Experiential E-Learning: A Creative Prospect for Education in the Built Environment?

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Abstract. A novel e-learning initiative improved learning and cognitive understanding of learning outcomes in the Department of Architecture, within the Faculty of Engineering, Built Environment and Information Technology (EBIT) at the University of Pretoria, South Africa. This paper presents a typical case study of experiential e-learning through incorporating High Impact Teaching Practices (HIP) in the module Plant Sciences (PWT322), taught to third-year landscape architecture students. Learning was improved through self-paced interactive videos and videos of real-time projects, learning communities, group assignments, and constructive lecturer feedback. These activities were implemented within the Technological Pedagogical Content Knowledge (TPACK) framework. Results from a survey and focus group meeting revealed that online experiential learning, cross-disciplinary discussions, positive lecturer feedback and teamwork improve and enrich the learning experience and motivate students, although contact teaching and site visits are valued by students. Class averages for the integrated design module increased with 6% in the June examination and 2% in the December examination from 2019 to 2020.

Keywords: Experiential e-learning · High impact educational practices (HIP) · Implicit positive education pedagogy · Technological pedagogical content knowledge framework (TPACK)

1 The Context and Problem

1.1 Module Context

The Plant Sciences module (PWT322) is taught to the third-year landscape architecture students in the Department of Architecture within the Faculty of Engineering, Built Environment and Information Technology (EBIT) at the University of Pretoria, South Africa. This study was conducted in the context of three integrated modules, Design (ONT302), Plant Sciences (PWT322) and Construction (KON320), for fourteen weeks during the second semester of 2020, together with Plant Sciences (PWT312), taught in the first semester, as it forms the basis for PWT322. These are all year modules and build on outcomes of the first semester. PWT322 emphasizes plant community conservation based on ecological principles in the urban environment, including the technical

W. Zhou and Y. Mu (Eds.): ICWL 2021, LNCS 13103, pp. 102–114, 2021.
https://doi.org/10.1007/978-3-030-90785-3_9

aspects of planting in these complex environments. The goal is to prepare students to develop a design and working documentation to establish plants in the built environment. Design documentation refers to the design development for a construction project and entails a sketch plan, sections, elevations, and three-dimensional architecture or landscape architecture project proposals. Working documentation entails the construction and procurement documentation and includes construction drawings, specifications, and a schedule of quantities to enable the project's construction. The second semester focuses on plant community conservation in the urban environment and considering the technical aspects of planting in these complex environments, especially regarding finite soil volumes. Learning outcomes of PWT322 are set out in Table 1.

Table 1. PWT322: learning outcomes

No	Description of learning outcome
1	Evaluate complex urban environmental factors influencing plant material selection and apply them to design in urban conditions
2	Determine and design the detailed interaction between the built and natural environments to facilitate both plant habitats and human comfort
3	Apply planting design methodology, appraising social, technical, ecological and aesthetic factors
4	Identify considerations for specification of sound soil preparation, planting establishment and maintenance
5	Apply standards and conventions applicable to planting design communication and documentation for construction purpose

The module's structure firstly focuses on study precedents of urban agriculture projects enhancing ecosystem services, followed by the analysis and construction detailing different living wall systems, rooftop gardens and wetlands. The last part of the module provides research opportunities for students of different African Orphan crop species. Finally, students are required to apply what they have learnt through incorporating and detailing a living wall system, rooftop garden or constructed wetland in their final design.

1.2 Pedagogy

The nature of the lecture to student ratio in the Architecture Department at UP is relatively low, which has advantages for monitoring student well-being and learning success. For example, there were 13 students in 2019, 14 students in 2020 and 11 students in 2021 for PWT322. This ratio assists lecturers in the department to apply implicit positive education pedagogy, which involves creating a learning environment with greater emphasis on the overall well-being of students than on the content of learning outcomes [1, 2], amongst other pedagogical approaches, as well-being is vital in a creative learning or working environment. For PWT312 and PWT322, this was achieved through communication between the lecturer and all students via a WhatsApp group, emails and discussions during lectures.

