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Engaging students in cross-disciplinary module design: a case study on the co-creation of a sustainaibility module in Singapore

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Abstract

This research engaged undergraduate students to design a learner-centric multi-disciplinary module that encompassed the three main pillars of sustainability, namely the economic, environmental, and social pillars of sustainability as well as the United Nations Sustainable Development Goals (SDGs). Collaborating in multi-disciplinary groups, participating students examined their learning experiences through the perspectives of educators while researching on sustainability and pedagogy. Both groups of students were provided with a framework of pedagogical approaches, such as flipped classroom, student-centred learning, collaborative learning, outcome-based learning, and formative assessment. Beyond the focus on sustainability as a subject matter and the pedagogical framework little guidance was provided during the creation process. Through their participation in the five-day bootcamp-style Module Design Workshop, both groups created an engaging and creative module that addressed their educational needs and expectations. Moreover, participating students clearly exhibited an increased understanding of pedagogy, sustainability, and the SDGs. Through pre-and post-workshop surveys and post-workshop group reports participating students illustrated a range of perceived and experienced challenges and takeaways, such as lack of time, lack of knowledge, changed perception of higher education pedagogy, and a sense of achievement. Observations throughout the Module Design Workshop found that both groups of students demonstrated their ability to work in multi-disciplinary teams and develop strategies to overcome difficulties. The research project has proven that both groups were able to create a well-designed module on sustainability, which could be offered to undergraduate students in order to facilitate sustainability education in all academic disciplines.

Introduction

Traditionally, course modules are created by academic staff addressing an educational need while utilising their core competencies. Students are usually not involved in the design process and, consequently, often find that modules do not fully meet their expectations and needs. Despite being drivers for innovation and change, some academic processes and educators have often been conservative and resistant to change. On the other hand, educators who have seen the value of engaging students as partners in the process of pedagogical development have been reaping the rewards of such collaborative efforts (Bengtson et al., 2017). Nevertheless, actively engaging students in the process of curriculum design has been a widely underused concept, with little use of research on engaging students in the module design process. To date, hardly any research on students as collaborators in course development has been done in the Singapore context. The aims of this research have been to bridge academic curricular development and the needs and expectations of students by engaging them as partners in the curriculum design process and empowering them to create a learner-centric sustainability module that addresses their needs and expectations. As such, the article will illustrate the underlying pedagogical approach and the module design process with reference to the benefits of building sustainability into the general education curriculum. The inherent multi-disciplinary character of sustainability, combined with the urgent need to address pressing sustainability issues in the academic context, made sustainability an ideal topic for this study. Furthermore, NTU has set itself ambitious targets in its 15-year manifesto aimed at building the university's reputation as a global leader in sustainability (Nanyang Technological University, 2023). Hence, it becomes increasingly pressing to adequately build sustainability into the curriculum.

Additionally, the methods and procedures of recruiting suitable students and the execution of the Module Design Workshop will be discussed. The Module Design Workshop was a five-day bootcamp-style workshop, which was conducted to establish a collaborative climate which, according to Kapp (2009), allows students to optimise collaboration and focus entirely on the task at hand. As such, two teams of seven undergraduate student participants were tasked to design a multi-disciplinary sustainability module that could be offered to all undergraduate students at NTU. As per instructions, this module had to encompass the three main pillars of sustainability, namely the economic, environmental, and social pillars of sustainability, while using the United Nations Sustainable Development Goals as a framework (Department of Economic and Social Affairs, 2019).

Taking these three aspects into consideration, the research aims to evaluate how undergraduate students from diverse academic fields can be engaged in the process of designing a module built on the three pillars of sustainability, with the intention to offer the modules created as part of the general education programme offered at Nanyang Technological University (NTU).

Research context

Researchers have pointed out how educators need to change their perception of the educator-student relationship in order to bring about educational change (Matthews et al., 2018). More pointedly, Nel (2017) posits that student engagement ought to move beyond the surface level of purely gathering their feedback as sources for data and contends that active steps should be taken to involve students as collaborators in all aspects of the pedagogical transformation process. He argues that benefits and transformations in the educational process can only be achieved by acknowledging the value of students' perspectives. Additionally, Tan (2022) argues that there is a need for educators to become more mindful and inclusive to enable learners to learn, grow, and connect with others.

Bengtson et al. (2017) found that interviewing undergraduate students and collaborating with them to redesign a university course led to a complete change in course curriculum, resulting in a noticeable increase in student satisfaction. Creating opportunities for students to express their views in the development process consequently improved the course, while the dialogues also allowed the educator to understand the learning progress of his students (Anderson 1996). Engaging students in the design of learning materials has also been proven to benefit such students by improving their broader academic skills (Surata & Lansing, 2015); promoting peer learning (Kinsella et al., 2017), instilling a sense of accountability for students' personal actions, and creating a sense of empowerment amongst students.

While it is important for educators to recognise the value of engaging students as partners in the process of educational transformation, it is also crucial for academics to adequately prepare students for such a challenging process in order to ensure that they are able to contribute meaningfully to the improvement of teaching and learning. The notion that students lack pedagogical knowledge is common among educators and might contribute to educators having reservations about engaging students in the process of curriculum design. Students, on the other hand, experience a range of pedagogical practices throughout their academic studies and can draw on personal experiences when included in the design process. Additionally, specific pedagogical principles can be imparted to students prior to engaging them to ensure that they have a good working knowledge of the basic ideas and concepts related to pedagogy by the start of the curriculum design process. Awareness of pedagogical concepts enables students to examine their learning experiences through the perspectives of educators while drawing on their personal educational experiences through a more academic lens, enabling students to make highly meaningful contributions to the module design process.

Pedagogical approaches underlying the Module Design Workshop

The pedagogical approaches identified by the Principle Investigator (PI) to be used as the basis for the Module Design Workshop are student-centred and collaborative learning

in a flipped classroom and an outcome-based education framework that incorporates formative assessment.

Student-centred learning is a teaching and learning approach that allows students increased responsibility while working with more autonomy (Lee & Hannafin, 2016). According to McCabe and O'Connor (2014), it has the potential to transform the educational environment, enabling critical thinking, deep reflection, and enhanced productivity. Student-centred learning has helped to promote learning and enabled students to attain higher academic performances (Chung & Chow, 2004). Slunt and Giancarlo (2004) also note improvement in academic performance. Wright (2011) states that students have thrived in learner-centric educational settings and argues that an increasing number of educators favour a student-centric learning approach.

Collaborative learning is broadly employed to enable students to interact with their peers and build social skills. It is a pedagogical tool which can be applied in any educational discipline and level (Loes et al., 2018). According to Mistry (2010), it is widely recognised as being highly efficient. Collaborative learning supports the self-directed creation of knowledge rather than a unidirectional transfer of knowledge (Enkenberg, 2001). It also enables students to be more open to a larger level of diversity in perspectives, resulting in higher academic performance and achievements (Loes et al., 2018). Hence, this learning approach is essential for preparing students for the workplace.

The flipped classroom is an educational model that brings students in contact with new materials pre-class, followed by discussion and application in face-to-face classes (Long et al., 2017). Strayer (2012) argues that 'flipping' the classroom is an innovative model that provides teachers with time and space to help students with their learning in class instead of using class time to introduce new material. Akçayır and Akçayır (2018) posit that this approach has a positive effect on learning, resulting in better academic performance. The flipped classroom has become much more feasible with the availability of free and low-cost audio-visual technological products and increased online presence, which can be applied to the educational framework. Albert and Beatty (2014) argue that they ought to be used to facilitate a shift towards a new better student learning experience in the form of a flipped classroom. The flipped classroom is an increasingly popular strategy for making room for in-class application, discussion, and collaborative learning.

Outcome-based education is an integral part of this research project, considering that a course could only be implemented at NTU after completing the OBTL review process. Outcome-based education, as Gurukkal (2018) asserts, is an effective, transparent educational framework encompassing teaching, learning, and evaluation, which allows the quality of a course to be assessed prior to its implementation. Barman et al. (2014) also argue that in addition to its application in the teaching and learning design, the nature of transparency could be used as a means of assuring quality and institutional accountability. Outcome-based education enables students to assess their own performance in the process of working towards a desired result (Gurukkal, 2020), which makes it all the more valuable for university curriculum design.

