

APPLING INFORMATION COMMUNICATION TECHNOLOGY (ICT) AND EXPERIENTIAL LEARNING IN CLIMATE CHANGE EDUCATION AT HIGHER EDUCATION: A CASE STUDY

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Kieu Thi Kinh

Abstract: Education is among effective tools to build climate change (CC) resilience. Higher education institutions have a crucial role to play in such difficult tasks. Despite existing and prospective impacts of CC in Vietnam, there are very few publications related to teaching CC at a higher education level. Thus, the research was designed to present initial efforts to mainstream CC at higher education. This article firstly presents the students' reflections after participating in two CC training courses. Then, it draws lessons learned based on student discussion and recommendation before analyzing a teaching strategy to ensure the success of teaching CC. Those lessons learned and the teaching strategy can be applied to encourage CCE at other higher education institutions.

Key words: climate change education; higher education; digital hybrid textbook; experiential learning.

1. Background

1.1. Climate change education (CCE) at higher education

Higher education has a critical role to play in climate change (CC) response with three main functions: education, research and governance. By providing research and education around adaptation strategies and science, higher education institutions (HEIs) strongly enhance society's awareness and preparedness to cope with CC [1]. Research results of CC not only provide precious materials for teaching but also gradually influence the governmental policies. In many regions, CC adaptation and mitigation have been integrated into their development strategies under the consultation of university staff.

climate adaptation - that is, preparing for and responding to impacts of CC [1].

Recognizing the significance of such topic, HEIs have embedded CC in their training programs to educate the employees with high climate literacy that can flexibly work in this context. Crowdsourcing various approaches, Ryan et al have classified CCE at higher education level into five broad categories [2]:

- Focused Degree Programs: Degree programs focused specifically on teaching the complex problems and solutions to CC.
- Focused Researched Centres: Research dedicated to understanding and solving the complex problems the world faces as a result of CC.
- Optional Modules & Extra Qualifications: Additional learning which can be taken by both students and staff, to understand CC.
- University-wide Integrated Initiatives: Integrating CC awareness in teaching across the whole higher education institute, reaching various disciplines and departments.
- Trans-university Integrated Initiatives: Externally led integration of CC awareness into university teaching, and collaboration between universities.

* Corresponding author

Kieu Thi Kinh
The University of Danang - University of Science and Education
Email: ktinh@ued.udn.vn

Higher education has taken a leadership role in climate mitigation - that is, preventing CC by reducing greenhouse gas emissions. It now must take the lead in

Various researches have been conducted to identify the effectiveness of CCE at HE, including contents, teaching pedagogies and strategies. For contents, there are several popular topics such as: greenhouse effect/global warming, meteorology, carbon emissions, ecological footprint, CC impacts, CC mitigation and adaptation [1, 3, 4]. There are different approaches in teaching CC of which Information and Communication Technology (ICT) is widely applied to mainstreams CC across university. ICT promotes autonomous learning, curriculum differentiation, student-centered learning, higher order thinking, problem-solving, cooperative learning, clarification of abstract concepts and transformation of the understanding of the subject matter [5-7]. Four ideas to create an attractive program are: make it local, make it human, make it pervasive and make it hopeful [8].

Despite the increase of CCE research, there remains little known about students' knowledge and attitudes about this issue [9]. Thus the research has been conducted to explore university students' understanding of global CC and to identify the appropriate approaches in teaching CCE at higher level.

1.2. CCE in Vietnam

Recently Vietnam has been recognized as one of the world's countries most vulnerable to the effects of CC [10], hence CC-linked natural disasters have become an urgent concern in Vietnam. Since the Action Plan for the Education Sector's response to CC from 2011-2015 and the Action Plan of the Education Sector for prevention and mitigation of natural disasters in 2011-2015 were approved, CCE and education for disaster risk reduction have been widely disseminated from the elementary to university level. However, most programs are not implemented in formal education but by NGOs and other civil society actors, such as youth unions and environmental clubs.

Most of projects were designed for general education (from elementary to junior high school) but not higher education and were conducted in the Mekong Delta region where CC will adversely affected. Among such projects, "T-Learning" project conducted by Center for Research & Promotion of ESD brought a very new concept in CCE [11]. "T" refers to Transdisciplinary, Transformative, Transgressive and

Together Learning. This project enables CC educators holistic thinking competence when they design and implement training activities.

