Piloting the CLIMASP -Tempus Interdisciplinary Minor in Climate Change and Sustainability Policy: Outcomes Achieved

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Abstract
Higher education plays a unique and critical role, one often underestimated and/or neglected in building a more sustainable society. This paper deals with the piloting and validation of an interdisciplinary minor program in climate change and sustainability policy across 10 universities in Egypt, Jordan and Lebanon. It is a European Commission funded programme led by the University of Crete, Greece. A holistic and innovative assessment instrument was developed based on experiential, constructivist and transformative approaches to sustainability education. A pre-test questionnaire was given to assess: 1) previous teaching and learning practices; 2) sustainability education competences and 3) interdisciplinarity consisted of three scales- interdisciplinary skills, reflective behavior, and recognizing disciplinary perspectives as well as key learning pillars and critical skills. The same test was given at the end of the semester. The reliability tests performed showed that all the scales were valid for further statistical analysis. The pre-test and post-test analysis revealed statistically significant changes in students' performance as a result of the impact of the CLIMASP minor courses.

Keywords: Interdisciplinarity, climate change, sustainability policy, minor, higher education

Introduction

In recent years, we have experienced a number of environmental, social and economic problems that threaten the very existence of humankind. Problems such as extreme weather patterns and melting glaciers, deforestation and land degradation, habitat and biodiversity loss, air and water pollution, overuse of natural resources, poverty and violation of human rights, and global climate change, all pose critical challenges for people, communities and institutions across the world. Understanding sustainability problems, especially climate change, their causes, and their solutions is critical for building a sustainable global future. Dealing with sustainability problems there is need of shifting emphasis from disciplinary knowledge and skills to developing learners' interdisciplinary and action competence to participate actively in counteracting climate change and related problems. Higher education institutions (HEIs) play a unique and critical role, that is often overlooked, in making a healthy, just and sustainable society employing interdisciplinary perspectives (Makrakis & Kostoulas-Makrakis, 2014;2013ab). Blake et al. (2013) found that it appears to be raising demand for interdisciplinary understanding in relation to sustainability issues characterized by complexity and uncertainty, and this is likely to exert pressures on traditional disciplinary modes of teaching, content and organization in HEIs. They also found that programs which are promoting an interdisciplinary approach to sustainability are often seen as innovative, but still problems persist around the "uneasy fit between their cross-boundary integrative approaches and participatory pedagogies on the one hand, and discipline based university structures and methods on the other" (p. i). The higher education academic system is still very much structured on disciplines and the integration of interdisciplinary perspectives and programs have become unusual to the undergraduate fields of study (Davies et al. 2010). This necessitates a shift to new organizational and administrative forms that differ from traditional academic departments and faculties alongside with new curricula and teaching methodologies such as problem-based learning. Interfaculty and interdisciplinary collaboration are essential for modernizing higher education and it is a necessary condition for any transformation to meeting the challenges of climate change and sustainable development. Climate change and other sustainability problems require interdisciplinary approaches that can bridge the compartmentalization of knowledge and the isolation of academic fields in order to facilitate policy choices toward a path of ecologically sound and socially equitable solutions. There is, thus, a critical need for Middle Eastern universities, our focus here; in light of the climate change challenges their region is facing, to cultivate interdisciplinary expertise among their teaching staff and students.

Whilst the term 'interdisciplinarity' is often used flexibly to mean any approach that goes beyond a single discipline, the core characteristic of interdisciplinary approaches is their goal to analyze, synthesize and integrate concepts, methods and principles from different disciplines (Lawrence, 2010). This is different from what might be called a multidisciplinary subject which juxtaposes multiple perspectives on the same topic without integration and stays within their boundaries (Stock & Burton, 2011) while transdisciplinarity creates a unity of intellectual frameworks beyond the disciplinary perspectives (Domik, 2008; Choi & Pak, 2006). Based on a thorough literature review (e.g. Servant & Dewar, 2015; Brush & Saye, 2014; D'Ottavio & Bassan, 2014) we found that interdisciplinary students need to:

- Learn to interrogate multiple ways of knowing and methods and to talk critically but reasonably across these perspectives.
- Develop a reflective and explicit knowledge of how different disciplines work, the issues and problems they can address, and the strengths and limitations of each discipline.
- Balancing, weighing and accommodating a variety of disciplinary perspectives in order to reach a reasonable and creative decision or outcome.
- Understand that there are several important disciplinary perspectives that are relevant to every sustainability decision.
- Think critically, communicate effectively, and work collaboratively when addressing and solving the complex sustainability problems facing humanity.