While many universities still rely heavily on summative assessments in the form of mid- and end-semester examinations, formative assessment has proven to be more effective. Formative assessment is a process of educators providing ongoing feedback and information to the student during the learning journey (López-Pastor & Sicilia-Camacho, 2017). Yorke (2003) considers formative assessment of vital importance to the learning journey, while Gikandi et al. (2011) deliberate that regular review and feedback enable educators to monitor and assess students' progress in order to modify instruction and facilitate further learning, making formative assessment a necessary tool to achieve optimal learning.

The pedagogical context at NTU

This research project was conducted at Nanyang Technological University Singapore (NTU). NTU has adopted an Outcome-based Teaching and Learning approach (OBTL), where all courses at NTU have to comply with OBTL requirements and complete an OBTL review process before being implemented. Additionally, continuous assessment must form at least 40% of the total score of a course at NTU. The purpose of this policy is to increase the opportunities to engage students in deeper learning by providing an opportunity to improve their work upon providing feedback (Centre for Teaching, Learning & Pedagogy, 2023). In line with the OBTL approach, educators at NTU begin the course design process by developing the Intended Learning Outcomes (ILO) of a course before aligning the content, assessment methods and criteria, as well as teaching and learning activities with the ILO. In addition to outlining the weekly schedule of a course, educators are also required to justify their teaching and learning approach by explaining the ways in which it enables students to achieve the ILO.

It was the aim of this research project to create a scenario in which the students are to replicate this internal process and assume the role of educators in the module design process. Repko and Szostak (2017) argue that the complex realities beyond the university make an interdisciplinary approach a necessity. NTU has placed an increasing focus on interdisciplinary education (Nanyang Technological University Singapore, 2023). The research project took the university's strategy into consideration by choosing the multi-disciplinary field of sustainability as the subject matter. The multi-disciplinary module created as a part of this research project aims to showcase further cross-disciplinary collaborations in the NTU educational landscape and be aligned with the university's drive for interdisciplinary education. Honing a research-based understanding of all facets of sustainability amongst students would also support the success of the NTU EcoCampus initiative, which relied on the adoption of eco-friendly practices by staff and students. This idea is supported by a case study from Greifswald University in Germany, which shows that research on sustainability within the university serves to promote sustainability and encourage sustainable behaviour amongst students (Udas et al., 2018).

Methods

The student participant recruitment process

Ducate (2016) argues that students studying German language and culture as well as sustainability will integrate ideas and concepts from a range of disciplines, which meets the needs of students. Based on the interdisciplinary approach, the recruitment team comprising the Principal Investigator (PI) and two research assistants recruited 14 undergraduate student participants from various core disciplines at NTU who were also enrolled in the German language classes offered as electives at NTU. Popular among undergraduate students from a wide range of disciplines, the German language classes provided a ready pool of potential candidates who were suitable for this research project. Students who were interested in participating in this research project were invited to complete a recruitment questionnaire (see Table 1 for sample questions). The recruitment questionnaire was designed to provide the recruitment team with a preliminary understanding of the candidates' personality traits, leadership, communication, interpersonal and collaborative skills, their motivations for participating in the research project, as well as their previous learning experiences at NTU.

Table 1. Sample recruitment questions.

Category	Question
Motivation	Why do you want to participate in this research project?
Personality Traits	Describe yourself in ONE word.
	What is your best quality?
	What is your biggest weakness?
	How do you deal with interpersonal conflicts?
Leadership Skills	Do you work better alone or in a team?
	When working in a team, do you prefer to lead or to follow?
Learning Experiences	Do you think the modules taught at NTU are well-designed?
	Tell us about your favourite classroom experience at NTU.

Two rounds of recruitment were conducted. In the first round, the recruitment team received 33 applications. Each member of the recruitment team evaluated the completed recruitment questionnaires individually before coming together to review their assessments and selections of student applicants as a team. Based on their answers in the recruitment questionnaires, the student applicants were evaluated and ranked in order of suitability. Consequently, 23 student applicants were invited for individual interviews while excluding the ones that explicitly stated that the monetary rewards were their main driver for wanting to participate. The personal interviews allowed the recruitment team to gain a deeper understanding of the applicants' personality traits and communication skills and a better assessment of their interest in sustainability as the main topic of the research project in order to determine their ability to contribute effectively to the research project. Consequently, the recruitment team was able to identify 14 suitable student participants for the project as well as two substitutes to prepare for contingency. As the originally planned dates for the module design workshop had to be postponed considerably due to Covid-19 restrictions, six students were not available at the later dates, which made a second round of recruitment necessary.

Surprisingly, of the 14 undergraduate student participants recruited for this research project, 13 were female and only one was male. While this project aimed to recruit an equal number of male and female student participants, the recruitment team received a disproportionate number of applications from female students. Additionally, priority was given to suitable personality traits and interest in the research, which resulted in a major deviation from an equal gender balance. The questionnaire did not factor in such a deviation and thus could not provide any answers as to why the majority of applicants were female students. Possible reasons could be work or internship commitments during the summer break or a more prevalent personal interest in participating in the academic process. Yet, despite the lack of gender balance, the recruited students came from a wide range of disciplines, including STEM disciplines, social sciences, and the humanities.

The 14 student participants were carefully divided into two diverse teams of students to ensure a diverse mix of academic disciplines, ethnicities, and personality traits, to attain balanced team dynamics that would allow for effective group discussions. The team dynamics were double-checked during the pre-workshop meeting, where student participants met one another for the first time to discuss their upcoming project for an hour.

Characteristics of the Module Design Workshop

Each group of student participants was tasked to design a credit-bearing academic module in a week-long workshop that resembled a boot camp, during which they worked from 10 am to 7 pm each day with one-hour lunch breaks. Each team alternated between individual work and group discussions throughout the day for four days. On the last day, both teams were given time to finalise and rehearse their presentations before presenting and defending their module proposals to a panel of educators from various disciplinary backgrounds as well as an online audience. Each presentation and module proposal defence session lasted about an hour. To prepare teams for the module proposal defence session, each group was required to give daily mini-presentations to the PI during the first four days of the workshop. These presentations provided opportunities for feedback and asked members of each team to justify their proposals. At the end of the Module Design Workshop, both groups of student participants were expected to deliver an OBTL document based on the template provided by NTU.

Each group was assigned a facilitator to supervise their work. Both facilitators were involved in the interview and recruitment process to better understand the participants and the group dynamics. Throughout the workshop, the facilitators played a supportive role by ensuring that the classroom environment was conducive to work, setting up Telegram groups and Microsoft Teams groups for the student participants, reminding the student participants to take their breaks to prevent burnout, encouraging student participants at various points of the workshop, and taking daily attendance. The facilitators could provide their teams

with feedback and suggestions but were instructed never to take any decisions on behalf of the students. The role of facilitators also included resolving possible conflicts.

In order to prepare the student participants for the module design workshop, readings were assigned one week prior to the start of the Module Design Workshop. Student participants were provided with a range of materials to introduce basic concepts related to sustainability and the UN Sustainable Development Goals (SDG), as well as educational pedagogy such as flipped classroom, student-centred learning, collaborative learning, outcome-based education, and formative assessment. Students were tasked to familiarise themselves with the chosen topics and pedagogical approaches to be incorporated into their module proposal.

Participants also learned about course design concepts such as "higher order thinking skills" to enable them to create a module proposal that would enhance "deep learning" (Arthurs, 2016, p. 208). Further guidelines given to the student participants were that the designed module has to be based on a partially flipped classroom and one hundred per cent continuous assessment. Thus, the Module Design Workshop provided student participants with a platform to hone their communication and leadership skills while engaging in self-directed learning.

To reduce the risk of spreading Covid-19, the Module Design Workshop and all workshop-related activities were conducted while maintaining the official guidelines on social distancing. Participants who were physically present at the workshop were required to wear masks, maintain a one-metre distance from one another at all times during the workshop, and take their body temperatures at least twice a day. Each team was assigned to a classroom for the duration of the Module Design Workshop, while the module proposal defence session was conducted in a larger classroom, with only the presenting teams and the academic panel present, while a larger community was invited to attend the presentations online.

Pre-workshop briefing and meeting

Student participants attended a pre-workshop briefing conducted by the PI followed by an ice breaker. The briefing focused on pedagogy to help conceptualise the objectives for the module the student participants were to design. The purpose of having all student participants participate in the briefing sessions together was to promote a minor degree of healthy competition, which was perceived as a form of motivation in a highly competitive Singaporean context.

