuthill, G. (2003). Virtual field trips Best practices. *International Journal of Instructional Media*, *30*.

Klippel, A., Zhao, J., Oprean, D., Wallgrün, J. O., & Chang, J. S.-K. (2019). *Research Framework for Immersive Virtual Field Trips* 2019 IEEE Conference on Virtual Reality and 3D User Interfaces, Osaka, Japan.

Klippel, A., Zhao, J., Oprean, D., Wallgrün, J. O., Stubbs, C., La Femina, P., & Jackson, K. L. (2019). The value of being there: toward a science of immersive virtual field trips. *Virtual Reality*, *24*(4), 753-770. https://doi.org/10.1007/s10055-019-00418-5

Kolås, L., Eriksen, L. F., Hoem, J. Ø., Nygård, S. A., & Holand, I. S. (2020). Interactive Virtual Field Trips. *Journal of Educational Multimedia and Hypermedia*, *29*(4).

Kolb, A., & Kolb, D. (2019). Eight important things to know about the experiential learning cycle. *Australian Educational Leader*, *40*(3). https://doi.org/10.3316/informit.192540196827567

Kolb, A. Y., & Kolb, D. A. (2017). Experiential Learning Theory as a Guide for Experiential Educators in Higher Education. *Experiential Learning & Teaching in Higher Education*, *1*(1).

Kolb, D. A. (2015). The Learning Cycle and the Learning Spiral. In A. Neidlinger (Ed.), *Experiential Learning - Experience as the Source of Learning and Development* (2 ed.). Pearson Education.

Kolivras, K. N., Luebbering, C. R., & Resler, L. M. (2012). Evaluating Differences in Landscape Interpretation between Webcam and Field-Based Experiences. *Journal of Geography in Higher Education*, *36*(2), 277-291. https://doi.org/10.1080/03098265.2011.621165

Konak, A., Clark, T. K., & Nasereddin, M. (2014). Using Kolb's Experiential Learning Cycle to improve student learning in virtual computer laboratories. *Computers & Education*, *72*, 11-22. https://doi.org/10.1016/j.compedu.2013.10.013

Koohang, A. (2004). Students' perceptions toward the use of the digital library in weekly web-based distance learning assignments portion of a hybrid programme. *British Journal of Educational Technology*, *35*(5), 617-626. https://doi.org/10.1111/j.0007-1013.2004.00418.x

Kori, K., Pedaste, M., Leijen, Ä., & Tõnisson, E. (2016). The Role of Programming Experience in ICT Students' Learning Motivation and Academic Achievement. *International Journal of Information and Education Technology*, *6*(5), 331-337. https://doi.org/10.7763/ijiet.2016.V6.709

Krakowka, A. R. (2012). Field Trips as Valuable Learning Experiences in Geography Courses. *Journal of Geography*.

Kundu, S. N. (2016). *Designing an effective Virtual Field trip for e-Learning* IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), Bangkok, Thailand.

Larsen, C., Walsh, C., Almond, N., & Myers, C. (2016). The “real value” of field trips in the early weeks of higher education: the student perspective. *Educational Studies*, *43*(1), 110-121. https://doi.org/10.1080/03055698.2016.1245604

Lawrence, L. M. (1987). The Effect of Prior Experience and Level of Interest on Student Performance in Light Horse Management. *NACTA Journal*, *31*(1), 25-27.

Lee, H., Stern, M. J., & Powell, R. B. (2020). Do pre-visit preparation and post-visit activities improve student outcomes on field trips? *Environmental Education Research*, *26*(7), 989-1007. https://doi.org/10.1080/13504622.2020.1765991

Lee, K., Fanguy, M., Bligh, B., & Lu, X. S. (2021). Adoption of online teaching during the COVID-19 Pandemic: a systematic analysis of changes in university teaching activity. *Educational Review*, *74*(3), 460-483. https://doi.org/10.1080/00131911.2021.1978401

Leininger-Frézal, C., & Sprenger, S. (2022). Virtual Field Trips in Binational Collaborative Teacher Training: Opportunities and Challenges in the Context of Education for Sustainable Development. *Sustainability*, *14*(19). https://doi.org/10.3390/su141912933