It is, thus, crucial that education for sustainability leads in a deeply engaged interdisciplinary movement in HEIs, one which explicates the skills and practices enabling teaching staff, students and administrators to work meaningfully to this end. Education for sustainability is by itself an interdisciplinary field. The critical question to be raised is: how can we construct and embed an appropriate interdisciplinary paradigm in university curricula? Seeking interdisciplinary climate change education for sustainable development requires HEIs to:

1. Institutionalize sustainability methods and pedagogies based upon principles of social, environmental, economic and cultural justice.
2. Adopt interfaculty and interdepartmental cooperation for meeting demands of interdisciplinary cooperation within and between HEIs.
3. Encourage university-community partnerships through student practicum placements and service learning.
4. Develop to the maximum the potential of all students to play a leading and transformative role in their social and working roles.

The CLIMASP Minor

Our focus here is the Middle East and North African (MENA) region, and more specifically, Egypt, Jordan and Lebanon, countries that are heavily being threatened by climate change. Higher education institutions in the MENA region, in general, while recognizing that their region's contribution to the damage of the global climate is much less when compared to developed regions; they do recognize the urgency for tackling the challenge of climate change (Makrakis & Kostoulas-Makrakis, 2014). Although, interdisciplinary teaching and learning is highly prioritized in most of the MENA region Higher Education Institutions (HEIs), in practice, there is lack of interdisciplinary perspective and motivation among teaching staff in undergraduate studies, with the exception of some interdisciplinary programs within Masters and Ph.D. programs (Khadri, 2014; Makrakis, 2014).

As a response to these challenges, the UNESCO Chair ICT in Education for Sustainable Development at the University of Crete has initiated and developed the CLIMASP project proposal that has been funded through the European Commission Tempus program. CLIMASP adopts a multi/inter-disciplinary and systemic approach that, at a wider level, aims to transform current unsustainable practices leading to climate change and promote interdisciplinary collaboration alongside with developing sustainable leadership in the partner countries' universities (Makrakis & Kostoulas-Makrakis, 2015). Specific objectives, within the aforementioned wider ones, include the:

- Development of capacity-building programs to train university teaching staff and key administrators for interdisciplinary collaboration and building partnerships with local/national/regional partners;
- Involvement of university staff and other key stakeholders (e.g., students, professionals, employers) in the development of an undergraduate interdisciplinary programs (minors) on climate change and sustainability policy in each partner country university;
- Integration and implementation of the interdisciplinary minors as an integral part to existing undergraduate academic degrees in disciplines like education sciences, applied sciences, technical sciences, economics/business sciences, and social sciences; and
- Monitoring, evaluation and review of the interdisciplinary programs on climate change and sustainability policy in each partner country institution.

The key outcome of the CLIMASP project is the development of interdisciplinary minors in 10 partner universities in the MENA region (Egypt, Jordan and Lebanon). Each partner university has mapped out 25-30 undergraduate courses from at least three academic faculties based on certain criteria. Among the criteria are those of relevancy, faculty and staff interest, and commitment. The interdisciplinary CLIMASP courses chosen have gone through a process of revising that aimed to embed sustainability into content and teaching methods. The CLIMASP courses are an integral part of the existing collaborating undergraduate disciplines such as education sciences, technical sciences, economics/business sciences and social sciences. The minor consists of core courses, elective courses and the required capstone course in three concentration areas: 1) Climate Change, Environment and Society; 2) Climate Change, Economics and Public Policy; and 3) Climate Change, Science and Technology. Each of the core and elective courses is equivalent of 6 ECTS and the capstone course of 10 ECTS. The capstone course is based on an internship that provides a strong mechanism for integrating academic coursework with practical experience. The amount of the minimum courses to be taken across the three concentration areas by undergraduate students to qualify for the CLIMASP minor is around 45-60 ECTS. This provides students a formal credential through transcript documentation adapting the Europass supplement diploma to certify that they have developed leadership in the field of CLIMASP.

The CLIMASP minor is framed on an interdisciplinary modular structure that enables each partner institution to tailor CLIMASP according to its specific needs. For a smooth transition from disciplinary to interdisciplinary curricula, a piloting stage started in the spring academic semester 2014-15 on a small number of CLIMASP courses. Piloting creates the opportunity to demonstrate what interdisciplinary learning and teaching looks like throughout the semester and allows faculty, students

and evaluators to observe processes, methods and practices. Based on the pilot assessment, proper interventions to enhance content and methods will be applied to all the 240-300 CLIMASP course modules across the 10 partner universities.