Both student groups were then given an hour for discussion, during which each student participant chose an area of expertise to focus on. Within each group, one student participant had to focus on pedagogy, and two student participants had to focus on the economic, environmental, and social aspects of sustainability, respectively. The student participants were expected to act as the subject matter experts for their chosen topics during group discussions. Both groups of student participants were informed that they were expected to drive all group discussions and make decisions entirely as a team. Every participant was expected to participate actively in group discussions and to make their opinions heard and considered by their group members. The student participants were also asked to conceptualise a group decision-making process to ensure that all group member's opinions were taken into consideration by the group as a whole.

During the initial meeting, student participants in Group 1 were extremely motivated. They began by looking at module assessments and listing their goals for the first day of the workshop. Enthusiastic about the project, the student participants went so far as to give themselves homework to do. Each of them had to research their chosen topics and examine case studies in preparation for the workshop. The student participants were also reluctant to end their discussion and go home at the appointed time.

In Group 2, the team appointed a note taker for their first group discussion, during which they brainstormed ideas for their ideal module. Student participants shared teaching methods and approaches they experienced in the courses they took previously and thought of incorporating the ones they deemed effective in their module proposal. Student participants were engrossed in their discussions and had to be told to end their discussions when the allotted time came to an end. Student participants in Group 2 also took detailed notes during the pre-workshop briefing conducted by the PI. One student participant uploaded the notes of the briefing and meeting to their Microsoft Teams Group after the pre-workshop meeting. A couple of other student participants also added the notes that they took during the meeting.

Findings and observations

Pre- and post-workshop surveys were conducted, and the survey results were analysed together with post-workshop group reports to compare and evaluate student participants' expectations and perceptions of the workshop experiences. The surveys and reports assisted the team in better understanding the feasibility and value of engaging undergraduate students in the module design process.

Pre-Module Design Workshop expectations of student participants

Based on the answers provided in the pre-workshop survey, both groups of student participants expected the Module Design Workshop to be difficult and were worried about a myriad of matters (Appendix 1: Pre-workshop Survey Questions).

The challenges foreseen by student participants in Group 1 included being anxious about discussing their ideas with student participants with whom they were unfamiliar, being unable to align the 'definition and scope of sustainability with the group mates given that it's such a wide and diverse topic', having insufficient time to complete the project, being unable to manage their time or absorb the content of

the project quickly enough, being unable to come up with creative ideas due to stress or time constraint, being unable to communicate with or engage other student participants effectively, being unable to handle the stress in 'this intensive working environment', being unable to stand up for their own opinions, being overwhelmed by the scope of the project, being lazy due to a lack of pressure, and being unable to produce quality work.

The challenges foreseen by student participants in Group 2 included having 'insufficient time to design a good module on sustainability', being unable to understand the situation and their roles quickly enough during the workshop, being unable to 'bond with all members of the team', being unable to put in 100 per cent of their effort into the project, being unable to reach a 'common understanding' of their goals as a team, overanalysing their work, being too critical or negative rather than optimistic, being impatient and frustrated, being too judgmental about themselves and giving in to other student participants without standing up for themselves and being unable to build personal relationships with other student participants due to a lack of time.

Despite all their worries and anxieties, the student participants were positive about the Module Design Workshop and were motivated. Not only did the student participants look forward to learning more about the 'different facets of sustainability' and pedagogy, but they were also excited about learning from and collaborating with student participants from different disciplines.

Table 2: Selected explanations provided by student participants in Group 1.

'I'm really excited about the research portion of this workshop, as I believe that there is always something more to educate ourselves on. For example, learning more about how other societies manage their sustainability problems would be very enriching and a gear change from the Singaporean-centric and sometimes American-centric rhetoric on sustainability that NTU students are exposed to.'
'It's an amazing opportunity to put words into action and transform all the frustrations and opinions I have on the modules into creating a tangible better alternative.'
'I am looking forward to working with my peers from different backgrounds because this is a rare opportunity for me to team up with them and know about their ideas or perspectives about sustainability. I hope we can exchange our ideas and insights.'

Table 3: Selected explanations provided by student participants in Group 2.

'Getting involved in the pedagogy side of a module. Instead of complaining about an NTU module, we can now plan a module for students to complain about ;) Well, we would always hope that the students find the module rewarding and are vested in it throughout the semester.'
'It would be like a week-long hackathon, but with less snacks and more sleep. I think that is a good trade. I am also looking forward to working with students from other disciplines/majors. I find that students from each discipline always have something different to bring to the team.'
'I am looking forward to the discussions on sustainability and learning/teaching methods that will be used in the module design because I think it will be very interesting to learn about other people's views and methods used in Germany. I also look forward to getting to know new people through this project.'

In addition to their positive attitudes, the student participants also had concrete ideas on how they could contribute during the Module Design Workshop. Student participants in Group 1 planned to contribute their knowledge, ideas, perspectives, organisational skills, interpersonal skills, time management skills as well as writing skills. They also intended to contribute to the project by getting their jobs done efficiently, being a strong team player, paying attention to details, engaging 'everyone in the team', setting specific small goals in order to achieve the team's overall objectives efficiently, being adaptable, conducting research, being open-minded, resolving any potential disputes, being 'objective and logical when dealing with reasoning or practical application', acquiring new knowledge, and listening to other student participants' opinions.

Student participants in Group 2 intended to contribute their 'ideas', 'unique perspective', 'creative and design skills' as well as reasoning skills. They also planned to contribute to the project by being open to other student participants' ideas, doing their tasks to the best of their abilities, facilitating discussions, encouraging other student participants to share their opinions, ensuring all student participants get equal opportunities to voice their ideas and concerns, being curious and highly adaptable, listening actively to other student participants' ideas, communicating clearly and creating well-defined goals, paying attention to details, being proactive, self-driven and disciplined in finishing or initiating various tasks, conducting research, crafting a structured module proposal, streamlining the module proposal by identifying 'things that are unnecessary or unlikely to be effective', creating a 'collaborative working environment', coming up with innovative solutions, and produce high-quality work.

Daily observations during the Module Design Workshop

Throughout the Module Design Workshop, the two facilitators were instructed to observe the daily schedule and collaboration of the student participants. Both groups were provided with a workshop schedule which served as a general guideline on the amount of time they needed to spend on individual work and group discussions. Student participants were given the flexibility to modify the schedule to suit their needs. Group 1 chose to modify the daily schedule and to allocate homework, while Group 2 adhered largely to the schedule provided. This might also be influenced by the different personalities of the facilitators, with the facilitator for Group 1 being extremely laissez-faire, while the facilitator of Group 2 is more inclined to discipline. Further details on the daily running of the workshop and the differences between the two groups handling of the given task can be found in Appendix 3: Daily observations of groups 1 and 2.

Observations of emotions, difficulties, and coping strategies during the Module Design Workshop

On day 1, members of Group 1 appeared highly motivated, and three stayed behind after the workshop to discuss their project. This was contrasted by members of Group 2, who initially were unsure about where to start and had to refer to the workshop briefing presentation slides and the notes they took during their pre-workshop meeting to get a sense of the scope of the work. Some members also appeared frustrated by the fact that group members were sharing ideas in a disorganised and unstructured way. One student participant suggested that the group examine sample course outlines before creating an outline and structure for

their module proposal. At the end of the day, one student participant commented that it was a very tiring day due to the many brainstorming sessions and the need to figure out how to create a module proposal.

On day 2 sparked some disputes over the complexity of the module in Group 1, but the group managed to reach an agreement by debate. On the other hand, Group 2 felt the need to focus on garnering the interest of potential future students. Thus, the group based the case studies in their lesson plan on what they thought a larger student community would find interesting and relevant to sustainability issues. They argued that the case studies needed to be applicable to the Singapore context and bring about different views and opinions in order to encourage students to discuss and critique existing solutions to real-world problems. During group discussions, student participants were respectful and willing to listen and consider one another's ideas.

The facilitator observed student participants in Group 2 became more bonded and felt more comfortable with one another on day 3. They began to share personal interests and hobbies, a few doodled on whiteboards, and more jokes and laughter were heard throughout the day. Nevertheless, members of the same group remarked at the end of the day that it was a very tiring day due to long group discussions.
On day 4, student participants of Group 1 complained about their workload and thought the amount of time allocated for their final presentation was too short. Due to a lack of time, the student participants decided to divide their presentation slides amongst themselves rather than work on them together as a team. Likewise, student participants in Group 2 became a little anxious about their module proposal defence session scheduled on the next day and asked the facilitator a number of questions regarding their defence session.