Leonard, S. N., Fitzgerald, R. N., & Riordan, G. (2015). Using developmental evaluation as a design thinking tool for curriculum innovation in professional higher education. *Higher Education Research & Development*, *35*(2), 309-321. https://doi.org/10.1080/07294360.2015.1087386

Levers, M.-J. D. (2013). Philosophical Paradigms, Grounded Theory, and Perspectives on Emergence. *SAGE Open*, *3*(4). https://doi.org/10.1177/2158244013517243

Litherland, K., & Stott, T. A. (2012). Virtual Field Sites: losses and gains in authenticity with semantic technologies. *Technology, Pedagogy and Education*, *21*(2), 213-230. https://doi.org/10.1080/1475939x.2012.697773

Lombardi, D., Shipley, T. F., Bailey, J. M., Bretones, P. S., Prather, E. E., Ballen, C. J., Knight, J. K., Smith, M. K., Stowe, R. L., Cooper, M. M., Prince, M., Atit, K., Uttal, D. H., LaDue, N. D., McNeal, P. M., Ryker, K., St. John, K., van der Hoeven Kraft, K. J., & Docktor, J. L. (2021). The

Curious Construct of Active Learning. *Psychological Science in the Public Interest*, *22*(1), 8-43. https://doi.org/10.1177/1529100620973974

Luckin, R., Bligh, B., Manches, A., Ainsworth, S., Crook, C., & Noss, R. (2012). *Decoding learning: The proof, promise and potential of digital education.* Nesta.

Maiden, S. (2020). *University fees: Cost of arts degrees to double, maths and science degrees slashed*. News.com.uu. https://www.news.com.au/finance/economy/university-fees-cost-of-arts-degrees-to-double-maths-and-science-degrees-slashed/news-story/790caa4253741c764832ee5169778367

Majid, I., Alikutty, F., & Rahaman, S. (2017). Introduction of Objective Structured Clinical Examination, an assessment method for undergraduate students in a dental school. *Journal of Contemporary Medical Education*, *5*(1). https://doi.org/10.5455/jcme.20170216062547

Major, J., Tait-McCutcheon, S. L., Averill, R., Gilbert, A., Knewstubb, B., Mortlock, A., & Jones, L. (2020). Pedagogical Innovation in Higher Education. *International Journal of Innovative Teaching and Learning in Higher Education*, *1*(3), 1-18. https://doi.org/10.4018/ijitlhe.2020070101

Mathews, S., Andrews, L., & Luck, E. (2012). Developing a Second Life virtual field trip for university students: an action research approach. *Educational Research*, *54*(1), 17-38. https://doi.org/10.1080/00131881.2012.658197

McCarthy, M. (2010). Experiential Learning Theory: From Theory To Practice. *Journal of Business & Economics Research*, *8*(5).

McMorrow, J. (2005). Using a Web-based Resource to Prepare Students for Fieldwork: Evaluating the Dark Peak Virtual Tour. *Journal of Geography in Higher Education*, *29*(2), 223-240. https://doi.org/10.1080/03098260500130445

Mead, C., Buxner, S., Bruce, G., Taylor, W., Semken, S., & Anbar, A. D. (2019). Immersive, interactive virtual field trips promote science learning. *Journal of Geoscience Education*, *67*(2), 131-142. https://doi.org/10.1080/10899995.2019.1565285

Meezan, A. L., & Cuffey, K. (2012). Virtual Field Trips for Introductory Geoscience Classes. *The California Geographer*, *52*.

Mills, A., Ashford, P., & McLaughlin, P. (2006). The value of experiential learning for providing a contextual understanding of the construction process. AUBEA 2006 : Proceedings of the 31st Australasian University Building Educators Association Conference, Sydney, NSW.