Moreover, the lecturer developed an in-depth understanding of student knowledge gaps through communication, formative assessments and their application of all learning outcomes indicated in Table 1 in the design module. During the integrated Design module examinations in June and November 2019, the lecturer identified a gap in the understanding of the third-year students in their ability to apply learning outcomes 3, 4 and 5 of PWT322. Therefore, the pedagogical approach for the module Plant Sciences was adapted to address knowledge gaps in 2020 through student-centered, experiential learning. [3] (See Fig. 1).

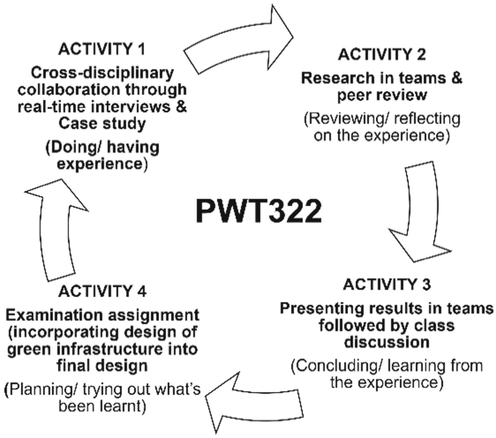

Fig. 1. Experiential learning cycle with activities applied to learning outcome 1 of the PWT322 module

The planned approach entailed active, physical participation and cross-disciplinary collaboration to assist students to gain a better understanding of module learning outcomes.

Kolb's learning theory [4] was applied for all five learning outcomes of the module. Activities were therefore introduced to assist students to experience the activity through real-time interviews with other disciplines, after which students did research to reflect on their experience and concluded what they learnt by presenting their findings in teams to other students in the class. The last activity entailed their module examination assignment and incorporating their learning outcomes in their design examination, which is the last activity of Kolb's learning cycle, namely, implementing what they have learnt.

The PWT322 module, which is the focus of this paper, was primarily offered online in 2020/21. The lecturer embraced the e-learning methodology and approach following the UP's hybrid teaching and learning model. E-learning can be defined as "using information and communication technologies in diverse education processes to support and enhance learning in higher education institutions, as a complement to traditional classrooms" [5].

The successful implementation and adoption of new learning technologies, such as the H5P (LTI) tool used in PWT322, requires a team approach between the lecturer, education consultant and instructional designer [6]. According to Neelen and Kirschner [6], teaching and learning can continuously improve, and a lecturer should seek opportunities to do so. They also emphasize that the learning experiences designed for learners should be effective, efficient, and enjoyable. They coined this as a 3-Star learning experience that requires the following for the facilitation and support of learning: the use of tools such as videos; techniques such as collaborative learning and feedback; and ingredients which include the domain knowledge to be mastered on the one hand, and assessment opportunities and tasks on the other [7].

Simply adding digital technology to e-learning practice does not guarantee meaningful and successful learning for learners. On the contrary, it requires lecturer competency to intentionally choose technologies best fit for supporting students to achieve the intended learning outcomes. The Technological Pedagogical and Content Knowledge Framework (TPACK) developed by Koehler and Mishra [8] is an effective guideline lecturers can utilize when considering integrating digital technologies to support e-learning and pedagogy of a specific subject area online environment. TPACK is thus the integration point where the lecturer uses and combines technology (e.g. computer, LMS, LTI tools, video's), pedagogy (e.g. Teaching methods and students' learning modalities), and extensive content knowledge (e.g. the specific subject).

The TPACK framework, [8, 9] steered the teaching of PWT322. This was achieved through combining 1) technological knowledge (TK) through additional Blackboard (LMS) functionalities over and above the standard teaching platforms, 2) content knowledge (CK) through the lecturer's extensive experience and content knowledge of the module she needs to teach and 3) pedagogical knowledge (PK) such as her teaching, assessment and evaluations methods and techniques used in PWT322. More specifically, the technological pedagogical knowledge (TPK) [8, 9] was achieved through interactive videos (H5P Blackboard LTI integration functionality), as a platform for online experiential learning, enhanced by a flipped-classroom approach, reflective discussions, cross-disciplinary discussions, collaborative assignments, group work, peer and lecturer interaction, and immediate feedback. Pedagogical content knowledge (PCK) [9] was gained through experiential learning aligned with the module outcomes. Finally, technological content knowledge (TCK) [9] was applied through teaching and assessment using the H5P Blackboard functionality, Blackboard Collaborate and peer review tools (iPeer and Qualtrics).