On day 5, student participants in Group 2 were also stressed about their final presentation and module proposal defence. One student participant wrote a long script but had trouble recalling her script during the rehearsal, and several student participants were extremely nervous during the rehearsal. Overall it was observed that at times some student participants in both groups were carried away by their passion for certain topics during group discussions, went off-track or got caught up in the details, yet all students were able to remind themselves to refocus on the bigger picture.

Post-workshop survey results on challenges

Once student participants had completed their Module Design Workshop group report, student participants from both groups gathered together to share their feedback and workshop experiences. Student participants from both groups enjoyed the workshop and were proud of their work. One student participant reflected that through participating in the workshop, she finally achieved her goal of giving her 100% to something. A few student participants from Group 1 complained about the heavy workload and about the need to bring work home due to a lack of time. Student participants in Group 2 had not taken their individual work home, and after learning that members of Group 1 had worked at home after the daily workshops, members of Group 2 felt grateful for being in Group 2.

After the student participants had completed the Module Design Workshop, a post-workshop survey was conducted to understand their experiences. For comparison, the survey mirrored the pre-workshop survey (Appendix 2: Post-workshop survey questions).

Of the following list of challenges (Table 4), the top four challenges anticipated by student participants in the pre-workshop survey and encountered by students during the workshop were identical. Yet, a slight change in the order of difficulty was recorded (see Table 5).

Table 4: List of challenges.

1. lack of time
2. freeloaders
3. scope of work
4. disputes
5. lack of subject competence
6. lack of pedagogical competence
7. dislikes and/or personality clashes

Table 5: Challenges in decreasing order of difficulty.

Challenge (decreasing order of difficulty)	Pre-workshop survey	Post-workshop survey
1.	lack of time	scope of work/ lack of pedagogical competence
2.	lack of pedagogical competence	lack of subject competence/ lack of time
3.	lack of subject competence	
4.	scope of work	

Scope of work

To some extent, student participants from both groups were overwhelmed by the 'broad scope' of work of the Module Design Workshop, especially on the first day of the workshop, where a few student participants in both groups experienced a sense of disorientation by 'not knowing where to start'. Sustainability is a broad topic, and student participants in both groups found it 'difficult to identify relevant topics and case studies because of the amount of information online that had to be sifted through to find the most suitable one'. Group 1 declared the 'intensity of the workshop was also very high as there were a lot of tasks to complete in a short amount of time', and 'keeping up [with] the pace set during the first day was pretty hard'. According to a student participant from Group 2, the large scope of work, coupled with unfamiliarity with team members, made the workshop all the more challenging for student participants on the first day since they had to get used to the 'working style and dynamics of the team' and it was 'not easy trying to learn about one another'.

Lack of pedagogical competence

At times, student participants from both groups struggled to work on their module proposal due to the lack of

pedagogical competence. Student participants in Group 1 found it tedious to simultaneously balance the need to include 'enough tests to check learning' and to avoid 'over-testing' students. Student participants in Group 2 found it 'hard to decide how much content would be good and feasible for students to cover'. They also reflected that it was the 'most difficult to create the lesson plan as a group' and link their ideas 'in a cohesive manner', having taken 'the longest' time to 'shift activities and lessons around with student learning in mind'.

Lack of subject competence

Student participants in Group 1 found it 'very difficult to choose topics' and even more so to 'justify' their choice of topics as a team due to a general lack of 'in-depth knowledge about sustainability issues' among the team members. Consequently, one student participant in Group 1 was 'worried that the case studies [they] found for weekly lesson plan [were] biased'.

Just like student participants in Group 1, student participants in Group 2 also struggled to 'readily defend and give good rationales' for their ideas and decide 'which ideas to incorporate' during the workshop. Student participants in Group 2 also experienced challenges due to a lack of subject competence:

> Personally, I feel that deciding what to put into the syllabus is pretty tedious because without a deeper understanding to sustainability, it's hard to accurately filter what information is most crucial for students to learn. And how this information could be further synergised and integrated such that it is relevant to students of different disciplines. In addition, the information we are able to gather in the short span of time must be too shallow or not substantial enough for a full 13 weeks module.

Lack of time

Student participants in both groups were provided with a workshop schedule which served as a general guideline on the amount of time they needed to spend on individual work and group discussions. Student participants were given the flexibility to modify the schedule to suit their needs.

Student participants in Group 1 decided as a team, to take work home on most days of the Module Design Workshop. It was noticeable that the team decided to give themselves homework even before the start of the Module Design Workshop. A closer examination of the survey results revealed that student participants in Group 1 felt the need to bring work home due to their change in schedule:

> Not enough time, had to bring home work to do. Even when we were working very hard and hardly taking any breaks, there was a significant amount of work to do, and most of the day was spent doing group discussions. Although the original "timetable" had alternative two-hour blocks of individual and group work, most of the first three days were group work, and the third evening was a lot of individual research at home.

The allocation of more time for team discussion led to the team's failure to allocate enough time to complete their individual work during the workshop:

> I feel that there was not enough time to prepare the case studies, so I spent quite some time after the daily meetings to finish the research.

Consequently, student participants in Group 1 had 'little time to rest and sleep', having to 'get up so early and sleep late'. A common and repeated complaint coming from this group of students at the end of the Module Design Workshop was that they had to continue to work at home, which made their workshop experience 'quite stressful':

> I don't think I've worked this hard since A levels. It was a very short period of time to do very intensive work.

Sleep-deprived and stressed student participants in Group 1 also found it hard to cope with the duration of the Module Design Workshop. Most of them complained of feeling 'very tired sometimes', having 'dry and tired' eyes due to the need to 'look at the laptop screen for the whole day' and getting 'a headache' every day at around 5 pm 'after thinking too much throughout the day'. One student participant also wished more time was provided for the project so that she could 'actualise' the group's vision using case studies and examples.

Student participants in Group 2, on the other hand, followed the workshop schedule rather closely on the first two days and not a single one of them had to continue to work at home throughout the Module Design Workshop. They remarked that the workshop timings were 'well-structured', that 'sticking to the work schedule' and 'respecting break times' helped to prevent burnout, and that not having to think about the project 'outside of the workshop' enabled them to work better during the workshop. One student participant from this group commented, however, that she would appreciate 'a bit more flexibility' in their schedule, especially on the first few days of the workshop, since it was 'difficult to predict' exactly how much time was needed for discussions and individual work. One student participant in Group 2 also struggled to cope with the 'long hours' of the Module Design Workshop due to the need to adjust her biological clock.

> Having to readjust my body clock to attend the workshop - I had been living in the American timezone until this workshop, and I had a hard time adjusting on the first few days and was afraid of being late. Otherwise, everything was good.

Nevertheless, on days 4 and 5 of the Module Design workshop, students from Group 2 felt less prepared and consequently felt more nervous and anxious than students from Group 1.

Post-survey feedback on how participants overcame their challenges

Student participants in Group 1 overcame their challenges by planning and creating objectives for each day of the workshop, creating an environment where everyone felt that they could speak and have their opinions heard, improving one another's ideas and suggestions, questioning one another's decisions to ensure that they had 'sound reasons' for their decisions, working hard to 'achieve consensus' on various different issues and making sure everyone was 'on the same page', organising themselves into different groups to work on various parts of the project, using whiteboards in the classroom to work out the details of the project as a group, constantly checking one another's progress, and seeking clarifications from one another. A more introverted member of the group attested that the team involved everyone in their group discussions:

> It was also quite chaotic as my teammates were people who were very talkative and had very high energy. However, I like that they make an effort to include the less talkative members, and I slowly became more comfortable in voicing out my opinions.

Student participants in Group 2 overcame their challenges by splitting their workload amongst themselves 'evenly' from the 'very first day', taking the 'initiative to organise the team's documents', engaging in 'active listening and discussion' to understand one another's points of view, respecting one another's opinions and being considerate, reminding one another to 'take breaks' to refresh their perspectives and to prevent burnout, reminding themselves of the workshop objectives and 'revisiting the big picture', creating a 'cooperative environment' that made collaborating with one another 'easy', communicating 'clearly and respectfully' with one another to ensure that they were 'on the same page' and that their 'individual work would make sense when put together', looking at their challenges in a 'more holistic manner', asking 'a lot of why questions' during discussions to ensure the rationales behind all the decisions that they made were 'clear and logical', evaluating one another's progress, supporting one another by reviewing and editing one another's work:

> To be honest, I don't think I have a moment I didn't enjoy. Because all the problems, whether it is about our ideas or personality, were resolved in a mature manner. We never took criticism personally and made sure none of us did. In that way, it made us more focused on improving our work the best we can.

