Reflection of an Online Climate Change Course and Its Pedagogies: Retrospection and Prospect

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ABSTRACT: The impetus to raise awareness and impart positive attitude change toward climate action as one of the sustainability goals has catalyzed the introduction of climate change courses in universities, particularly in developing countries. An online climate change course has been developed and delivered as an elective to the first-year students of a university in China. A reflection of the course in terms of its teaching and learning and assessment was conducted based on the Gibbs' Reflective Cycle with SWOT employed for evaluation and analysis of the experience. The course has the strength of incorporating abundant audio-visual elements, highlighting important points in slides, employing gamification, and simulating community projects in assignments. However, online teaching could be more time-consuming than face-to-face teaching in certain aspects, such as preparation of activities and games, and responding to students after office hours. Despite this, students felt that more interactions could be integrated, and teamwork might lead to advantage-taking and unequal task distribution in certain groups. This reflection calls for further improvement with the greater use of online interactive platforms and databases; interactions with experts and scientists in the field; delivery of community projects or talks to a real audience; and cross-varsity and cross-regional collaborations.

KEYWORDS: Climate change; learning; teaching; assessment; community

1. Introduction

Education for Sustainable Development (ESD) was popularized by the United Nations Decade of Sustainable Development, 2005–2014 (DESD), aiming to utilize educational resources in the quest for sustainability [1]. DESD was led by the United Nations Educational, Scientific, and Cultural Organization (UNESCO), which was tasked with forming alliances with various stakeholders, promoting ESD research, and sharing best practices in ESD [2]. DESD strived to make sustainability a part of people's mentality so as to promote actions for sustainability [3]. Courses on sustainable development were rolled out by universities in response to DESD and elements of sustainability were embedded into the curricula of pre-primary, primary and secondary education [4-6]. Pedagogies suited to ESD were also developed during DESD [7]. Integration of sustainable development into education aligns with the initiatives of UNESCO

to partner with children, youth, and students as agents of change who should actively participate in what shapes their future [8].

In particular, the Global Action Programme (GAP) was established to increase the momentum of ESD, in particular in the mutual integration of education and sustainable development, to prepare the general public in terms of the knowledge, skills, and attitudes for sustainable development [3]. It adopts four strategies which align with the roles of UNESCO in ESD, namely: establishment of partnerships; developing a global community; demonstrating good practices; and scaling up ESD [9]. In this era of GAP, more efforts were made to include elements of ESD into international and national educational policies, as well as institutional programs and individual development [9]. Emphasis on youth as the agents of change has been continued while local communities are involved in the drive toward sustainable development [9]. ESD is a broad area encompassing the three sustainable development pillars of the environment, society, and economy [10]. A wide range of ESD courses have been offered, many of which are centered on the themes of sustainability. Climate change is a course that can be categorized under ESD since it ultimately merges with sustainability as a channel to adapt to and mitigate climate change [4,11]. However, it could be distinct from ESD in the sense that it also delves into the science, modeling, projection, and multi-faceted impacts of the changing climate [12]. It is as broad in nature as ESD. With emphasis on the specific theme of climate change due to increasing concerns about global warming and extreme weather events, as well as the call of the United Nations Framework Convention on Climate Change (UNFCCC) to address the changing climate, Climate Change Education (CCE) emerged and eventually developed into a stream distinct yet related to ESD [13,14].

CCE ultimately aims to promote climate action, which is now classified as a Sustainable Development Goal, thus further linking CCE to ESD [14]. Like ESD, imparting knowledge and skills and facilitating positive attitude change are at the core of CCE [15]. An emphasis on climate change has been made in the ESD for 2030 rolled out as the successor of GAP [16]. ESD for 2030 specifically mentions the mainstreaming of ESD, which will catalyze more intensive integration of ESD and CCE into education at all levels [17]. Over the years, pedagogies related to ESD and CCE have been developed. In delivering CCE, the strategies promulgated include teaching the science of climate change with attention to the underlying complexity, uncertainty, and nuance; covering the fundamentals and arguments of climate change; adopting a learner-centered approach; and authentic participation [18]. Other strategies mentioned in the literature are making CCE personally meaningful, having deliberative discussions, interacting with scientists, organizing institutional or community projects, and addressing misconceptions [19]. It is apparent that being learner-centered through embedding personal touches in climate change lessons, paying special attention to the complexity of the subject through addressing misconceptions, and garnering authentic participation through projects are the commonalities. Besides, community involvement has always been an important facet of ESD.