According to Peggi Maki, "course and educational experience design require identifying the pedagogies, academic practices, progressions, and contexts for learning, such as peer-to-peer learning online, that foster and engage all students' achievement of targeted outcomes" [10]. Therefore, High Impact Teaching Practices (HIP), as defined by George Kuh [11, 12], were implemented in the teaching of this module to ensure the engagement of all students. The features included everyday intellectual experiences through reflective discussions and self-paced interactive videos, learning communities (LCs) through dialogues and cross-disciplinary engagement, collaborative assignments and projects through teamwork, undergraduate research, diversity and global learning through peer and lecturer interaction, service-learning (through videos of real-time projects) [11–13].

In conclusion, the lecturer of PWT322 contributed to a learner-centered design [10] of her module to improve and advance a positive and enjoyable learner experience by implementing e-learning strategies and digital platforms that promote and supported her students to meet course expectations extend their knowledge and application beyond PWT322.

Scholarship of Teaching and Learning

In 2020 the lecturer received a Scholarship of Teaching and Learning (SoTL) grant for a project titled "African Food crops in living wall systems", which addresses the module Plant Sciences outcomes. The lecturer planned to expose students to two real-life projects where green principles were implemented to support ecosystem services. In addition, a real-time case study was also included to attune to the local context through the planting of African food crops on the Future Africa campus of the University of Pretoria in two different typologies of green wall systems.

The Covid-19 lockdown regulations, which were implemented in March 2020, impacted the module's planned teaching and learning methods. The lecturer had to reflect on the learning outcomes she wanted the students to achieve through an online environment, as contact teaching was no longer possible. Through this crisis, the opportunity arose to exchange ideas with the faculty Head Education Consultant, who provided a different perspective on approaching the online environment to achieve the required outcomes. This collaboration led to novel teaching and learning methods in the EBIT faculty. Throughout the teaching and learning initiative, the lecturer and Head Education consultant worked in close partnership. Weekly meetings added value to the result: the students' knowledge and learning experience and the lecturer's teaching journey.

The objective was to analyze and define student learning through virtually engaging with a real-life project and cross-disciplinary collaboration (landscape architecture, landscape technology and horticulture).

The purpose of the amended SoTL study was to assist students in the experiential learning process through participating virtually in the following activities:

- Evaluating the physiognomy of modular living wall infrastructure systems in South African urban environments, that show the most significant potential to provide suitable habitat conditions for cultivating African orphan crops for food production.
- Assessing plant species that are suitable for utilization for food production in South African urban environments.

The design approach for the SoTL project and engagement with students entailed:

- collaborative assignments through teamwork and cross-disciplinary discussions to understand diverse viewpoints,
- constructive feedback by the lecturer [14] following assignments, and
- self-paced learning through interactive videos, with in-video assessment and quizzes. The H5P platform, accessed through Blackboard, was utilized for this purpose.

1.3 The Problem

The hypothesis directing this study stated that; experiential e-learning in a higher education environment could improve learning for undergraduate students in the built environment.

The study aims to understand online experiential teaching and learning for undergraduate students in the built environment. The research questions are stated as follow:

- Does experiential e-learning in higher education improve learning for students in the built environment?
- Which practices enhance online experiential learning for landscape architecture and architecture students?

2 Methods

A qualitative exploratory typical case study research design was followed. The case study approach allowed for a more in-depth exploration and analysis of the module PWT322 and the experiential learning of the participating students in the module. Detailed information was obtained through data collection of numerous sources, after which a conclusion was reached by combining all the data [15].

Ethical clearance was obtained from the EBIT Faculty Research Ethics Committee at the University of Pretoria before feedback was requested from students. Student feedback was obtained through qualitative methods, with quantitative data obtained from marks.

Data was collected from three sources over 12 months to address the research questions. Firstly, students were requested to complete questionnaires regarding their experience and preferences related to the research at the end of the second semester in 2020. A total of 12 students completed the questionnaires. Secondly, a Qualtrics survey was conducted in December 2020 following the completion of the module. The survey comprised research-specific questions to reflect on the success of the interactive videos, cross-disciplinary discussions, teamwork and associated peer assessment and constructive feedback. Likert scale questions and open-ended question types were included in the survey.