Additionally, students provided suggestions for successful collaborative work as follows:

> Patience, I would say. I was ready to be patient with my teammates and myself. Listen to them and trust them. And I am happy with how it turned out.

Post-workshop survey feedback on what student participants enjoyed the most

Student participants in Group 1 enjoyed discussing ideas, gaining new perspectives, learning more about sustainability and working collaboratively with their group members to achieve a common goal. The aspect of teamwork and learning to work interdisciplinarily while accommodating others' needs was highlighted. Also, the boot camp-style workshop was perceived positively in order to facilitate a focused, productive work environment.

Table 6. Post-workshop survey feedback from Group 1 participants.

'Collaborative work with groupmates who were very proactive in sharing their opinions and examples. I also really enjoyed splitting up into smaller groups of two and three to work on specific parts of the project, and it was very productive!'
'I liked bouncing ideas off each other in a group setting and being in an environment where we were all working together to achieve a common goal.'
'The discussion, in general, I get to learn about the teaching experience my groupmates had in their respective discipline and that made me reflect on my own experience and biases.'
'I really enjoyed learning what everyone knew about sustainability and enjoyed working with the team bouncing ideas off each other. I also had faith in my group members that each of us would get our work done properly, which felt like great teamwork.'
'Learning more about sustainability and understanding how all the different UNSDGs relate to sustainability development. I also became more aware and conscious of how every action that I take in my everyday life and that we need to critically analyse how our actions can affect the Earth.'
'The teamwork with people from different courses is really interesting. And I enjoy hearing my teammates share their findings and general knowledge about sustainability.'
I enjoyed learning the different working styles of everyone in my group and learning how to accommodate each of their personalities and styles.'
'I also enjoyed the idea that it was an intensive boot camp style of working because personally, I tend to work best in a completely focused environment when I only focus on one thing instead of having too many activities and breaks in between.'

The student participants felt fulfilled and 'very proud' of their work after learning how to manage their time, working together as a team under 'great pressure and time constraint' and making the most out of the week-long intensive Module Design Workshop.

Student participants in Group 2 enjoyed their group discussions the most, while a few students thoroughly enjoyed the long hours of the Module Design Workshop.

Table 7. Post-workshop survey feedback from Group 1 participants.

'I enjoyed discussing the module design with my team members, as everyone had good and important things to share. It was fun getting to know new people from different disciplines and learning about how they experience school differently from me.'
'I did enjoy exchanging and critiquing the ideas that we had during the team discussions. I felt that we were able to make good progress for most of it.'
'I enjoyed discussion with my fellow teammates and bouncing ideas with one another. Even though there were times when our ideas conflicted with one another, the process of figuring out solutions has been extremely fulfilling for me. Additionally, I appreciate that both my facilitator and teammates respected break time and used that time to know one another on a personal level, which directly helped us improve our teamwork.'
'I personally enjoyed the intense work environment for the five days because I knew it was just for five days, from 10 am to 7 pm.'
'The long working hours enabled me to sleep more soundly than I normally can. It also kept me from feeling depressed because I felt productive and was committed to doing something well.'

Student participants also listed 'friendship and camaraderie' as some of their biggest takeaways from the Module Design Workshop. The student participants became friends after getting to know one another on a personal level. They shared the same sense of humour, enjoyed one another's company and felt safe and easy to share their honest opinions and past learning experiences with one another

as they worked hard together to achieve a common goal. As the student participants took turns to take notes of meetings and lead discussions in the process of developing their team dynamics, they also realised that it was possible to work well together as a team without assigning fixed roles to each group member—as long as they were respectful of one another.

Outcomes, discussion, and conclusions

Self-evaluation

All 14 student participants reported on time throughout the Module Design Workshop, which is testimony to their dedication to the task. A few student participants arrived daily before 9 am, even though the workshop began at 10 am. Committed and driven to producing high-quality module proposals, the student participants put in their 'best effort' to complete all their tasks on time and did them well. All the student participants either met or exceeded their own expectations to complete their duties during the workshop; overall, students exceeded their own expectations in reference to task completion by 33%. With the exception of two student participants, one from each group, all student participants either met or exceeded their own expectations in contributing meaningfully during the workshop; overall, students exceeded their own expectations in relation to their personal, meaningful contribution by 17%.

The student participants set high expectations for themselves and tended to be rather hard on themselves in their self-evaluations. Student participants in Group 1 criticised themselves for a multitude of matters, which included having 'really ugly handwriting on the whiteboard', having 'last-minute jitters out of a sudden' during the presentation, being 'narrow-minded' when focusing on a familiar topic, not 'contributing enough original ideas', being 'a bit too talkative and pushy during group discussions', being 'too bossy' at times, not making an effort to assume a leadership role, being unable to contribute as much as they had hoped to, being unable to contribute much to the brainstorming sessions due to difficulty in articulating their thoughts clearly, not having enough 'insightful ideas to share', asking other student participants for clarifications and consequently risking rubbing them 'the wrong way', being inefficient, and needing more time than their peers to do their work or process their thoughts.

Student participants in Group 2 criticised themselves for being too direct in communication, having 'an unapproachable demeanour' that made people feel uncomfortable or 'hesitant' to talk to her, being 'too fast' in processing information and consequently making it difficult for other student participants to catch up with their line of thought, having 'allowed a personality clash to get in the way' rather than reacting 'in a helpful manner', being too shy to speak their mind, 'not being active in every single discussion' and losing track during group discussions at times, not performing as well as they hoped during the presentation, needing more time to process information and being unable to catch up with other student participants at times to contribute meaningfully to the group work, not contributing as many ideas to other student participants' chosen topics, having short attention span, and not being as productive as they could be.

Student participants learned more about sustainability

All of the 14 student participants became more knowledgeable about sustainability and were able to name the 17 SDGs correctly after the workshop. Only two student participants managed to name these goals correctly in the pre-workshop survey. Overall, the student participants' interest level in sustainability increased by 9% after the workshop. However, two student participants became a little less interested in sustainability after the workshop. On the other hand, the post-workshop surveys and group reports demonstrated that students enjoyed learning more about sustainability and the SDGs, felt the need for more engagement in all aspects of sustainability, and the need for more education in this field. One student participant explained how she realised the 'urgency of reversing overexertion' on the Earth's natural resources and thought of raising student awareness of sustainability issues as her understanding of sustainability deepened:

> I contributed to the ecological pillar of our lesson plan under life on land and introduced the idea and mechanics of the challenges. I learnt a lot about the ecological devastation when I was conducting individual research and thought that it could be introduced to students in a more detailed manner rather than classifying them all under eventual habitat loss and declining populations of certain endangered species. Case studies, videos, and pictures are what I think could make students care about the secondary effects of human activities – effects that we do not feel primarily as humans.

Student participants' changed perception of higher education pedagogy

With the exception of one student participant, all student participants' knowledge about educational pedagogy increased after the workshop; the student participants' knowledge about educational pedagogy increased by 73% overall. As evident from the data in Tables 6 and 7, student participants from both groups gave more thought to teaching strategies and assessment methods after acquiring more knowledge on educational pedagogy. They also thought more from the perspective of a module designer than that of a student who was comfortable with engaging in mostly self-directed learning when considering the options for improving the courses at NTU (Appendix 3).

As the student participants gained more knowledge about higher education pedagogy and attained a deeper understanding of module design, they became less satisfied with existing courses at NTU. Overall, the student participants' satisfaction with the Core Modules, GER-PEs and UEs at NTU decreased by 6%, 15% and 4%, respectively, after the workshop. Student participants from Group 2 explained that their understanding of module design made them realise that 'a good number of modules' at NTU needed a 'major

face lift'. As shown in the graph below, 13 out of 14 student participants thought that the assessment methods of NTU courses could be improved after the workshop. The number of student participants who thought that course content and teaching styles of NTU courses could be improved also increased after the workshop. A smaller number of student participants thought class size should be reduced after learning that it was something beyond educators' control.