Over the years, studies related to the design of ESD and CCE courses have been on the rise. There are numerous studies on interventions to increase the effectiveness of ESD and CCE [5,10,20]. Their effectiveness has been investigated through multiple perspectives, from the gain of knowledge, values, and beliefs to the change of attitudes and behaviors [20,21]. There have been arguments that ESD and CCE need to move beyond imparting knowledge and changing self-perceived attitudes to the manifestation of behaviors parallel to sustainable

development and climate action [22]. If ESD and CCE fail to influence positive behavioral changes in students, their contributions to sustainability and climate change mitigation would be greatly diminished [22,23]. Often, educators' reflection is an important means to evaluate if a course has been successfully delivered in line with the intended learning outcomes and if further improvement can be made [24]. It is an established qualitative research method which permits researchers to engage in meaningful thoughts about their lived experiences and in teaching and learning, the experiences related to different facets of a course [25]. It has been employed by multiple researchers in educational research, particularly in post-course reflection to enhance learning effectiveness [26] and in improving distance learning [27]. The goal of this study is to think about how an online course on climate change was made and taught and to look for ways to make it better.

2. Methods

In response to the increasing emphasis on CCE, a course called "Climate Change" has been developed. The course was designed with four intended learning outcomes, namely: 1) students should be able to explain and evaluate the evidence for climate change; 2) students should be acquainted with the causes of climate change and the roles of anthropogenic greenhouse gases in climate change; 3) students should be able to explain the impacts of climate change; and 4) students should know the existing climate change policy as well as the efforts at all levels to adapt to and mitigate climate change.

With these learning outcomes in mind, the following topics have been included in the course: 1) the natural and anthropogenic causes of climate change; 2) the positive and negative feedback mechanisms affecting climate; 3) the different arguments pertaining to climate change; 4) the scientific evidences of climate change; 5) the fundamentals of climate change modelling and projection; 6) the impacts of climate change on society, ecosystem, and agriculture [28-30]; 7) climate change policies; and 8) mitigation of and adaptation to climate change by different stakeholders. The course was offered as an elective to first-year students of all majors at a higher education institution in China. It represents one of the first tertiary-level climate change courses delivered in English via online mode in the region. Conventionally, elements of climate change are embedded in courses related to renewable energy and sustainability, and most of the existing relevant courses are offered in Chinese [31]. Students were required to physically attend the classes at designated locations where an online connection with the instructor was established. With cases of COVID-19 under control, an increasing number of higher education institutions in China have resumed physical classes in the second half of 2020.

The course was delivered to the first-year students of a higher education institution in China as an elective, with certain pedagogies suggested in the literature [18,19]. Students were exposed to the complexity of climate change through examining natural and anthropogenic factors; historical and modern climate change; the fundamentals of the climate system; and the various forcings affecting climate. The course adopted a student-centered approach through an understanding of their expectations, preconceptions, and misconceptions in order to tailor the delivery of course contents to optimize their understanding. For instance, debates or arguments on the controversial aspects of climate change, including its anthropogenic and natural causes, were included as part of interactive learning. These interactions were facilitated with online platforms such as Poll Everywhere for conducting polls, short quizzes, and quick question and

answer sessions. Padlet was used for more in-depth discussion, peer feedback, and written debates. Verbal debates were facilitated by a teaching assistant in class together with the online instructor. Also, Kahoot was sometimes used to make learning more fun by having competitive quizzes in class.

The videos on various aspects of climate change and those with scientists commenting or arguing on its controversies were played to the students. Interactions subsequent to the videos were mainly in the form of discussions facilitated by the course instructor, either verbally through a video-conferencing platform or through online forum channels such as Poll Everywhere and Padlet. A group assignment was designed to simulate a community project in which each group of students was asked to organize a climate change awareness talk targeting a particular segment of society, for instance, the children, the youth, university students, or the elderly. The students were required to deliver the awareness talk to other students in their class, assuming they were the target audience. Through providing talks, it was hoped that the messages were internalized and made personally meaningful.

Figure 1. The elements of SWOT analysis.