In terms of formal education, ministry of education and training (MOET) approved a nationwide program "Integrating knowledge, skills to response disasters into school curricula in the stage of 2011 - 2020". Since then, CC and disaster have been integrated into textbooks and teaching programs across the general education system (K12) [12]. At higher education level, several universities have launched CC as new decree programs (bachelor and master). In additional, other programs related to environment such as environmental engineering, environmental management, environmental science and natural resources management have embedded CC as an important course.

Researches of CC at HEIs play critical role in generating update and local knowledge for training students. Hence, the government prioritizes such researches for university lecturers. According to the ministry of planning and investment (MOPI), Vietnam spent 0.1% of the country's GDP on CC response of which research took a large proportion [13]. The Vietnam National University (VNU) is among the pioneer HEIs to boost CC teaching and researching with numerous themes, including assessment and prediction of CC impacts, meteorological of the Red River Delta region, livelihood generation in the context of CC and CC mitigation (by means of geothermal energy, and biodiesel) [14].

Despite the impressive movements of HEIs in teaching CC, there are few publications concerning this topics and mainly in Vietnamese. This research thus was implemented at The University of Danang - University of Science and Education (DUeD) to present the initiatives in teaching CC to undergraduate students.

2. Research design and methodology

The research has been conducted for 2 years under two projects. Within those two projects, 15 students were invited to join two CC training courses. Afterwards, they were interviewed by semi - structure questions and joined in a focus group discussion. The description of each course is presented as following:

- Meteorology and CC course (formal education from August 15, 2018 to January 15, 2019 - Course 1): this two-credit course is an elective course of natural resources and environmental management bachelor program. There were 15 undergraduate students registered the courses (total 46 students of the programs). The courses lasted for 15 weeks (100 minutes/week). The contents were divided into two sections: (i) Meteorology that explained the basic concepts of meteorology, atmosphere, hydrology and natural phenomena linked to global warming and CC; and (ii) CC which focused on explanation of CC impacts of different economies and human, international and national policies to response to CC. It is noticed that the course applied a digital book consisting videos, audios, links and quiz to promote students' interaction and learning autonomy¹. During the classes, two lecturers also applied other educational software and tools, Kahoot, for instance, to draw students' interest and attention.

- CC and disaster response course (non-formal course in November 29 and 30, 2018 - Course 2): The 2-day training course was designed between the DUEd staff and the Department of Natural Resources and Environment (DONRE) staff to enhance awareness of students about CC and disasters. Also involved were local experts such as DONRE officials, Bureau of Disaster Prevention officials and DUEd lecturers. The first day of training focused on CC issues (how, when, where and response). The second day was about disaster prevention (types of disasters, their impacts, and how to

¹The digital book was designed with the advice of professors from Hull University under project named "Vietnam - Digital Hybrid Texts" supported by the Newton Fund, managed by the British Council.

face with such disasters). At each day, guest speakers shared with students their knowledge and experience in the morning section and in the afternoon, hands-on activities (town-watching, university survey on students' understanding of CC) were organized by the mentors to help students reinforce their lessons learned.

The first survey was implemented before students commenced the course. The aim of the survey is to understand if they paid attention to CC problems and reasons. The second survey was implemented after students finished two courses in early February 2019. The author applied a semi-structure interview to understand students' awareness of CC and their reflections on the two training courses, then examined their suggestions to renovate CCE. Information of the interview allowed the author to run a focus group of 6 students who expressed their attention to CC and desired to participate in renovating CC teaching.

Manual coding according to the streamlined code to theory method [15] was conducted for the interview data to identify themes and quantify the qualitative data for comparison. Codes, key phrases and paragraphs that had emerged from the semi-structured interviews and focus group discussion were analyzed to identify weaknesses and strengths of each course and to discover how much it reflected on students' cognition of CC. Ideas to advance CCE generated from interview was discussed in detail to be applied in the upcoming school year.

3. Results

3.1. Students' cognition of CC and its related problems

The first survey results indicated that 100% of interviewed students agreed that CC was necessary and all of them were concerned themselves with this topic. There are totally 43 codes divided into 6 categories that made students believe the course's necessity (shown Figure 1).