A methodological framework for piloting the CLIMASP minor

Attempting to assess the CLIMASP courses piloted, an instrument was constructed that consists of five parts. In the first part, a number of student background variables were posed, including gender, faculty and discipline, study year and previous attendance of courses related to sustainable development. In the second part, we have framed a scale to measure teacher-centered (3 items) and student-centered (11 items) modes of teaching and learning. In the third part, the scale referred to the 10Cs, which is critical skills needed for the 21st century was framed. These skills and understandings are vitally important to support problem solving and sustainability decision-making. We have realized that there is a need to go beyond the 4Cs for workforce readiness in the 21st century - critical thinking & problem solving, communication, collaboration & team building and creativity & innovation (AMA, 2010; Partnership for 21st C. Skills, 2011; AT21CS, 2012). In a world of rapid change and expansion of human knowledge, along with sustainability crisis that threatens the very existence of humankind, education must extend beyond the focus on the 4Cs to what we have coined 10Cs (Makrakis & Kostoulas-Makrakis, 2014), namely:

1. Critical thinking and problem solving
2. Communication
3. Collaboration
4. Creativity and innovation
5. Connectivity
6. Critical consciousness
7. Critical reflection
8. Cross/inter-cultural competence
9. Co-responsibility
10. Constructing knowledge

Although there is some overlap among the 10Cs, each one has its own role in teaching and learning for problem solving. For example, critical thinking and problem solving refers to the ability to make decisions, solve problems and take appropriate action, using learning processes such as conceptualizing, applying, analyzing, synthesizing and/or evaluating information gathered by multiple means. Communication refers to the ability to synthesize and transmit ideas in written, oral and virtual formats. Collaboration refers to the ability to work effectively with others, including those from diverse groups and with opposing points of view. Creativity and innovation refers to the ability to apply new ideas in developing innovative applications and solutions. Connectivity addresses the complexity of human to human interaction as well as to society and nature. This is driven by the theory of connectivism- a response to a need to derive and express meaning, and gain and share knowledge, in an increasingly networked global society (Siemens, 2004; 2006). These connections occur on neural, conceptual and social levels (Siemens, 2008). Critical reflection refers to a complex process that strongly engages learners to critically reflect upon their reality, personal and social, and to transform it through action and reflection (Stanlick, 2014). Cross/inter-cultural competence requires that learners

examine their own cultural backgrounds and identities to increase awareness of personal assumptions, values, and biases in order to work effectively in cross-cultural situations. Co-responsibility refers to a culture of sharing that necessitates shifting to less ego-centric principles and practices. Critical consciousness or concientization in Freire's (2000) terms denotes the process of developing a critical awareness of one's social reality through reflection and action. Constructing knowledge represents an attempt to shift from consuming information to constructing knowledge that merges with action.

In the fourth part, the scale consisted of 27 items referred to the six pillars of 21st century learning. The first four of these pillars (learning to know, learning to be, learning to live together and learning to do) were addressed in the 1996 report to UNESCO, Learning: The Treasure Within, The International Commission on Education for the 21st Century, "provide maps of a complex world in constant turmoil" as well as "the compass that will enable people to find their way in it" (Delors et al. 1996, p.85). At a later, stage, a 5th pillar of learning to transform oneself and society was added by UNESCO. We have added a 6th pillar of 'learning to give & share' in order to respond to the quest for merging volunteerism, social activism and learning (Fig.1).