This reflection was conducted after the completion of the course, with all the learning activities carried out. It was guided by SWOT (strengths, weaknesses, opportunities, and threats), originally designed as a strategic planning tool, to evaluate the experience (Figure 1) [32]. SWOT has been applied for other purposes, such as marketing and community projects. It ended by stating what had been learned and what alternatives could have been taken to improve the course. These steps fell largely within the Gibbs' Reflective Cycle, as shown in Figure 2, with the description of the course provided as methods since course development and delivery constitute a part of this study [33]. Concerning feelings and evaluation, they were depicted in a more systematic manner using SWOT analysis, which has been used in multiple studies to

assess the effects of educational practices and approaches on course delivery [34,35]. It provides a straightforward, systematic, and sufficiently critical method for analyzing and evaluating plans, practices, and experiences [34].
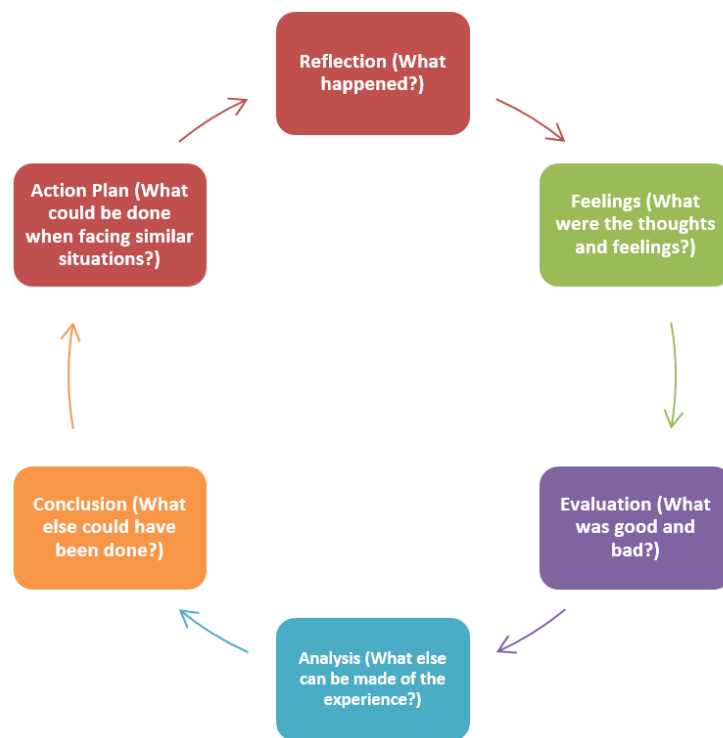

Figure 2. Gibbs' reflection cycle.

3. Results and Discussion

3.1. Strengths

The course and the institute of higher learning where the course was offered provided strengths [36]. The course has the advantage of multi-dimensionality as mentioned in the methods, covering a diverse range of contents from the science and arguments to climate change policy, mitigation, and adaptation, in line with the design promulgated [37]. Students found the course informative as it covered the breadth of climate change, though the depth was limited due to the wide range of topics included.

The course utilized audio-visual materials extensively, with the slides generously adorned with graphics and diagrams to facilitate students' understanding of the contents. Important points were highlighted, and the contents were drawn from different sources. The contents were organized to ensure their coherence, and this was also reflected in the positive feedback provided by students, stating that the course was well organized. Students also mentioned that the highlights helped them to identify important messages and the audio-visual aids contributed significantly to their comprehension of the materials [38]. Besides, the course instructor recorded the lessons and made them accessible to students through a learning management system.

The online course made use of Moodle as the learning management system, supported by other discussion platforms like Poll Everywhere and Padlet for interactions. Students enjoyed graphically presented polls, short quizzes, word clouds, and discussion boards with

different appearances [39]. Students particularly enjoyed Kahoot as the quizzes consolidated what they had learnt [40]. The quiz function of Moodle was valuable to educators due to functions such as question banks, shuffling of questions and answer choices, auto-calculation of marks and regrading, which greatly facilitated the administration of summative assessments [41]. WeChat was employed with all students, the teaching assistant and the course instructor in the course group to enable quick interactions, feedback and announcements. Students were also allowed to message the course instructor personally over WeChat to make up for the unavailability of face-to-face consultation in online learning. This improved the online learning experience of students as they yearned for quick feedback and they affirmed that the course instructor was responsive [42].

Grading of students' assignments was done with the Grade Mark function of Turnitin, guided by rubrics to confer transparency and clear feedback. Students appreciated the inclusion of feedback at the corresponding parts of the submitted work because it allowed them to clearly identify and improve their shortcomings [43]. Though welcomed by students, detailed feedback was time-consuming, especially if the class size was large. Students found the group assignments simulating community projects beneficial because the assignments exposed them to the planning and execution of awareness talks tailored for different types of audiences, though they were confined to online mode and the classroom. They demonstrated their creativity in the awareness talks through interactions with the audience, recorded interviews, the use of videos and the inclusion of data from simple surveys.