Mitchell, M. L., Henderson, A., Groves, M., Dalton, M., & Nulty, D. (2009). The objective structured clinical examination (OSCE): optimising its value in the undergraduate nursing curriculum. *Nurse Educ Today*, *29*(4), 398-404. https://doi.org/10.1016/j.nedt.2008.10.007

Moon, K., & Blackman, D. (2014). A guide to understanding social science research for natural scientists. *Conserv Biol*, *28*(5), 1167-1177. https://doi.org/10.1111/cobi.12326

Morris, T. H. (2019). Experiential learning – a systematic review and revision of Kolb's model. *Interactive Learning Environments*, *28*(8), 1064-1077. https://doi.org/10.1080/10494820.2019.1570279

Moseley, C., Summerford, H., Paschke, M., Parks, C., & Utley, J. (2019). Road to collaboration: Experiential learning theory as a framework for environmental education program development. *Applied Environmental Education & Communication*, *19*(3), 238-258. https://doi.org/10.1080/1533015x.2019.1582375

Mughal, F., & Zafar, A. (2011). Experiential Learning from a Constructivist Perspective: Reconceptualizing the Kolbian Cycle. *International Journal of Learning and Development*, *1*(2). https://doi.org/10.5296/ijld.v1i2.1179

Palaigeorgiou, G., Malandrakis, G., & Tsolopani, C. (2017). *Learning with Drones: Flying Windows for Classroom Virtual Field Trips* 2017 IEEE 17th International Conference on Advanced Learning Technologies (ICALT),

Palmer, E. (2013). Learning Geomorphology Using Aerial Photography in a Web-facilitated Class. *Review of International Geographical Education Online*.

Patiar, A., Kensbock, S., Benckendorff, P., Robinson, R., Richardson, S., Wang, Y., & Lee, A. (2020). Hospitality Students' Acquisition of Knowledge and Skills through a Virtual Field Trip Experience. *Journal of Hospitality & Tourism Education*, *33*(1), 14-28. https://doi.org/10.1080/10963758.2020.1726768

Patiar, A., Ma, E., Kensbock, S., & Cox, R. (2017a). Hospitality Management Students' Expectation and Perception of a Virtual Field Trip Web Site: An Australian Case Study Using Importance–Performance Analysis. *Journal of Hospitality & Tourism Education*, *29*(1), 1-12. https://doi.org/10.1080/10963758.2016.1266941

Patiar, A., Ma, E., Kensbock, S., & Cox, R. (2017b). Students' perceptions of quality and satisfaction with virtual field trips of hotels. *Journal of Hospitality and Tourism Management*, *31*, 134-141. https://doi.org/10.1016/j.jhtm.2016.11.003

Patron, L., Ellis, R. A., & Barrett, B. F. D. (2009). University professor approaches to case studies: virtual field trips. *Prospects*, *38*(4), 527-539. https://doi.org/10.1007/s11125-009-9098-x

Patton, M. Q. (1994). Developmental Evaluation. *Evaluation Practice*, *15*(3), 311-319.

Patton, M. Q. (2002). Variety in Qualitative Inquiry: Theoretical Orientations. In C. D. Laughton (Ed.), *Qualitative Research & Evaluation Methods* (3 ed., pp. 75 - 142). Sage Publications Inc.

Patton, M. Q. (2011). *Developmental Evaluation - Applying Complexity Concepts to Enhance Innovation and Use*. The Guilford Press.

Patton, M. Q. (2016a). The Developmental Evaluation Mindset: Eight Guiding Principles. In Michael Quinn Patton, Kate McKegg, & N. Wehipeihana (Eds.), *Developmental Evaluation Exemplars - Principles in Practice*. The Guilford Press.

Patton, M. Q. (2016b). State of the Art and Practice of Developmental Evaluation: Answers to Common and Recurring Questions. In M. Q. Patton, K. McKegg, & N. Wehipeihana (Eds.), *Developmental Evaluation Exemplars - Principles in Practice*. The Guilford Press.