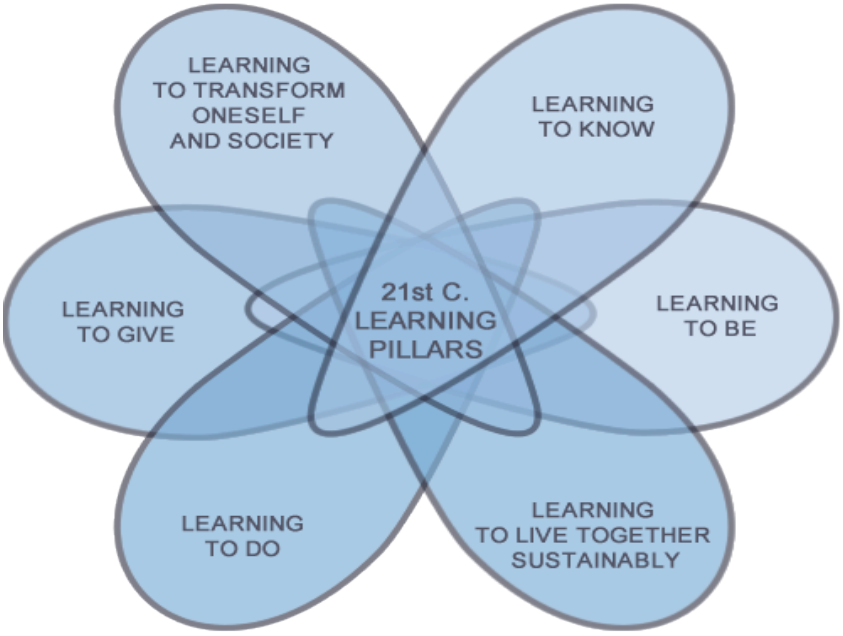

Figure 1: 21st Century Learning Pillars

Table 1: Definition of the 21st Century Learning Pillars

Learning to know	This type of learning concerns all the processes and practices that lead people to experience, construct and transform knowledge for making sustainability a mode of life and being.
Learning to be	This type of learning concerns all the processes and practices that lead to human self-actualization, self-regulation and cultivating a sense of being versus having.

Learning to live together sustainably	This type of learning concerns all the processes and practices that lead to a peaceful and non-discriminatory society and human co-existence with the natural world.
Learning to do	This type of learning concerns all processes and practices that lead to merging knowledge with action for building a sustainable future.
Learning to transform oneself and society	This type of learning concerns all the processes and practices to transform unsustainable values and behaviors and collectively engage to change society towards sustainability.
Learning to give and share	This type of learning promotes solidarity and caring attitudes to meet human needs as learners gain autonomy and purpose for their learning and civic engagement.

In constructing the six pillars of 21st learning scale, as far as the four learning pillars (learning to know, learning to be, learning to live together and learning to do) are concerned, the scale was based on the respective competences identified in the UNECE competence scale (cited in Dlouhá, Dlouhý & Barton, 2010). The other two sub-scales of learning to transform oneself and society and learning to give and share are based on our own measurement items.

Finally, the fifth part refers to the interdisciplinary problem-based learning scale that was modified from the one used by Lattuca, Knight & Bergom (2012). This scale has three key components: 1) interdisciplinary skills (8 items); 2) reflective behavior (2 items) and 3) recognizing disciplinary perspectives (3 items). As pointed by Lattuca, Knight & Bergom (2012), the Interdisciplinary Skills scale assesses students' perceptions of their abilities to think about and use different disciplinary perspectives in solving interdisciplinary problems or to make connections across academic fields. The Reflective Behavior scale includes items that operationalize the "reflexivity" dimension of interdisciplinarity. This scale includes items that reflect students' perceived ability to recognize the need to reconsider the direction of their thinking and problem-solving approaches. The final part of the scale, Recognizing Disciplinary Perspectives, measures students' perceived understandings of disciplinary knowledge, methods, expectations, and boundaries and how disciplinary knowledge might be applied in different situations.

Validating the CLIMASP course assessment scales

The validation process of the constructed measurement scales was based on the *Cronbach alpha* reliability analysis with a sample of 445 students from two CLIMASP partner universities (Jerash University (No= 326), Jordan and Suez Canal University (No= 119), Egypt). The *Cronbach's alpha* reliability analysis was based on the post-test items of the measured scales as the students participated in the survey were more familiar with the concepts that the items of the scales were composed. Table 1 shows the reliability analysis for the scale measuring student-centered and instructor-centered teaching methods. It has been revealed a very high reliability result equal to a=0.95 for the scale measuring student-centered teaching and learning methods and 0.90 for the instructor-centered teaching and learning methods. Similarly, the second scale concerned with the 10Cs, also based on our own conceptualization, exhibited a very high *Cronbach alpha* reliability value equal to 0.96 (Table 2).