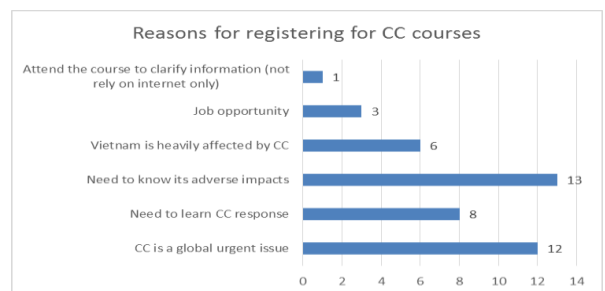


Figure 1. Reasons for registering for CC courses

There are always more than one reason that motivate students to learn CC. The most popular reason is climate change potential impacts on their lives. Students worried about the extreme weather, sea level rise and disasters (drought, flood and typhoon) thus they

needed to learn how to respond. Three students thought that understanding CC will empower them to find jobs at international organizations or NGOs after graduation and one student revealed that the course would provide them with correct information about CC instead of relying on information from the internet. Below is a quotation from a respondent’s answer.

“CC has become a popular topic, so when I googled, I found huge amount of information which I didn’t understand or doubted. Hence, I registered for the course to understand about CC and build my capacity to respond.” (S8, female)

The post course survey implied that students still remembers the core contents of the two courses. The interview indicated that students remembered the theoretical contents of course 1, particularly the meteorological knowledge, causes of CC and the disasters (formation and development). Course 2 impressed students by the lessons learned from the previous experiences in disaster prevention and preparation, CC adaptation and mitigation. The detailed of the number of generated codes is presented as follows:

- Meteorological knowledge with 25 codes related to earth climate system, parameters, observation, atmosphere and natural phenomena.
- CC mitigation and adaptation with 37 codes related to human activities (both negative and positive).
- Disasters with 28 codes related to typhoons, flood, drought and heat wave.
- Sea level rise with 6 codes.

3.2. Students’ reflections and recommendations

Students reflected their understanding of CC at the end of each course. For course 1, they proposed three proposals to response CC: (i) Planting urban home gardens to create mini carbon sinks of the city and provide green vegetables for citizens; (ii) Developing sea – island tourism taking account of sea level rise; and (iii) Applying experiential learning to teach CC at schools. Each group proposal was criticized by their friends and reinforced before submission to the lecturers. For course 2, students had built two hazard maps of DUEd and surroundings (for typhoon and flood) via town watching and local resident interviews . Subsequently, they created a communication plan to enhance other students’ awareness of risk when such disasters occur (Figure 2).



Town watching



Local resident interview



Hazard map presentation

Figure 2². Course 2’s reflection

The two courses not only improve their CC literacy but also other competencies to “think globally, act locally”. Those reflections implied that students had devoted their time to create very thoughtful and concrete project proposals. Moreover, they showed their responsibility to raise their friends’ awareness to prepare for disaster. With regard to answers concerning

advantages and disadvantages of the two courses, the results are presented in Table 1.

²Pictures are allowed to use by students.

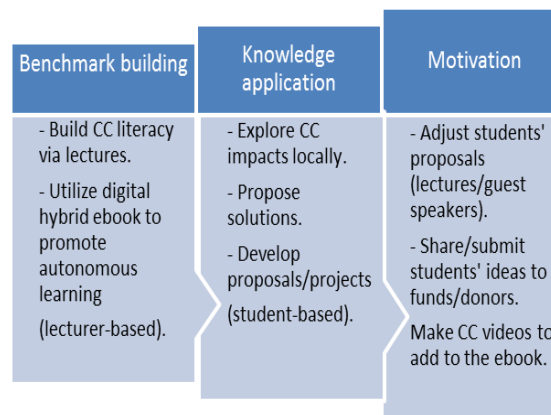
Table 1. Course advantages and disadvantages

Course	1	2
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Advantage	<ul style="list-style-type: none"> - Promotion of autonomous learning. - Easy to use ebooks. - Very interactive and user-friendly ebooks. - Utilization of Kahoot to engage students in brainstorming and learning. - Enthusiastic lecturers. - Reliable sources of information . 	<ul style="list-style-type: none"> - Guest speakers gave practical/local knowledge and experiences (in form of storytelling). - No pressure in learning. - Town watching and investigation. - Having mentors for group work. - Enlargement of network (with guest speakers) for further internship or job probation.
Disadvantages	<ul style="list-style-type: none"> - Lack of practical/local knowledge. - Pressure of memorizing knowledge. - Not able to run the proposals. 	<ul style="list-style-type: none"> - Time limitation.
Mark	7.2	7.9

Each course has both advantages and disadvantages, yet the advantages are overwhelming. Although course 2 was implemented for only two days, it did upgrade students' understanding of CC and motivate their actions to respond to CC. Students marked³ each of the courses to compare them with each other and course 2 score is higher than that of course 1. Additionally, communicating with the guest speakers helps students to find opportunities for their further internship or job probation. Students revealed that course 1 provided and fostered them with the most significant understanding of meteorology to explain natural phenomena and CC, while course 2 allows them to utilize their understanding in reality locally.