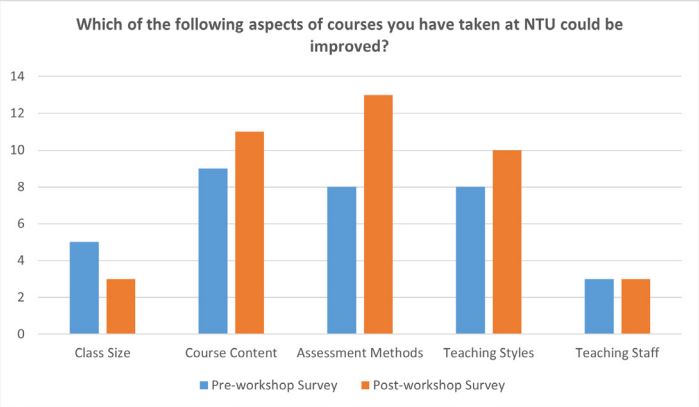

Figure 1. Changed perceptions of higher education pedagogy.

A few students became more satisfied with the more engaging modules they took at NTU after the workshop and expressed their appreciation for the use of flipped classrooms and being challenged in classroom discussions. Active engagement and peer-to-peer discussion and learning was listed as top contributing factors for good modules. The positive feedback on existing modules came without exception from humanities majors, predominantly from students reading History.

Yet, while students have positive impressions of their engagement in class and through flipped classroom activities, the same students criticised existing assessment styles. Specifically, modules that use memorisation rather than critical evaluation in the assessments fell short of student expectations.

Not only did these student participants become more appreciative of the more engaging modules that they took at NTU, they also borrowed from these courses teaching strategies that they deemed were effective in helping them to learn better:

> I also devised the mechanics of the third challenge, "In an ideal world..." where students could draw on whiteboards what an ideal sustainable world is to them. I borrowed this idea from a history class where we drew what we envisioned ritual halls of the Tang Chinese looked like for funerals. This helped me learn and remember better, and I applied it to the module design. I think that it could also serve as a personal/group vision for students to help remind themselves what they could be doing in order to achieve their ideal, sustainable world.

This demonstrates clearly that undergraduate students can leverage their personal, educational experiences in an effort to enhance their module proposal during the Module Design Workshop.

Evaluation of module proposals and of the feasibility of engaging students as partners in module design

Both groups of student participants managed to create well-designed and feasible module proposals on sustainability, which far exceeded expectations. Both proposals had different strengths, with Group 1 featuring creative assessment components, while Group 2 focused more on pedagogical details. The research demonstrated that students felt overpowered by the task at times, yet both teams found means to cope with the situation and completed the challenging task on time. The feedback from students also demonstrated the benefits of a clearly structured schedule and approach when working on a complex task. Additionally, it became clear that the students felt a strong sense of achievement and pride while exceeding their own expectations through this engagement. While engaging students in the module design process is not an entirely new concept, it is far from the norm in academic reality. Cook-Sather and Felten (2017) have highlighted the importance of the principles of respect and shared responsibility to be the norm in academia and illustrate the benefits of the "ethic of reciprocity". Moreover, previous research by Healey et al. (2015) clearly demonstrated the benefits and feasibility of engaging students in co-designing the curriculum, and as pedagogical consultants to academic staff, this research has demonstrated that students are capable of going beyond collaborating with staff or assisting staff. Instead, both groups completed the task of creating a new module from scratch. While the teams were scaffolded through the pre-workshop materials, the daily feedback provided, and the presence of the facilitators, the students clearly demonstrated that they were capable of creating a feasible and creative module that deeply engages learners with little guidance. In the process, students have drawn on their personal experiences, as well as immersed deeply in novel content and concepts. In the process, the student collaborators have far exceeded the expectations of the PI.

It is noteworthy that undergraduate students from very different disciplines and of contrasting personalities have worked closely together on the task. The daily observations, reports, and pre- and post-workshop surveys indicate that students explored different strategies to work with each other and to grow into their respective roles. While some disputes arose during the workshop, they were minor, and the participants were mature enough to manage and resolve them without interference from the facilitators. As such, students have navigated conflict and personality clashes but were able to resolve such conflict situations by working towards a common goal. Students also cherished their varied backgrounds and talents and made use of them in the module design process. This demonstrates that interdisciplinary work is possible and beneficial. The research also demonstrated that prior knowledge is only partially a limiting factor that can be easily overcome by focused self-directed research and reading. What enabled the teams of

students to complete the complex and challenging task was not prior knowledge, but focus, collaboration, and ongoing discussion. This suggests that academia ought to place a clear focus on the development of such skills to adequately prepare students for the ever-changing and complex post-university reality.

Based on the two proposals developed during the Module Design Workshop, a module combining elements of both proposals has been created and offered to undergraduate students at NTU. This module has proven highly popular. Offered to all undergraduate students at NTU, this module has deliberately utilised the diversity resulting from having a mix of students from a wide range of disciplines. It prepares students for their future work life by encouraging them to examine, analyse, and evaluate complex issues and phenomena collaboratively in multi-disciplinary teams and in a flipped-classroom setting. As a further result of the findings of this research, several modules have been proposed by the PI built on the principle of peer teaching, empowering diverse teams of first- and second-year students to research a topic, present it to class, and engage their classmates in interactive class activities.

Conclusion

This research project proved that it is feasible and beneficial to engage undergraduate students in the module design process in the Singapore context. Firstly, the participating students demonstrated comprehensive awareness of the educational pedagogy that benefited their learning, and participants drew on these insights during the Module Design Workshop. Secondly, stepping out from the receiving end of the learning process, they also proved exceedingly capable of creating novel module proposals, despite their initial lack of in-depth subject matter knowledge. Lastly, the project demonstrated that students draw on their varied skills and are able to tackle complex and challenging tasks when collaborating in multi-disciplinary groups. It is, therefore, essential for universities to engage students as partners in teaching and learning to improve the curriculum, teaching strategies, and assessment methods. Such an approach also engages students much deeper in the learning journey and develops higher-level skills.

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References

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. *Computers & Education 126*(1), 334-345. https://doi.org/10.1016/j.compedu.2018.07.021

Albert, M., & Beatty, B. J. (2014). Flipping the classroom applications to curriculum redesign for an introduction to management course: Impact on grades. *Journal of Education for Business, 89*(8), 419-424. https://doi.org/10.1080/08832323.2014.929559

Anderson, R. D. (1996). Student collaboration on course improvement. *Journal of Science Teacher Education, 7*(4), 295-301. https://www.jstor.org/stable/43156077

Arthurs, L. (2016). Course design principles for enhancing student learning. *Oceanography, 29*(4), 207-208. https://www.jstor.org/stable/10.2307/24862296

Barman, L., Bolander-Laksov, K., & Silén, C. (2014). Policy enacted – teachers' approaches to an outcome-based framework for course design. *Teaching in Higher Education, 19*(7), 735-746. https://doi.org/10.1080/13562517.2014.934346

Bengtson, C., Ahlkvist, M., Ekeroth, W., Nilsen-Moe, A., Vedin, N. P., Rodiuchkina, K., Ye, S., & Lundberg, M. (2017). Working as partners: Course development by a student-teacher team. *International Journal for the Scholarship of Teaching and Learning, 11*(2), 1-9. https://doi.org/10.20429/ijsotl.2017.110206

Centre for Teaching, Learning & Pedagogy (CTLP). (2023). *Designing your course*. https://www.ntu.edu.sg/education/teaching-learning/teaching-and-learning-resources/obtl

Chung, J. C. C., & Chow, S. M. K. (2004). Promoting student learning through a student-centred problem-based learning subject curriculum. *Innovations in Education & Teaching International, 41*(2), 157-168. https://doi.org/10.1080/1470329042000208684

Cook-Sather, A. & Felten, P. (2017). Ethics of academic leadership: Guiding learning and teaching. In F, Wu. & M. Wood. (Eds)., *Cosmopolitan perspectives on becoming an academic leader in higher education* (pp. 175-191). Bloomsbury.