Table 1: Student-centered and instructor-centred learning and teaching methods

Teaching and learning methods	**Items corresponding to student-centered and instructor-centered learning and teaching methods**	**Alpha if item deleted**	**Item Means**
Student-centered teaching (Alpha =.96) **Total items Mean= 2.8**	In classes, the discussion was led by both the instructor and students	0.96	3.7
	Connecting the course content with volunteering in the community	0.96	3.1
	Connecting the course content with practice outside the university.	0.96	2.6
	Connecting course content with online learning.	0.95	2.6
	Asked to reflect on what I have learned and think.	0.96	3.3
	Asked to do a project with real life issues/problems collaboratively	0.96	3.2
	Asked to make a presentation in class.	0.96	2.6
	Asked to solve a real life issue/problems and provide solutions.	0.97	2.8
	Asked to solve a real life issue/problem based on problem-based learning.	0.96	2.6
	Asked to review/criticize the work of other students.	0.97	2.3
	Asked to keep a portfolio for all class activities.	0.96	1.8
Teacher-centered teaching (Alpha= .93) **Total items Mean= 2.3**	In classes, the instructor led the course	0.90	2.8
	In classes the instructor led the discussion	0.92	2.7
	Asked to write down a final class exam.	0.90	1.6

Table 2. The 10Cs and their measurement items

Factor 10Cs (Alpha= .96) Items Mean= 3.4	**Items corresponding to each critical skill**	**Alpha if item deleted**	**Item Means**
Critical thinking and problem solving	Making reasoned judgments that are logical, well thought out and reflective.	0.96	3.6
Communication	Sharing thoughts, questions, ideas and solutions effectively and efficiently.	0.96	3.5
Collaboration	Working together to efficiently and actively achieve a defined goal.	0.96	3.5
Creativity and innovation	Turning new and imaginative ideas into reality.	0.96	3.5
Connectivity	Linking to and communicate with others by using multiple means of communication.	0.96	3.5
Critical consciousness	Perceiving social, environmental, and economic oppression and take action.	0.96	3.4
Critical reflection	Questioning assumptions, presuppositions, and meaning perspectives.	0.97	3.6
Cross/inter-cultural competence	Communicating effectively and appropriately with people and cultures.	0.96	3.4
Co-responsibility	Being responsible, answerable or accountable for something within one's power, control or management.	0.96	3.5
Constructing knowledge	Constructing new knowledge and meaning upon previous experiences and ideas.	0.96	3.4

Regarding the sub-scales measuring the six pillars of learning, the Cronbach a reliability test exhibited very high reliability indices ranged from a= 0.84 to 0.94 (Table 3). Similar results were also obtained regarding the three sub-scales measuring the CLIMASP courses' interdisciplinbary dimensions. More specifically, as depicted in Table 4, the reliability test exhibited high *Cronbach's alpha* values ranging from .0.88 (Reflective behavior) to 0.90 (Recognizing disciplinary perspectives) and 0.95 (Interdisciplinary skills). Although, the scores are very high, it is our perception that there is need to enrich the scales with the fewer items with more items.

Table 3: The six learning pillars scale

Learning pillars	Items corresponding to each learning pillar	Alpha if item deleted	Item Means
Learning to know/learn (Alpha= .94) Total items Mean= 3.3	Posing analytical questions/critical thinking.	0.93	3.4
	Understanding complexity/systemic thinking.	0.92	3.0
	Overcoming obstacles/problem-solving.	0.93	3.4
	Managing change/problem-setting.	0.93	3.4
	Creative thinking/future-oriented thinking.	0.93	3.3
	Understanding interrelationships across disciplines/holistic approach.	0.92	3.3
Learning to be (Alpha= .92) Total items Mean= 3.5	Feeling self-confidence.	0.90	3.4
	Self-expression and communication.	0.90	3.5
	Coping under stress.	0.89	3.5
	Identifying and clarify values.	0.89	3.5
Learning to live & work together (Alpha= .94) Total items Mean= 3.2	Acting with responsibility (locally and globally).	0.94	3.6
	Acting with respect for others.	0.94	3.5
	Identifying stakeholders and their interests.	0.94	2.5
	Collaboration/team working.	0.93	3.3
	Participating in democratic decision making.	0.93	3.2
	Negotiation and consensus building	0.93	3.0
	Distributing responsibilities (subsidiarity)	0.93	3.2
Learning to do (Alpha= .94) Total items Mean= 3.4	Applying learning in a variety of life-wide contexts.	0.93	3.4
	Decision making, including in situations of uncertainty.	0.93	3.4
	Dealing with crises and risks.	0.92	3.4
	Acting responsibly.	0.93	3.5
	Acting with self-respect.	0.93	3,4
	Acting with determination.	0.93	3.4
Learning to transform oneself & society (Alpha= .90) Total items Mean= 3.5	Acting personally and collectively for the common good.	0.84	3.4
	Acting responsibly for social and economic injustices.	0.92	3.4
	Acting for environmental integrity.	0.83	3.6
Learning to give & share (Alpha= .84) Total items Mean=	Giving and sharing from own resources.	-	3.4
	Connecting learning with	-	3.1

3.25	volunteering.		