Student focus group discussion indicated that they expected to integrate the advantages of those two courses by means of a suggested teaching strategy.



Students also emphasized that during the course, lecturers should apply interactive games, software (like Kahoot) to engage them in building CC literacy. They hoped that their proposals would be adjusted by experts including university lectures and CC experts to address local issues in coping with such issues. This follow-up step will enhance students' competencies to adapt with the global rapid changes. Moreover, students suggested that they would take videos and collect pictures as evidence of disasters and CC impacts to enrich the ebook materials. Such fruitful discussion shows their great interest in the course.

4. Discussion

4.1. Lessons learned of CCE from the case study

³According to the 10-score scale

There is an increasing demand for CCE, particularly in vulnerable developing countries. Nevertheless, teaching CC is not an easy task. It is not just an add-on course integrated into the existing curriculum but it requires various efforts concerning teaching contents, pedagogies and strategies that consume a large amount of time and energy. In the case of teaching CC at DUEd through two different approaches, there are several initiatives that can be applied to promote renovation of CCE:

- Relevant contents: to build CC literacy as a prerequisite for learners to understand the history, causes and impacts of CC and to be able to distinguish the terms in this field [4]. Then, local CC issues are taught by local experts. The local impacts of climate and environmental changes are emphasized as the core components in many CC courses [1, p.16-18].

Climate change educational interventions are most successful when they focus on local, tangible and actionable aspects of CC, especially those that can be addressed by individual behavior. [19, p.197]

- Applying ICT: digital hybrid textbook and Kahoot quick test evidently engaged students in the learning process. Introduction a new learning tool like that ebook on the one hand gets their attention and on the other hand promotes students' self-study competence as other CCE courses have applied [7,8,9]. The development process of the ebook can enhance lecturers' capacity to revise conventional textbooks by means of audios, videos, internet links, quizzes and games. Such skills are essential for their teaching, particularly for developing online training courses.

- Engaging local experts: in course 2, three local experts were invited to share their knowledge and experiences in CC and disaster response. They provided students with valuable practical knowledge and experiences by sharing true stories in disaster response. Knowledge of adaptation practices that can contribute to building resilience and sustainability [4].

- Teaching pedagogies: during the two courses, innumerable constructivist methods were applied to ensure the students-centered approach, problem-based learning, inquiry-based learning, simulations, town watching, discussion and presentation. Such teaching methods increase students' interest and enjoyment in learning [17]. Moreover, students interacted with local

residents in the town watching practice and then communicated with their friends as the follow-up activities to develop their own knowledge and to reinforce their understanding. Those teaching methods have been commonly used by educators in a variety of contexts worldwide [17].

Overall, CCE practice at DUEd inherited successful experiences from the previous researches. Analyzing students' reflections and recommendations presents the significance of different factors which must be integrated with each other to enhance student understanding, to build their resilience and to motivate their responsibility. The interactive approaches are certainly a prerequisite to successful CCE (as quoted below).

"They include activities that allow learners to actively engage with concepts, discuss their understanding, practice actions, and engage with relevant, local examples of CC impacts. We wish to reinforce that good education for CC can include the full complement of teaching methods that are proven to be successful, such as field trips, flipped classrooms, simulations, worksheets, data collection, role plays, and community action projects". [17, p.14]

4.2. Building a teaching strategy for CCE - A way forward

The 50-minute discussion of students resulted in a very thoughtful teaching strategy to advance the future CCE course. In many situations, the teaching activities end once projects are finished. There are three stages of learning:

- Step 1: Build their CC literacy by means of the interactive pedagogies.

- Step 2: Design activities that allow students to apply their understanding.

- Step 3: Motivate them when the course ends.