3.2. Weaknesses

Similar to strengths, the weaknesses of the course stemmed internally from the course and the associated higher education institution [36]. While the course covered a broad range of topics, the delivery was not easy, especially when students taking this course were first-year students. Students found it difficult to understand the contents in the beginning, and the online course instructor needed to slow down the pace of delivery, simplify the English used, repeat certain contents, and prompt students constantly to check their understanding. For the course instructor, this was time-consuming and certain contents were reduced to make room for the slow pace and repetition. Students had difficulty discussing, communicating, and writing in English, but they were willing to try [44]. The flexibility of using Chinese to express certain difficult ideas was granted.

Incorporating abundant pictures and highlighting important points in the course slides were time-consuming for the course instructor, but worthwhile. Similarly, searching for appropriate educational videos on YouTube took time. Facilitating in-class discussion has not been easy as the students were generally passive unless prompted [45]. Prompting by calling out names, therefore, became a common practice in class. Students seemed to prefer writing on online discussion boards like Poll Everywhere and Padlet, but participation tended to wane over time when the same platforms were repeated. While students enjoyed Kahoot, designing games on Kahoot also consumed the time of the course instructor, whose time was divided between teaching, research, and administrative tasks. Students were able to access the course instructor easily, but there was a tendency for the students to also message the course instructor after office hours and over the weekends, and there was an unspoken expectation of a quick response from the course instructor.

The course instructor cherished the function of GradeMark built into Turnitin, which allowed assignments to be marked online and feedback given immediately [43]. However, giving personalized feedback to a large class was also time-consuming. Taking on assignments proved difficult for students who had little experience working on reports and team projects [44]. Some students complained about the unequal distribution of tasks in their groups and the presence of free riders. They were also unfamiliar with the preparation of a proposal, which necessitated a clear template and instructions, including the expected contents and formatting, to be provided by the instructor. They required detailed instructions for their presentations, which were essentially awareness talks to different social groups. At first, each group was asked to prepare a poster for the talk, but the poster was later changed to slides as many students mistook promotional posters for academic posters.

3.3. Opportunities

The online course could potentially open the doors to external opportunities [36]. Collaborative teaching can be forged with other online climate change courses in other regional higher education institutions of similar nature to provide cross-varsity interactions. Cross-regional collaboration is also possible with an online mode of learning where teaching collaboration can be established with universities in other countries [46]. This allows sharing and mutual enhancement of the course contents. Guest speakers comprising industrial experts and scientists could be invited to give talks and interact with the students to enhance their learning experience, particularly in the aspect of interacting with scientists or experts [19,47]. In fact, students had expressed a yearning for more interactions through multiple channels. They also desired a field trip, and this could be facilitated by the teaching assistant or conducted virtually. The online class has widened the horizon in the use of online tools and assessment, which can be further extended. Students could be exposed to more online platforms related to climate change, such as those related to the calculation of carbon footprint, simulation of carbon emissions, and changes in biodiversity with time. Students could use carbon footprint calculators to make simple calculations about the carbon footprints of their daily activities, which helps make the lessons more relevant to their lives [48]. They could be prompted to propose and put into practice ways to reduce their own carbon footprints.

Opportunities also stem from the design of the assignment. The awareness talks could be extended to a real audience through online mode, rather than having the class pretending to be the targeted audience. This would increase the personal significance and community impact of the assignment. Students could be asked to plan and execute the awareness talks or even organize virtual site visits to confer on them the crucial skills of community project management [1]. With the facilitation of the teaching assistant, students could even organize physical awareness-raising community activities during which they could set up an online connection with the course instructor or record the events for evaluation by the instructor.

3.4. Threats

Threats are external factors that could negatively impact the course. Because the course was delivered online, internet connection was critical to the course's quality. Without a stable internet connection, teaching and learning would be disrupted [49]. In fact, this was also a major challenge faced when delivering the course. There were times when the internet was unstable, either on the students' side or the instructor's side, causing disruption of teaching and

learning. There was also a lag between the transmitting and the receiving ends, though it was not perceived as a major issue. The use of online interactive platforms mentioned requires good internet access, without which the interactions would be significantly affected [39,40]. In comparison to other platforms dedicated to these purposes, Moodle, as a useful open-source learning management system with functions such as attendance tracking, conducting surveys and quizzes, and managing assignments and learning resources, is relatively limited in gamification and real-time interactions [50]. As with these platforms, internet availability is a must to access Moodle.

