



Lessons Learned in the Paths of Developing a Multidisciplinary Certificate Program

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Abstract

Multidisciplinary education is highly valued and strongly emphasized; however, many institutions still struggle to create the opportunities within their curriculum. Relevant efforts and experiences need to be further studied in order to expand the impacts of multidisciplinary education. This paper will examine challenges and opportunities as well as lessons learned in creating a multidisciplinary master's certificate program on circular economy from both the perspectives of faculty and students. A circular economy taskforce, supported by National Cheng Kung University, was set up during the fall of 2016 to boost the ongoing efforts for sustainability, with an aim of developing an international and multidisciplinary certificate program to enhance students' capacity for solving multidisciplinary problems through real-world issues and cross-disciplinary team experiences. The taskforce is represented by faculty members from different departments as the university seeks for a holistic integrated approach. At various departments, courses are modified to shift focus to the circular economy approach; and new circular economy courseware is being developed. Students and faculty members have been working on various initiatives to start pilot projects on campus and in the city. A two-week international summer school on circular economy was conducted in 2017, and a design internship program was organized. All these efforts have been integrated for developing a new master's certificate program. Faculty members as well as students who have been involved in these efforts, representing more than eight programs, were interviewed to gather their insights on opportunities and challenges of creating such a multidisciplinary master's degree program. Participants included department chairs, program coordinators, members of the task force, faculty who coordinate or teach courses, and students who work on the pilot projects. Results from the analysis will be presented in order to share lessons learned in developing a new master's certificate program, with recommendations for creating a more multidisciplinary learning environment for students. Initial thoughts on the next steps in the development process will be presented.

Keywords: Multidisciplinary education, Circular Economy, Circular Economy education, cross-disciplinary team, developing education programs

Introduction

Specialist disciplines are getting more specialized, creating information silos. Yet, we are also coming to a greater realization that many real-world problems require the close integration of many disciplines. What is perceived as a solution in one discipline may cause a problem in

another discipline. For instance, fossil fuel is a convenient energy resource, but it is causing problems to air quality and the global climate. It seems almost obvious that these problems would need to be addressed by collaborations and integrated solutions. The famous words from Einstein in 1946 seem to be very well in place: "*We can't solve problems by using the same kind of thinking we used when we created them* [1]." The sustainability problems obviously need a more multidisciplinary type of thinking strategy.

Circular Economy is becoming widely accepted strategy for integrating solutions to provide for humanity's needs, while creating profit in a sustainable manner [2]. The Ellen MacArthur Foundation is one of world's leading promoters of Circular Economy. They have used this term to describe the break from unsustainable linear economic strategies, based on a "take, make, dispose" model of production [3]. A generally accepted definition of Circular Economy is "a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling [2], [3]." From this definition of Circular Economy, one quickly realizes that this topic of study is not something that simply fits into one discipline. Instead, this topic involves management, planning, design, social and environmental challenges, and engineering, which is highly multidisciplinary and requires a whole systems perspective [5]. For example, the positive or negative impacts on the environment will have to be properly addressed in the design of future products and services [6]. The government of Taiwan has established Circular Economy as one of the seven forefront strategies to establish a more sustainable national economy in mid-2016. As multidisciplinary education has been highly valued and strongly emphasized in higher education [4], [7], many institutions make further efforts in educating their students to echo this national strategy to deal with sustainability issues.

A circular economy taskforce, supported by National Cheng Kung University in Taiwan, was set up during the fall of 2016 to boost the ongoing efforts for sustainability, with an aim of developing an international and multidisciplinary master's certificate program to enhance students' capacity for solving multidisciplinary problems through real-world issues and cross-disciplinary team experiences. The taskforce is represented by faculty members from different departments as the university seeks for a holistic integrated approach. At various departments, courses are modified to shift focus on the circular economy approach; and new circular economy courseware is being developed. Students and faculty members have been working on various initiatives to start pilot projects on campus and in the city. A two-week international summer school on circular economy was conducted in 2017, and a design internship program was organized. All these efforts have been integrated for developing a

new certificate program. This paper examines challenges and opportunities as well as lessons learned in creating such a multidisciplinary certificate program on circular economy from both the perspectives of faculty and students. Initial thoughts on the next steps in the development process are presented.

Context

The certificate program on Circular Economy, named Circular NCKU, is launched in early 2018. It is Taiwan's first program on Circular Economy. Any master student, regardless of his or her department, is eligible to enrol and earn the certificate. The diverse academic backgrounds of the students will add to the multidisciplinary thinking being promoted.

For students to earn the Circular NCKU certificate, they will be required to take an additional 15 course credits, in addition to the required credits for their respective master's programs. Students can choose to complete the required Circular Economy credits in one semester or several semesters. The first mandatory course to be taken will be "Introduction to Circular Economy," and the program can only be completed after completing the "Pilot for Circular Economy." Additionally, 10 credits must be obtained as electives from the Circular Economy courses list. In order to ensure interdisciplinary learning and engagement, the courses chosen must be from at least three different "circular aspects." These circular aspects are Data Analysis, (Spatial) Planning, Biological Systems, Technical Systems, Energy Footprint, Water Footprint, Business Models, Social Elements, Innovation Strategy and Design, and Policy [5]. Circular aspects divide the big theme of Circular Economy into aspects which can easier be found at various departments. These aspects have some resemblance with the Circular Economy program at Cranfield University which uses: Circular Economy Context; Biological Systems; Renewable Energy Systems; Material Innovation; Circular Manufacturing; Circular Design; and Circular Value Chains [8].