Step 1 and 2 are typical for course design and practice in the literature review [4, 17, 19]. In this research, students brainstormed and suggested useful ideas to motivate themselves and revise the CCE course for other students. They expressed their enthusiasm to create videos and add to the ebook for the next learner generation and recommended those prospective students to continue making movies. In a research work to promote CCE in Colorado, students learned to produce

short videos about how CC affects their lives. It is realized that student-produced videography is an active learning technique that has been successfully used to expose students and teachers to authentic learning about the local impact of climate and environmental change [16]. Thus, the ebook should save some space for students to contribute their videos/audios or any other products each year and keep it opened for further discussion.

The suggested teaching strategy will ideally bring the best results to students, yet there remain a lot of constraints with a big question: is it feasible without projects? Teaching CC or any other topics (i.e. environment) in developing countries needs low cost but effective approaches. In this research, CCE was conducted under two projects thus the following table will discuss the feasibility of suggested ideas:

Table 2. Analysis of the feasibility of teaching strategy

Teaching strategy/activity	Feasibility	Reason
Inviting local experts	Yes but with consideration	Expenses, time and effort required for inviting guest speakers without projects and for applying invitation procedures related.
Using interactive ebooks	Yes	The first ebook version has been developed and used.
Experiential learning (i.e. town watching)	Yes	Be careful with traffic.
Interactive pedagogy	Yes	Lecturers must devote their time and energy (just for the first course).
Create video	Yes but with consideration	Good videos require technical skills and high quality cameras.
Project proposal and submission	Yes but very uncertain	Depending on the donors/grant/proposal themes

Each activity can be conducted but the analysis above implies that the suggested teaching strategy looks extremely ambitious. If a lecturer applies all such activities, it will cost both teachers and students a lot of time and energy that extends beyond a course in an environmental management bachelor program. Furthermore, students have ignored the crucial role of non-formal education. A formal course is frequently responsible for building students' knowledge and important skills with a certain period while non-formal education is relatively flexible without time limitation.

5. Conclusion

CC poses burning questions for human development. HEIs take a leadership role in CC mitigation and adaptation with three main functions: research, training and, knowledge and technology transfer. CC is an important topic but difficult to teach because of scientific complexity, societal implications, and political associations around CC [18]. Therefore, the constructivist approach is essential to changing

students' attitudes of learning about CC. The research results draw some lessons learned to boost CCE at a HEI by two approaches: utilization of digital hybrid ebooks and experiential learning.

It is necessary to propose a comprehensive teaching strategy to sustain CCE at any HEI. Conversely, there is a lack of integration between a formal education course and other forms of education, particularly in Vietnam and some countries where relevant attention has not been paid to non-formal and informal education. An interactive and comprehensive teaching strategy requires tremendous efforts of lecturers and students to accomplish. Integration among formal education, non-formal education and informal education is an ideal solution to mainstream CCE at HEIs longer rather than just one course in a semester. This solution needs further study to develop a detailed framework to integrate the three educational categories.

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ỨNG DỤNG CÔNG NGHỆ THÔNG TIN VÀ GIÁO DỤC TRẢI NGHIỆM TRONG DẠY HỌC BIẾN ĐỔI KHÍ HẬU Ở BẬC ĐẠI HỌC: MỘT TRƯỜNG HỢP NGHIÊN CỨU

Tóm tắt: Giáo dục là một trong những công cụ hiệu quả nhằm nâng cao năng lực thích ứng với biến đổi khí hậu (BĐKH). Các trường đại học đóng vai trò quan trọng trong nhiệm vụ khó khăn này. Mặc dù những tác động trước mắt và lâu dài của BĐKH đến Việt Nam rất rõ ràng nhưng có rất ít công bố liên quan đến giáo dục BĐKH ở bậc đại học. Do đó bài báo này trình bày kết quả nghiên cứu ban đầu về các hướng tiếp cận trong việc dạy học BĐKH. Bài báo trình bày kết quả tác động của hai khóa học đến sinh viên sau khi tham gia. Sau đó, bài báo đưa ra những bài học kinh nghiệm dựa trên thảo luận nhóm của sinh viên và những đề xuất trên cơ sở phân tích chiến lược dạy học BĐKH hiệu quả. Những bài học kinh nghiệm và đề xuất chiến lược dạy học có thể được ứng dụng để thúc đẩy giáo dục BĐKH tại các trường đại học khác tại Việt Nam.

Từ khóa: giáo dục BĐKH; đại học; giáo trình điện tử; giáo dục trải nghiệm.