Department of Economic and Social Affairs. (2019). *Sustainable development*. United Nations. https://sdgs.un.org/goals

Ducate, L. (2016). Casting a university-wide net: Teaching sustainability in Germany. *Unterrichtspraxis/ Teaching German, 49*(1), 69-79. https://doi.org/10.1111/tger.10212

Enkenberg, J. (2001). Instructional design and emerging teaching models in higher education. *Computers in Human Behavior, 17*(5), 495-506. https://doi.org/10.1016/S0747-5632(01)00021-8

Gikandi, J.W., Morrow, D., & Davis, N. E. (2011). Online formative assessment in higher education: A review of the literature. *Computers and Education, 57*(4), 2333-2351. https://doi.org/10.1016/j.compedu.2011.06.004

Gurukkal, R. (2020). Outcome-based education: An open framework. *Higher Education for the Future, 7*(1), 1-4. https://doi.org/10.1177/2347631119886402

Gurukkal, R. (2018). Towards outcome-based education. *Higher Education for the Future, 5*(1), 1-3. https://doi.org/10.1177/2347631117740456

Healey, M., Bovill, C., & Jenkins, A. (2015). Students as partners in learning. In J. Lea (Ed.), *Enhancing learning and teaching in higher education: Engaging with the dimensions of practice* (pp. 141–163). McGraw Hill/Open University Press.

Kapp, E. (2009). Improving student teamwork in a collaborative project-based course. *College Teaching, 57*(3), 139-143. https://www.jstor.org/stable/25763382

Kinsella, G. K., Mahon, C., & Ullis, S. (2017). Facilitating active engagement of the university student in a large-group setting using group work activities. *Journal of College Science Teaching, 46*(6), 34-43. https://www.jstor.org/stable/44579943

Lee, E., & Hannafin, M. (2016). A design framework for enhancing engagement in student-centered learning: own it, learn it, and share it. *Educational Technology Research and Development, 64*(4), 707-734. https://doi.org/10.1007/s11423-015-9422-5

Loes, C., Culver, K., & Trolian, T. (2018). How collaborative learning enhances students' openness to diversity. *The Journal of Higher Education, 89*(6), 935-960. https://doi.org/10.1080/00221546.2018.1442638

Long, T., Cummins, J., & Waugh, M. (2017). Use of the flipped classroom instructional model in higher education: Instructors' perspectives." *Journal of Computing in Higher Education, 29*(2), 179-200. https://doi.org/10.1007/s12528-016-9119-8

López-Pastor, V., & Sicilia-Camacho, A. (2017). Formative and shared assessment in higher education. Lessons learned and challenges for the future. *Assessment & Evaluation in Higher Education, 42*(1), 77-97. https://doi.org/10.1080/02602938.2015.1083535

Matthews, K. E., Cook-Sather, A., & Healey, M. (2018). Connecting learning, teaching, and research through student–staff partnerships: Toward universities as egalitarian learning communities. In V. Tong, A. Standen., & M. Sotiriou (Eds.), *Shaping higher education with students: ways to connect research and teaching* (pp. 23-29). UCL Press, http://www.jstor.com/stable/j.ctt21c4tcm.7

McCabe, A., & O'Connor, U. (2014). Student-centred learning: The role and responsibility of the lecturer. *Teaching in Higher Education, 19*(4), 350-359. https://doi.org/10.1080/13562517.2013.860111

Mistry, V. (2010). Collaborative learning and development: Critical success factors from the experience of four UK universities. *Development and Learning in Organisations: An International Journal, 24*(2), 14-16. https://doi.org/10.1108/14777281011019461

Nanyang Technological University Singapore. (2023). *Interdisciplinary learning*. https://www.ntu.edu.sg/education/interdisciplinary-learning

Nanyang Technological University Singapore. (2023). *Sustainability*. https://www.ntu.edu.sg/sustainability

Nel, L. (2017). Students as collaborators in creating meaningful learning experiences in technology-enhanced classrooms: An engaged scholarship approach. *British Journal of Educational Technology, 48*(5), 1131-1142. https://doi.org/10.1111/bjet.12549

Repko, A., & Szostak, R. (2017). *Interdisciplinary research: Process and theory* (3rd edition). Sage.

Slunt, K. M., & Giancarlo, L. C. (2004). Student-centered Learning: A comparison of two different methods of instruction. *Journal of Chemical Education, 81*(7), 985-988. https://doi.org/10.1021/ed081p985

Strayer, J. F. (2012). How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environments Research, 15*(2), 171-193. https://doi.org/10.1007/s10984-012-9108-4

Surata, S. P. K., & Lansing, J. S. (2015). Engaging student teachers in designing ecopedagogy learning modules for Bali's Subak cultural landscape. *NACTA Journal, 59*(2), 139-143. https://www.jstor.org/stable/10.2307/nactajournal.59.2.139

Tan, E. (2022). 'Heartware' for the Compassionate Teacher: Humanising the academy through mindsight, attentive love, and storytelling. *Journal of Applied Learning & Teaching, 5*(2), 152-159. https://doi.org/10.37074/jalt.2022.5.2.ss1

Udas, E., Wölk , M., & Wilmking, M. (2018). The 'carbon-neutral university' – a study from Germany. *International Journal of Sustainability in Higher Education, 19*(1), 130-145. https://doi.org/10.1108/IJSHE-05-2016-0089

Wright, G. B. (2011). Student-centered learning in higher education. *International Journal of Teaching & Learning in Higher Education, 23*(1), 92-97. https://files.eric.ed.gov/fulltext/EJ938583.pdf

Yorke, M. (2003). Formative assessment in higher education: Moves towards theory and the enhancement of pedagogic practice. *Higher Education, 45*(4), 477-501. https://doi.org/10.1023/A:1023967026413

Appendices

Appendix 1: Pre-workshop survey questions.

No.	Pre-workshop Survey Question
Q1.1	We would like to know about your current understanding of sustainability. Please choose the answers with 0 being nothing, 1 being very little, and 10 being very much. - To what extent are you interested in sustainability? - To what extent are you knowledgeable about sustainability?
Q1.2	In your opinion, which of the following topics fall under the umbrella of sustainability? You can choose any number of answers. - Poverty - Hunger - Health - Sanitation - Clean Energy - Economic Growth - Infrastructure - Equality - Gender Equality - Sustainable Cities - Consumption - Production - Climate Action - Life in Water - Life on Land - Peace - Justice - Work
Q2.1	Based on your personal classroom experiences at NTU. Please indicate your satisfaction, with 0 being not at all, and 10 being very much. - How satisfied are you with the core modules you have taken at NTU so far? - How satisfied are you with the GER-PEs you have taken at NTU so far? - How satisfied are you with UEs modules you have taken at NTU so far?
Q2.2	In your opinion, which of the following aspects of courses you have taken at NTU could be improved? You can choose any number of answers. - class size - course content - assessment methods - teaching styles - teaching staff - others (please indicate):
Q2.3	In your opinion, how could existing modules at NTU be improved? Please explain in detail.
Q2.4	To what extent are you knowledgeable about educational pedagogy? Zero indicates none, and 10 very much. - My current knowledge about educational pedagogy is:
Q3.1	We would like to know how confident you are about the following aspects in regard to the upcoming workshop: - Your ability to contribute meaningfully to the upcoming workshop - Your role in the upcoming workshop
Q3.2	What are your biggest concerns in regard to the upcoming workshop? Please rank the items with #1 being the biggest concern. Please keep 'others' blank and in the lowest position, if there are no other concerns you want to add. - lack of time - freeloaders - scope of work - disputes - lack of subject competence - lack of pedagogical competence - dislikes and/or personality clashes - others (please describe in detail):
Q3.3	Which personal challenges do you foresee during the workshop? Please describe in detail.
Q3.4	What are you looking forward to in regard to the upcoming workshop? Please describe in detail.
Q4.1	What is your biggest strength? Please explain in detail.
Q4.2	What is your biggest weakness? Please explain in detail.
Q4.3	How will you be able to contribute most to the project? Please explain in detail.

Appendix 2: Post-workshop survey questions.