Questionnaires were corroborated by comparing marks for the module Plant Sciences and Design for 2019, 2020 and 2021, as the second data source.

The third source was a focus group meeting, comprising 11 students, held in the first semester of 2021 to collate students' feedback of experiential learning and introduce different High Impact Practices (HIP's). In addition, open-ended questions were asked relating to the research questions. Finally, students reflected on the value of the teaching and learning experience during the first semester of the module Plant Sciences.

3 E-learning Tools and Platforms

Electronic learning, or e-learning, is "learning supported by digital electronic tools and media" as an alternative to contact learning [16]. Due to the changes required following the Covid lockdown regulations, tools and software for online teaching and assessment of module outcomes had to be considered an alternative for contact teaching. Tools and platforms utilized for instruction and assessment to support the pedagogy approach and TPACK and HIP principles are discussed in the sections below.

3.1 Tools and Platforms for Online Teaching

A 360-degree camera to record two and three-dimensional videos and images of the construction of projects was purchased with the SoTL funding. This enabled the recording of videos of the construction of projects, which showcased green infrastructure. Students, therefore, experienced the construction process of a living wall and completed projects with green infrastructure virtually to assist them to understand the module outcomes as an alternative to physical site visits.

The videos were imported into the Blackboard (Learning Management System) (BbLMS) LTI functionality H5P, a platform for interactive videos, to improve student learning. This functionality is part of clickUP, which is the in-house name for the BbLMS and official platform and communication mechanism of the UP between lecturers and students. ClickUp comprises a variety of functionalities for online teaching and assessment. During the lockdown period, lectures mainly took place through Collaborate, which entails synchronous or asynchronous communication with students. Interactive videos and the standard functionalities as a teaching platform were utilized to enrich the learning experience for students. Interactive videos included different activities such as explanations, additional images and questions. Questions in the videos were alternated to ensure various question types. They entailed true and false questions, multiple-choice questions, fill in the missing word questions, drag and drop questions, drag and drop text and images or diagrams to be uploaded. When submitting wrong answers, students were directed to the correct answers.

In addition to clickUP, students collaborated with the lecturer through a WhatsApp Group for the module. This platform allowed for more informal discussions between lecture times, which assisted the lecturer to develop a better understanding of the well-being of students.

3.2 Platforms for Grading of Online Assessment

Assignments for landscape architecture and architecture students at the University of Pretoria entail a design project for the main year module, Design 302, underpinned by and integrated with modules with fewer notional hours, such as PWT322. Design assignments are presented graphically and verbally. Assignments and examination assignments were uploaded on the clickUP platform and presented verbally through an online platform such as collaborate during online teaching in the Covid-19 lockdown period. The Semester 1 and 2 final design projects incorporated components of Plant Sciences. Therefore, their examination design projects provided insight into students' cognitive understanding of the outcomes of the module Plant Sciences, as students had to apply their outcomes in their designs.

An open-source web-based application, iPeer, which assists in peer evaluation by student groups completing a rubric to evaluate each group member's accountability

[17], was used to evaluate teamwork during the first assignment. Students evaluate individual contributions of other team members with this platform by completing a rubric that assesses criteria developed by the lecturer. Measures included the attendance of teamwork sessions, assistance with actions or advice, how the individual reacted to advice, listening and communication skills, and meeting deadlines. Unfortunately, it was found that some students rushed the completion of the rubric. Qualtrics, a web-based survey tool used by organizations to conduct surveys allowing respondents to remain anonymous [18], was used as a peer evaluation platform for the team assignment in the first semester of 2021.

4 Results

4.1 Module Marks

Following adjustments in the pedagogy approach in 2020, after knowledge gaps and concepts from the learning outcomes that students had difficulty with, were identified and observed in 2019, the class average increased with 6% between 2019 and 2020, and with 3% between 2020 and 2021 for the design examination in June, and with 2% for the final December examination. This improvement is illustrated in Table 2.

Table 2. Design (ONT302): comparison of average percentage marks of 2019, 2020 and 2021

Year	June examination (progress mark) class average (%)	December examination (final mark) class average (%)
2019	58	68
2020	64	70
2021	67	

Since 2019, where two students failed the Plant Sciences (PWT312) module, and one student failed the Design (ONT202) module, no failures were recorded for 2020 and 2021, and the class average increased by 2% between 2019 and 2020, and a further 5% between 2020 and 2021. Refer to Table 3 for a breakdown of the Plant Sciences module average marks.