Patton, M. Q. (2016c). What is Essential in Developmental Evaluation? On Integrity, Fidelity, Adultery, Abstinence, Impotence, Long-Term Commitment, Integrity, and Sensitivity in Implementing Evaluation Models. *American Journal of Evaluation*, *37*(2), 250-265. https://doi.org/10.1177/1098214015626295

Procter, L. (2012). What is it about Field Trips? Praxis, Pedagogy and Presence in Virtual Environments. *Procedia - Social and Behavioral Sciences*, *55*, 980-989. https://doi.org/10.1016/j.sbspro.2012.09.588

Raja, F. U., & Najmonnisa. (2018). Comparing Traditional Teaching Method and Experiential

Teaching Method using Experimental Research. *Journal of Education and Educational Development*, *5*(2).

Ramachandiran, M., & Dhanapal, S. (2016, 2016//). Evaluation of the Effectiveness of Field Trips in the Teaching and Learning of Biosciences. Assessment for Learning Within and Beyond the Classroom, Singapore.

Ramasundaram, V., Grunwald, S., Mangeot, A., Comerford, N. B., & Bliss, C. M. (2005). Development of an environmental virtual field laboratory. *Computers & Education*, *45*(1), 21-34. https://doi.org/10.1016/j.compedu.2004.03.002

Rankings and Reputation. (2020). https://agriculture.uq.edu.au/about/global-focus/rankings-reputation

Rey, L., Tremblay, M.-C., & Brousselle, A. (2013). Managing Tensions Between Evaluation and Research. *American Journal of Evaluation*, *35*(1), 45-60. https://doi.org/10.1177/1098214013503698

Richardson, V. (2003). Constructivist Pedagogy. *Teachers College Record*, *105*(9), 1623 - 1640.

Roy, S., & Searle, M. (2020). Scope Creep and Purposeful Pivots in Developmental Evaluation. *Canadian Journal of Program Evaluation*, *35*(1). https://doi.org/10.3138/cjpe.56898

Sabnis, S. V., & Newman, D. S. (2022). Epistemological Diversity, Constructionism, and Social Justice Research in School Psychology. *School Psychology Review*, 1-14. https://doi.org/10.1080/2372966x.2022.2094283

Sahu, P. (2020). Closure of Universities Due to Coronavirus Disease 2019 (COVID-19): Impact on Education and Mental Health of Students and Academic Staff. *Cureus*. https://doi.org/10.7759/cureus.7541

Schulze, D. G., Rahmani, S. R., Minai, J. O., Johnston, C. T., Fulk-Bringman, S. S., Scott, J. R., Kong, N. N., Li, Y. S., & Mashtare, M. L. (2021). Virtualizing soil science field trips. *Natural Sciences Education*, *50*(1). https://doi.org/10.1002/nse2.20046

Seifan, M., Dada, D., & Berenjian, A. (2019). The effect of virtual field trip as an introductory tool for an engineering real field trip. *Education for Chemical Engineers*, *27*, 6-11. https://doi.org/10.1016/j.ece.2018.11.005

Sharlanova, V. (2004). Experiential Learning. *Trakia Journal of Sciences*, *2*(4).

Shinneman, A. L. C., Loeffler, S., & Myrbo, A. E. (2020). Self-guided field trips allow flexibility in undergraduate student introductory field experiences. *Journal of Geoscience Education*, *68*(4), 371-379. https://doi.org/10.1080/10899995.2020.1768006

Shonfeld, M., Erez, A., & Litvak, R. (2003). Virtual Field Trips in Biology Courses. EdMedia + Innovate Learning, Honolulu, Hawaii, USA.

Smart, K. L., & Cappel, J. J. (2006). Students' Perceptions of Online Learning: A Comparative Study. *Journal of Information Technology Education*, *5*.

Smith, E. K., & Kaya, E. (2021). Online University Teaching at the time of COVID-19 (2020) An Australian Perspective. *IAFOR Journal of Education*, *9*(2).

Spicer, J. I., & Stratford, J. (2001). Student perceptions of a virtual field trip to replace a real field trip. *Journal of Computer Assisted Learning*, *17*.