No.	Post-workshop survey question
Q1.1	We would like to know about your current understanding of sustainability. Please choose the answers with 0 being nothing, 1 being very little, and 10 being very much. - To what extent are you interested in sustainability? - To what extent are you knowledgeable about sustainability?
Q1.2	In your opinion, which of the following topics fall under the umbrella of sustainability? You can choose any number of answers. - Poverty - Hunger - Health - Sanitation - Clean Energy - Economic Growth - Infrastructure - Equality - Gender Equality - Sustainable Cities - Consumption - Production - Climate Action - Life in Water - Life on Land - Peace - Justice - Work
Q2.1	Based on your personal classroom experiences at NTU. Please indicate your satisfaction, with 0 being not at all, and 10 being very much. - How satisfied are you with the core modules you have taken at NTU so far? - How satisfied are you with the GER-PEs you have taken at NTU so far? - How satisfied are you with UEs modules you have taken at NTU so far?
Q2.2	In your opinion, which of the following aspects of courses you have taken at NTU could be improved? You can choose any number of answers. - class size - course content - assessment methods - teaching styles - teaching staff - others (please indicate):
Q2.3	In your opinion, how could existing modules at NTU be improved? Please explain in detail.
Q2.4	To what extent are you knowledgeable about educational pedagogy? Zero indicates none, and 10 very much. - My current knowledge about educational pedagogy is:
Q3.1	Looking back, how do you evaluate your own performance during the module design workshop according to the categories below? - You were able to contribute meaningfully to the workshop - You were able to complete all your duties during the workshop
Q3.2	What were your biggest problems during the Module Design Workshop? Please rank the items, with #1 being the biggest concern. Please keep 'others' blank and in the lowest position, if there are no other concerns you want to add. - lack of time - freeloaders - scope of work - disputes - lack of subject competence - lack of pedagogical competence - dislikes and/or personality clashes - others (please describe in detail):
Q3.3	Which personal challenges did you face during the workshop? Please describe in detail.
Q3.4	What did you enjoy most during the module design workshop? Please describe in detail.
Q3.5	What did you enjoy least or find most difficult/ problematic during the module design workshop? Please describe in detail.
Q3.6	Which challenges/ problems/ difficulties in regard to your team did you experience during the module design workshop? Please describe in detail.
Q4.1	What was your biggest strength during the module design workshop? Please explain in detail.
Q4.2	What was your biggest weakness during the module design workshop? Please explain in detail.
Q4.3	How did you contribute most to the project? Please explain in detail.

Appendix 3: Daily observations of groups 1 and 2.

Day 1 observations

Student participants in Group 1 began the workshop by discussing the research that they had done at home prior to the workshop. They took turns sharing case studies that were related to their chosen topics and were very detailed in their explanations. As a group, the student participants chose primary and secondary areas of focus from the UN Sustainable Development Goals and penned their collective thoughts on whiteboards. Student participants had conflicting ideas but managed to reach a consensus through debates. They then rationalised their objectives for the day and moved on to draft the ILO, aims, teaching approaches, assessment components and lesson plan for the first week of the module. Student participants had differing views but managed to agree on a collective solution via debates. Student participants also spent some time working in pairs. Towards the end of the day, student participants presented their work to the PI, who provided them with feedback. The day concluded with student participants developing a strategy to achieve their goals for the following day.

Students in Group 2 did not do any individual work during the weekend prior to the workshop. Hence, they started with individual work before moving on to group discussions and then alternated between individual and group work throughout the day. Student participants then created files and documents in their Microsoft Teams group to keep track of their project deliverables. Student participants continued to discuss teaching methods and approaches they experienced in the courses that they took previously and decided that flipped-classroom approaches were the most effective. While a few students were always ready to agree with suggestions proposed by others, active group discussions took place, and the team was more interested in their discussions than going for lunch. During their second group discussion of the day, the student participants took turns presenting their findings and concluded that they needed more time to research information. The student participant who was in charge of pedagogy, did a great amount of focused research, and by the end of the day, she was ready to present the ILO, aims, and format of the group's module proposal to the PI. As a group, the student participants addressed the feedback given by the PI during the mini-presentation before the end of the day.

Day 2 observations

Student participants in Group 1 reviewed and refined the ILO, aims, assessment components, teaching approaches, and content of their module proposal. The content, in particular, had to be relevant. The group also worked on a sample three-hour lesson plan and established the main aims for each of the three hours. Activities such as gamification and roleplay were added to their module proposal to make the lessons more engaging. A 'myth-busting' segment was included to deal with fake news and allow flexibility for real-world events. Feedback from the PI was considered. Again, student participants engaged in group discussions most of the time and did one hour of pair work. The group's time management skills improved with time. Towards the end of the day, the group presented their work to the PI, who provided them with extensive feedback.

Student participants in Group 2 began the day with a 10-minute group discussion before moving on to pair or individual work. Student participants took turns leading group discussions and presenting their findings on their chosen topics before confirming the content of their module as a group. The group revisited the idea of incorporating activities they termed as 'fun challenges that were related to sustainability' to wrap up content and provide a platform for students to apply their knowledge. An avid player of video games contributed many ideas to the formulation of these challenges. The group then moved on to discuss assessment details and refine their ILO before working on their OBTL document. The group also came up with a few possible titles for their proposed module before presenting their work to the PI. Student participants finished by addressing the feedback provided by the PI.

Day 3 observations

Student participants in Group 1 were more energetic on the third day of the workshop than the day before. The student participants engaged in group discussions, pair work, and individual work throughout the day. They reorganised themselves a few times to get fresh perspectives from working closely with different group members. Student participants actively sought one another's opinions and supported one another. In smaller groups, the student participants worked on different parts of their OBTL document. The group finalised the ILO of their module proposal before moving on to work on their sample lesson plan, case studies, assessment details, and rubrics. The student participants spent much of their time justifying their decisions before presenting their work to the PI. Student participants decided to bring work home in order to complete their module proposal on time.
One student participant in Group 2 with a strong background in art and design found a suitable PowerPoint template for the group's final presentation and began to work on it. The student participants engaged in group discussions for almost the entire day and took turns leading group discussions. They refined the schedule and content of their proposed module to ensure the topics transitioned smoothly week by week, linked the ILO with the weekly topics and timeline, compiled rationales for their OBTL document and worked on assessment rubrics. Student participants presented their work to the PI and addressed the feedback given.

Day 4 observations

Student participants in Group 1 began with individual work before moving on to pair work and group discussions. The student participants took turns sharing their work progress with one another and worked on their OBTL document concurrently as a group. The group then appointed one student participant to format the document before moving on to work on their final presentation. After finalising the flow of their presentation slides, the student participants presented their work to the PI before taking their individual

work home.

Student participants in Group 2 finalised the structure of their PowerPoint presentation slides in the morning so that the student in charge of the design of their presentation slides would have enough time to work on it. After the short morning discussion, student participants did mostly individual work for the rest of the day. Once the structure and content of the presentation slides were more or less finalised, each student participant chose a section to present. They also chose a title for their proposed module. Towards the end of the day, the student participants presented their work to the PI and addressed the feedback provided.

Day 5 observations

Student participants in Group 1 completed their presentation slides the night before at home. Thus, they only had to touch up their slides during the workshop. Student participants then took some time to practise for their final presentation on their own before starting the first round of their group rehearsal. Thereafter, the group reviewed and edited their presentation slides together before rehearsing one more time for their final presentation.

Student participants in Group 2 took some time to finalise their presentation slides and other documents before rehearsing for their final presentation. The facilitator provided students with feedback on their rehearsal.
The two groups of student participants presented their module proposal and justified their decisions to a panel of five educators and researchers, as well as an online audience. After completing their final presentation and module proposal defence, both groups returned to their respective project venues to work on their Module Design Workshop group report. Both groups of student participants continued to review and refine their OBTL documents even though they had already completed both their final presentation and module proposal defence.

Appendix 4: Evaluation of higher education pedagogy: how could existing modules at NTU be improved?

Group 1

Pre-workshop survey	Post-workshop survey
More avenues for clarifying doubts	
More open-ended assessment methods, such as essays	
More self-directed learning	
More GER-PE modules to cater to students' interests	
More resources to facilitate learning before and after each module	
Smaller class size	Smaller class size
More problem-based learning and student-led learning using a mixture of the flipped classroom and traditional classroom styles	More flipped classroom learning
More debates, more team-based learning	More active learning through discussions and activities
More student engagement	More student engagement
Less theory, more real-life applications	Less theory, more real-life applications
	More peer-to-peer learning
	More student-centred learning
	More formative assessments
	More continuous assessments
	More creative and varied assessment methods
	More updated course content
	More gamification
	More guidance from facilitators during class discussions

Group 2

Pre-workshop Survey	Post-workshop Survey
More open-book exams; fewer closed-book exams	
More personalised feedback	
More flexibility for self-guided learning	
Smaller class size	
More weekly quizzes	
Clearer module outline	
More comprehensive and balanced grading system	
More continuous assessment	
More collaborative and integrative learning; more active learning through discussions	More class interaction, more discussion-based classes, fewer lectures
More facilities, tools and resources should be provided to students	More facilities, tools and resources should be provided to students
More student engagement	More student engagement
Less theory, more real-life applications	Less theory, more real-life applications
	More updated and relevant course content
	More flipped classroom learning
	Less boring recorded lectures
	More formative assessments; less summative assessments
	More break times