The positive effect of the improved pedagogical approach for PWT322, and its cumulative impact on ONT302 is reflected below (Figs. 2 and 3). The figures illustrate the distribution of marks and the increase of marks above 60% for both modules. Looking at the throughput of ONT302, the percentage of distinctions, which doubled in 2020, is encouraging.

4.2 Student Feedback via Qualtrics Survey

Student feedback related to their experience of the pedagogy approach applied in 2020. Questions focused on the module Plant Sciences (PWT322) was obtained in December

Table 3. Plant sciences (PWT 312 and PWT322): comparison of average percentage marks of 2019, 2020 and 2021

Year	June examination (progress mark) class average (%)	December examination (final mark) class average (%)
2019	62	66
2020	64	67
2021	69	

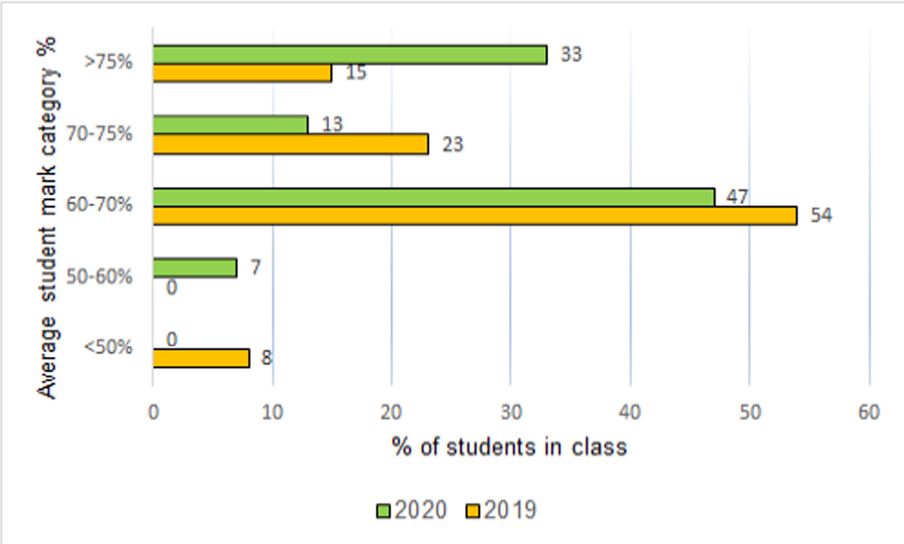

Fig. 2. Design (ONT302): comparison of 2019 and 2020 final year marks

2020. Students remained anonymous as part of the feedback process, and the questionnaires were submitted online to the Department for Education Innovation. Student responses are presented in this section. More than 90% of the students indicated that cross-disciplinary discussions enhanced learning, as illustrated in Fig. 4.

Although 81% of students found that experiential learning through interactive videos enhanced their learning (refer to Fig. 5), 58% of students indicated that they preferred combining interactive videos and synchronous teaching, with 42% of students selecting only synchronous teaching.

Students noted students' physical site visits and direct contact with peers and lecturers as crucial for future experiential learning (Refer to Fig. 6).

In order of preference, the most beneficial learning activities to students were 1) Constructive feedback by the lecturer and 2) experiential learning and teamwork (equal ratings), followed by team discussions. Students were divided on the advantages of peer evaluation, with 50% of students indicating that iPeer did not add value to their experience of teamwork. Students argued that the evaluation was time-consuming and