Access to certain online interactive platforms and databases could be blocked due to geographical factors, further limiting interactions and the accessibility of information [51]. The speed of certain online tools could be a limiting factor, leading to extra time spent on downloading or marking assignments. While videos were used to present the arguments and views about climate change posed by different scientists, they have the limitation of not allowing live interactions with scientists, an activity promulgated by some authors of CCE. This necessitates real-time sessions with climate experts remotely or in person. However, the availability of the experts and scientists for talks is another uncertainty, prompting careful planning and scheduling of such events. Similarly, the clashes and inappropriate timing might complicate the planning and delivery of awareness talks by students. Besides, a good internet connection on the audience's end is required to make the talks possible. Conducting a virtual site visit depends on whether the visited organizations or facilities are willing to engage and whether they have the equipment to do so.

In the era of COVID-19, its severity and control add a layer of complexity to teaching and learning, especially in China [52]. In the event that the number of cases increases, and the control is tightened, any physical activities would not be possible, including attending physical classes for online learning. Full online mode would be resorted to, during which the importance of a stable internet connection would be greater, and interactions might be further constrained.

3.5. Lessons Learned and Suggestions for Improvement

The online climate change course has provided much learning experience in the flexible delivery of the contents, the modification of teaching strategies to cater for the needs of first-year university students in China and the design of online learning activities using various interactive platforms. Personally, the greatest lesson has been to tend to the learning needs of students through adjusting teaching strategies, making assignment instructions clear through providing guides and templates, communicating with students during and after office hours through WeChat, and providing detailed feedback for assignments. It has been a humbling journey to relearn teaching and learn new teaching strategies suited to CCE. It has also been a journey of learning from students' feedback about interactions and usefulness of contents, adapting to different technical glitches of online lessons and unstable internet, as well as communicating with teaching assistants to optimize students' learning. Besides, students' feedback on the course revealed their desire for face-to-face learning and interactions, fieldwork, and face-to-face consultation where they could obtain immediate feedback, even though most of the messages over WeChat were actually replied to within fifteen minutes, if not half an hour, except for messages that came after 10 pm.

Future improvement could focus on simplifying the contents further for the first-year learners, simplifying the English used in the learning materials and in class, as well as designing

more interactive activities using different online platforms, particularly games [6,19]. For a better learning experience, it is worthwhile to invest in good internet, and institutional support could be provided. Activities that increase the personal significance of climate change, such as self-assessment of carbon footprints and the proposal of mitigation measures to which students could commit, could be added [15,18]. As stated in the opportunities above, imparting community impact by extending the awareness talks to an actual audience could be considered [37]. For this, institutional funding may be required. Incorporation of talks by experts and scientists, as well as virtual site visits, are some of the options for course improvement. While students desire a quick response, it is advisable to make the ground rules clear to students in terms of communicating with the course instructor through social media. It is deemed that a basic climate change course is insufficient in the mainstreaming of CCE and ESD. Where possible, other elements of CCE and ESD, such as community project management and carbon footprint assessment, could be covered in another dedicated course or embedded in other relevant courses [48].

4. Conclusions

In response to the emphasis on CCE in light of the increasing concerns for global climate change and as part of stepping up ESD, a climate change course has been offered through a unique online mode to the first-year student of a higher education institution in China. This reflection reveals that students appreciated the audio-visual elements incorporated into the course, the design of the slides with important points highlighted, the tailored pace of teaching and recapitulation of main course contents as well as gamification, assignment simulating community projects and detailed feedback for assignments. The instructor found that online teaching could be more time-consuming than face-to-face teaching in certain aspects such as preparation of activities and games, and responding to students after office hours. Despite, students felt that more interactions could be integrated, and teamwork might lead to advantage-taking and unequal task distribution in certain groups [53]. This reflection has the merit of pointing out the opportunities and threats of the online climate change course. Opportunities range from more use of online interactive platforms and databases, interactions with experts and scientists of the field, delivery of community projects or talks to real audience as well as cross-varsity and cross-regional collaborations. The threats are internet connectivity, availability of experts and scientists, scheduling of community outreach and COVID-19 policy. These could be addressed with investment in good internet facilities through institutional funding as well as proper planning in the invitation of speakers and online community outreach. This reflection calls for more CCE elements beyond a basic climate change course through other dedicated courses or integration to other relevant courses. This reflection is significant to the effective design and delivery of climate change courses particularly through online mode in the setting of a developing country. Effective CCE is instrumental to change the mentality and attitude of learners at all levels toward environmental protection and sustainability.

Competing Interest

No competing interest has been identified.

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