Most elective courses of the Circular NCKU program are existing courses, which are home to one department, and offered in English. The procedure for selecting existing courses as Circular NCKU elective courses was based on two main criteria: "*The course covers one or more 'circular aspects'*", and "*the course can be taken by students who are not home to the department offering the course.*" The second criterion enables a multidisciplinary study environment, but it may conflict with plans to establish more specialized courses. How this might affect the quality of the course is to be evaluated after the program has been running for two years.

Method

The development of the Circular NCKU program took about 1.5 years and was led by a small

taskforce from different departments. These members included professors from Hydraulics and Ocean Engineering, Architecture, Life Sciences, Environmental Engineering etc. The courses of the program involve more faculties and departments. The taskforce also gathered a group of 10 students from different disciplines that had a high interest in the subject of Circular Economy for almost one year. These students functioned as a group for testing and reflection. To analyse the lessons learned in developing this program, an online questionnaire was developed and distributed to faculty, students and facilitating staff who were involved in the program's development. The questionnaires were designed to take approximately 20 minutes to complete. The questions for each group addressed their points of view on both multidisciplinary education and circular economy, and involved surveying their personal definitions, valuations, motivations, experiences and recommendations on these two matters. The collected responses were further condensed and organized into a SWOT, a data-organizing tool to present Strengths, Weaknesses, Opportunities and Threats.

Results

Feedback was received from 31 students, 14 faculty and five facilitating staff members. The respondents are fairly distributed among various departments, but mostly engineering or design related. From the respondents, eight students, three faculty and three facilitating staff members were involved in creating the multidisciplinary program. A quarter of the student participants were from Western countries enrolled full-time in a program at NCKU. This demographic detail may be relevant regarding their perspectives on multidisciplinary education. One key question in the questionnaire was everyone's definition of

"multidisciplinary." The following were fairly typical of the answers given:

"People from different professional skills work together to address complex issues such as environmental challenges, sustainable development ... etc." Student A

and:

"... involving multiple fields of study or departments." Student B

and:

"Not just your own discipline, the involvement of other disciplines that provides spaces to learn for participants of the activities." Faculty A

All answers were given as one sentence and sometimes only a few words describing the definition. These summarized definitions did not conflict in their meanings. However, from the answers to other questions it was apparent that in some details the participants have different opinions on what a single discipline is. For example:

"My background is in landscape architecture, which is concerned with multidisciplinary issues." Faculty B

This answer is not in line with the answer of Student B, who implied that every department only covers one discipline.

Student B does comments in other questions to “... *look outside the academic bubble we are taught to stay within.*” and “... *lack of communication between professors from different departments and lack of crossover of students taking courses outside of their department.*” Student B does emphasize the need for multidisciplinary education to “... *create plans to tackle real life sustainability issues*” Student B was asked to elaborate more on these answers. Student B actually agrees that some departments cover various disciplines sometimes, but that “... *it doesn't go deep enough to be 'truly' multi-disciplinary.*” The obstacle mentioned by Student B was that academic approaches often isolate one problem into one discipline, whereas perceiving them into a “*holistic system thinking*” will provide more complete solutions.

Everyone agreed that ‘multidisciplinary’ should matter to a university, because:

“*This is where new discoveries are made.*” Student D

and:

“*Real-life problem(s) cannot be solved by single professionalism or viewed by one aspect, students need to know how to communicate or cooperate with others in order to solve the issues.*” Staff A

However, some disagreed that the university puts enough effort on multidisciplinary matters:

“*On the classroom level there is little deep interdisciplinary work or considerations. This may be due to the lack of communication between professors from different departments and lack of students taking courses outside of their department.*” Student B

and:

One faculty proffered a practical issue, which should be explored further, by acknowledging that “... *better solutions are made in multidisciplinary teams in real life, however, students may learn slower when surrounded by students from different disciplines.*” Faculty E

Students who volunteered to join in multidisciplinary projects were motivated to do so because:

“*Applicability/ employability/ research potential.*” Student D

and:

“*Learning new skills that I might use in my future career.*” Student E

Other students mentioned their interest to “*broaden*” and “*widen*” their education and learn from “*different expertise.*”

One faculty answered on her or his motivation to join multidisciplinary issues with:

“*Each discipline has its own body of knowledge and culture (I did study on disciplinary culture and creativity before), and I believe that better solutions could be produced from (successful) multidisciplinary collaborations.*” Faculty A

Everyone agreed that Circular Economy relates to (their definition) of “*multidisciplinary*” and that sustainability issues especially need a more multidisciplinary approach. Most responses given were similar to the following:

“*Circular economy is about making the earth for sustain, to achieve sustainability in the earth, we need different idea, not only from one side (ex: engineering) but another side (ex: business, design) can participate to gain the sustainability.*” Student A

and:

“*Circular economy integrates many disciplines on finding (circular) solutions good for people, planet and profit; this in contrast to only optimizing the short term profit as many companies do.*” Faculty C

and:

“*Circular economy emphasizes non-linear and integration, which echo’s ‘cross-disciplinary dialogues and efforts.’*” Faculty D

Students and faculty were also asked to grade different education styles on a 1–5 point Likert scale. Grading was done on the learning potential of each education style, disregarding the relative time to be spent on each style. Three styles were compared. First, “*working individual*”, referring to lectures, readings and homework assignments in which students would have little or no interaction with each other. Second, “*working with students of same discipline*”, referring to discussions and working in groups, with students who are all in the same discipline. Third, “*Interdisciplinary team work*”, referring to discussions and working in groups, with students who are in different disciplines. The results revealed, on average, that both students and faculty valued “*interdisciplinary team work*” the highest. While faculty value “*working individual*” above “*working with students of same discipline*”, students prefer team work to working individual. These three education styles were valued above three points by everyone, except two faculties who gave one or two points for “*interdisciplinary team work*”. Faculty E gave one point. However, for all the other related questions this person provided answers promoting more interdisciplinary methods (therefore this low point may be regarded as a mistake).

Table 1

Average ratings of different education styles, with 1 = least preferred and 5 = most preferred.

	Working individual	Working with students of same discipline	Interdisciplinary team work
Students	3.4	3.8	4.0
Faculty	4.0	3.5	4.1

Everyone was also asked what successes and/or failures they expected for the new Circular NCKU program. A variety of answers were given, with the results condensed and organized into a SWOT, i.e. Strengths, Weaknesses, Opportunities and Threats (see Table 2).

Table 2

SWOT on the potential success or failure of Circular NCKU program.

	Positive factors	Negative factors
Internal factors	<p>Strengths:</p> <ul style="list-style-type: none"> -First education program in Taiwan on CE^a -Direct applicability and employability -Certificate is benefiting students who delayed in their study -Attractive for exchange students -Companies offering real case studies -Growing list of CE courses 	<p>Weaknesses:</p> <ul style="list-style-type: none"> -Students and faculty are still unfamiliar with program -Poor communication between departments -NCKU has various scattered initiatives on CE -Low incentives for faculty to join -May not have enough CE courses yet
External factors	<p>Opportunities:</p> <ul style="list-style-type: none"> -Growth in interest for multi-disciplinary subjects -Circular Economy has become a policy in Taiwan -Growth in CE on: Interest, employability, profit, research et cetera. 	<p>Threats:</p> <ul style="list-style-type: none"> -Regulations that obstruct an ‘out-of-the-box’-program -Leadership and ownership issues at NCKU -Next government may not focus on CE

^aCE is the abbreviation for Circular Economy

Overall, the obstacles encountered in the development of this program can be categorized into two groups. First, setting up an education program on a fairly new subject (i.e., Circular Economy), which globally has only very few predecessors, will require the development of many novel courses. Second, multidisciplinary thinking will need to be introduced into an academic environment which is still primarily focused on specialization. The four NCKU staff who answered the questionnaire gave a lot of practical advice on how to establish more multidisciplinary education at NCKU. Staff A mentioned, *“Set up a new college and hire or transfer the teachers who are willing to do multidisciplinary.”* Faculty C also stated this as a suggestion *“as some universities also have a department for interdisciplinary studies.”* Other comments from staff were *“increase incentives for multidisciplinary topics”* and simultaneously *“decrease the control the departments and colleges have over the teachers.”*

Conclusions of the lessons learned

Education in multidisciplinary teams is valued higher than mono-disciplinary teams by both

students and faculty. However, both students and faculty believed that the education being provided at NCKU is not yet sufficiently multidisciplinary. From the questionnaires and direct experiences in setting up multidisciplinary education various obstacles and solutions have been found. A small interdisciplinary taskforce was adequate and effective in establishing the program. However, the taskforce had difficulty involving more faculty in the program. Solutions to this obstacle can be found in five potential approaches:

- 1)-Patience and persistence in communication on content and process.
- 2)-Providing incentives. This requires more administrative recognition and funding for the program. Another method is to reduce the incentives on mono-disciplinary research and simultaneously create more awareness of the potential of multidisciplinary research and education.
- 3)-A top-down approach of management, to order commitment from faculty. This solution was not tested and may not have worked either.
- 4)-Experience with other departments and administrative procedures.
- 5)-Create a multidisciplinary program which embeds existing courses to get faculty involved without requiring faculty to change their work and workload.

Student involvement seemed to be a lesser problem, at least for the preparation phase. The actual number of students who will enroll in the Circular NCKU program is as yet unknown. Student involvement in this study was successful due reasons similar to those mentioned for the faculty. The engagement of students may have been higher due more awareness on the needs for multidisciplinary methods on subjects like Circular Economy. Working with a multidisciplinary student team for testing and reflection turned out to be very informative and insightful.

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