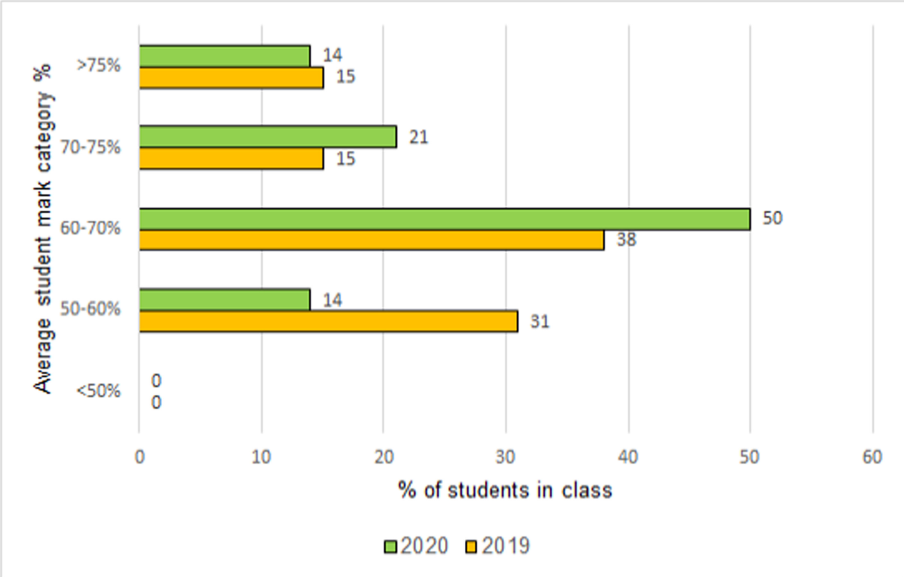

Fig. 3. Plant sciences (PWT322) comparison of 2019 and 2020 final year marks

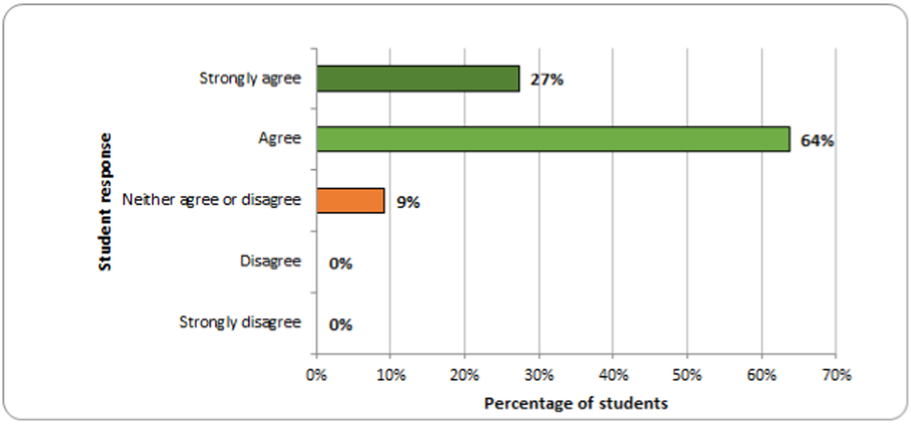

Fig. 4. Students' response to statement: Blackboard Collaborate sessions with guest from interdisciplinary network (Horticulture) regarding living wall systems enhanced my learning experience

therefore resulted in some students rushing off the evaluation process. Students also listed benefits, such as that their peers contributed better and put in a greater effort for team work to their performance being reviewed.

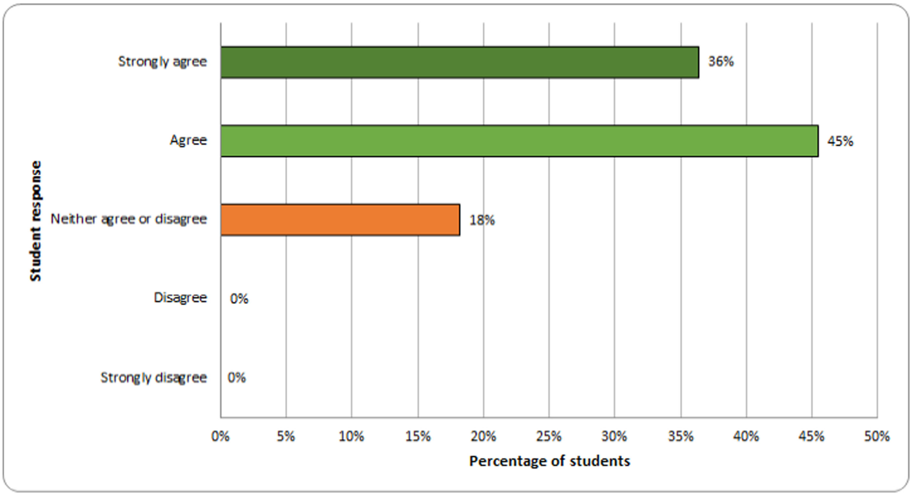

Fig. 5. Student feedback in response to statement: Experiential learning through self-paced interactive videos (H5P) enhanced my learning experience