Stainfield, J., Fisher, P., Ford, B., & Solem, M. (2000). International Virtual Field Trips: A new direction? *Journal of Geography in Higher Education*, *24*(2), 255-262. https://doi.org/10.1080/713677387

Sterman, J. D. (2002). *Business Dynamics System Thinking and Modeling for a Complex World* [Working Paper Series]. Massachusetts Institute of Technology

Stern, M. J., & Powell, R. B. (2020). Field Trips and the Experiential Learning Cycle. *Journal of Interpretation Research*, *25*.

Stoddard, J. (2009). Toward a Virtual Field Trip Model for the Social Studies. *Contemporary Issues in Technology and Teacher Education*, *9*(4).

Stumpf, R. J., Douglass, J., & Dorn, R. I. (2008). Learning Desert Geomorphology Virtually versus in the Field. *Journal of Geography in Higher Education*, *32*(3), 387-399. https://doi.org/10.1080/03098260802221140

Szijarto, B., & Bradley Cousins, J. (2019). Mapping the practice of developmental evaluation: Insights from a concept mapping study. *Eval Program Plann*, *76*, 101666. https://doi.org/10.1016/j.evalprogplan.2019.05.001

The Higher Education Standards Panel. (2015). *Higher Education Standards Framework*. Australia

Tremblay, M., Gokiert, R., Kingsley, B., Mottershead, K., & Pei, J. (2020). Using developmental evaluation and community-based participatory research to develop a model of supportive housing. *Eval Program Plann*, *82*, 101849. https://doi.org/10.1016/j.evalprogplan.2020.101849

Treves, R., Viterbo, P., & Haklay, M. (2015). Footprints in the sky: using student track logs from a “bird's eye view” virtual field trip to enhance learning. *Journal of Geography in Higher Education*, *39*(1), 97-110. https://doi.org/10.1080/03098265.2014.1003798

Tuthill, G., & Klemm, B. E. (2002). Virtual field trips Alternatives to actual field trips. *International Journal of Instructional Media*, *29*(4).

van Winkelen, C. (2016). Using developmental evaluation methods with communities of practice. *The Learning Organization*, *23*(2/3), 141-155. https://doi.org/10.1108/tlo-08-2015-0047

Villarroel, V., Benavente, M., Chuecas, M. J., & Bruna, D. (2020). Experiential learning in higher education. A student-centered teaching method that

improves perceived learning. *Journal of University Teaching & Learning Practice*, *17*(5).

Walker, J. P., & Rocconi, L. M. (2021). Experiential Learning Student Surveys: Indirect Measures of Student Growth. *Research & Practice in Assessment*, *16*(1).

Whitelock, D., & Jelfs, A. (2005). Would you rather collect data in the rain or attend a virtual field trip? Findings from a series of virtual science field studies. *International Journal of Continuing Engineering Education and Life-Long Learning*, *15*(1/2).

Wolf, M., Wehking, F., Montag, M., & Söbke, H. (2021). 360°-Based Virtual Field Trips to Waterworks in Higher Education. *Computers*, *10*(9). https://doi.org/10.3390/computers10090118

Yap, K., Sheen, J., Nedeljkovic, M., Milne, L., Lawrence, K., & Hay, M. (2021). Assessing clinical competencies using the Objective Structured Clinical Examination (OSCE) in psychology training. *Clinical Psychologist*, *25*(3), 260-270. https://doi.org/10.1080/13284207.2021.1932452

Young, M. R., Caudill, E. M., & Murphy, J. W. (2008). Evaluating Experiential Learning Activities. *Journal of Advancement of Marketing Education*, *13*, 28-41.

Yusri, G., Rahimi, N. M., Shah, P. M., & Haslina, W. W. (2012). Motivation in Learning Oral Arabic among Students with Different Prior Experiences and Gender. *Pertanika Journal of Social Science & Humanities*, *20*(3).

Zhao, J., Wallgrün, J. O., Sajjadi, P., LaFemina, P., Lim, K. Y. T., Springer, J. P., & Klippel, A. (2021). Longitudinal Effects in the Effectiveness of Educational Virtual Field Trips. *Journal of Educational Computing Research*, *60*(4), 1008-1034. https://doi.org/10.1177/07356331211062925