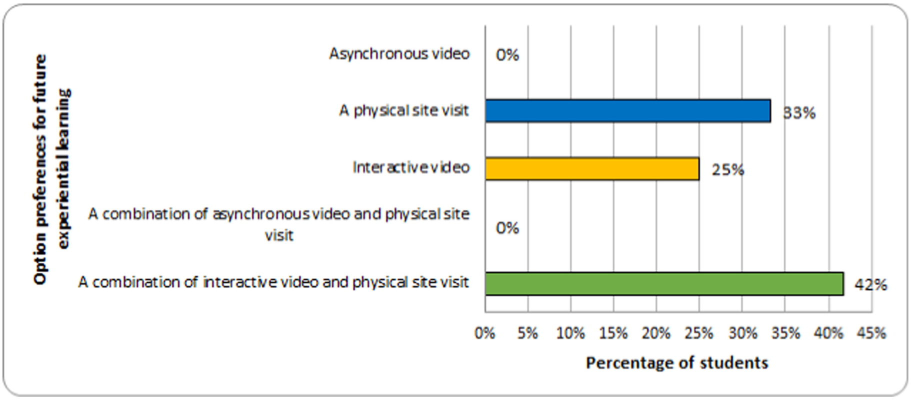

Fig. 6. Preferred options for future experiential learning

4.3 Student Feedback from Focus Group Discussion

A focus group meeting was held with the 2021 class for the module Plant Sciences. Similar questions were posed to students to determine the success of the pedagogy approach and student preferences.

Student preferences concurred with the priorities of the 2020 class, namely that cross-disciplinary discussions and constructive feedback were beneficial in terms of learning. They also indicated that they preferred physical site visits and that asynchronous videos would be beneficial in combination with site visits, but after the visit, to understand the full context.

5 Discussion

The findings of this study contribute to the understanding of experiential e-learning for undergraduate students in the built environment to inform future combined teaching and e-learning. From the annual improvement in the class average and distinctions in modules where learning outcomes are applied which doubled following experiential learning, it is evident that experiential e-learning succeeded in meaningful knowledge and a cognitive understanding of learning outcomes. This can be achieved through incorporating HIP practices, implemented within the TPACK framework. HIP practices which improved learning included reflective discussions, self-paced interactive videos, learning communities (LCs) through dialogues and cross-disciplinary engagement, collaborative assignments through teamwork, undergraduate research, diversity and global learning through peer and lecturer interaction and service-learning (through videos of real-time projects). These practices, except for peer and lecturer interaction, are independent of the scale of student groups due to the electronic platforms.

Although students indicated that self-paced interactive videos contributed to their learning, it was clear from their preference of constructive feedback and a combination of a physical site visit and an interactive/asynchronous video that contact with peers, other disciplines and the lecturer was important. Learning communities through dialogues and cross-disciplinary engagement were also valued by students. This underpins the implicit positive education pedagogy, with the well-being of students being pivotal to their learning and motivation.

Peer evaluation through the iPeer and Qualtrics platforms assisted in showing how behavior and accountability in teamwork can be improved, although further research is required to ensure that feedback adds value to teamwork in alignment with the program outcomes.

6 Conclusions

The authors conclude that experiential e-learning in a higher education environment can improve learning and cognitive understanding of learning outcomes for undergraduate students in the built environment. Moreover, the incorporation of HIP practices, implemented within the TPACK framework can enhance student engagement and create meaningful learning. These entail self-paced interactive videos and videos of real-time projects, learning communities, group assignments, and constructive lecturer feedback. In combination with e-learning through HIP practices, cross-disciplinary discussions, contact teaching and site visits are valued by students. With the support of the HOD, this initiative has been noticed and supported by the Department of Architecture for introduction in other modules comprising larger groups. Longitudinal research will therefore be conducted on bigger sample groups to assess the success of combined contact teaching and e-learning. In addition, this research will further assist in improving benefits of peer assessment for teamwork.

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