Table 4: Dimensions of the interdisciplinary scale and their measuring items

Factor	**Interdisciplinary items**	**Alpha if item deleted**	**Item Means**
Interdisciplinary skills (Alpha= .95) **Total items Mean= 3.5**	I value reading about topics outside of my own field/subject.	0.94	3.4
	I enjoy thinking about how different fields approach the same problem in different ways.	0.94	3.5
	Not all problems have purely technical solutions.	0.94	3.4
	In solving problems I often seek information from experts in other academic fields.	0.95	3.4
	Given knowledge and ideas from different fields, I can figure out what is appropriate for solving a problem.	0.94	3.5
	I see connections between ideas in my study/subject field and ideas in other study/subject fields.	0.94	3.5
	I can take ideas from outside my field and synthesize them in ways that help me better understand what I study.	0.95	3.5
	I can use what I have learned in one field in another setting.	0.94	3.4
Reflective behaviour (Alpha= .88) **Total items Mean= 3.4**	I often step back and reflect on what I am thinking to determine whether I might be missing something.	-	3.5
	I frequently stop to think about where I might be going wrong or right with a problem solution.	-	3.4
Recognizing disciplinary perspectives (Alpha= .90) **Total items Mean= 3.4**	If asked, I could identify the kind of knowledge and ideas that are distinctive to different fields of study.	0.83	3.4
	I recognize the kind of evidence that different fields of study rely on.	0.87	3.3
	I'm good at figuring out what experts in different fields have missed in explaining a problem/solution.	0.86	3.4

Outcomes achieved

One of the key aims of the CLIMASP pilot phase carried out in the spring semester of 2014-15 was to find out what changes have occurred as a result of the revised courses implemented. The change effects were measured through the use of paired-samples t-test by calculating the differences between the two measures. A pre-test/post-test evaluation is an assessment method that is administered at the beginning and at the end of a course. As pointed earlier, here we use the data collected from two partner institutions in Egypt and Jordan with a total sample of 445 students. When comparing pre-test and post-test class point scores for the whole group, the results show that significant changes occurred as a result of the course content and methods and teaching methods (Table 5).

Table 5: Pre-test and post-test comparisons of the interdisciplinary problem-based sustainability education scales and sub-scales

Scale	Type	Mean	t-test	d.f.	Sig.
Interdisciplinary Skills	Pre-test	2.87	-9.29	444	.000
	Post-test	3.45			
Reflective Behavior	Pre-test	2.98	-6.59	444	.000
	Post-test	3.44			
Recognizing disciplinary perspectives	Pre-test	2.87	-7.57	444	.000
	Post-test	3.36			
10Cs	Pre-test	2.12	-21.64	440	.000
	Post-test	3.45			
Learning to know	Pre-test	2.12	-18.99	439	.000
	Post-test	3.48			
Learning to be	Pre-test	2.96	-8.43	442	.000
	Post-test	3.48			
Learning to live Together	Pre-test	2.86	-5.04	441	.000
	Post-test	3.17			
Learning to do	Pre-test	2.75	-11.03	443	.000
	Post-test	3.42			
Learning to transform	Pre-test	2.93	-9.45	444	.000
	Post-test	3.53			
Learning to give & share	Pre-test	2.74	-7.05	444	.000
	Post-test	3.25			
Student-centered teaching methods	Pre-test	1.67	-17.88	445	.000
	Post-test	2.79			
Instructor-centered teaching methods	Pre-test	2.59	3.86	444	.000
	Post-test	2.35			

Examining the results in the interdisciplinay problem-based scale, we find that the average total pre-test Means ranged from 2.87 to 2.98 on a four-point scale [Strongly Agree, Agree, Disagree and Strongly Disagree] and the average post-test Means from 3.44 to 3.45, yielding an average statistically significant difference of + 0.52. In terms of the three sub-scales, the statistically significant difference measured through

the paired-sample t-test were for: 1) interdisciplinary skills, $t(444)= -9.29$, at $p< 0.001$; 2) reflective behavior, $t(444)= -6.59$, at $p< 0.001$; and 3) recognizing disciplinary perspectives, $t(444)= -7.57$, at $p< 0.001$.

Regarding the scale measuring the 10Cs, the statistical analysis shows that the pre-test average total items Means was 2.12 on a four-point scale and the average post-test total items Means 3.45, yielding a statistically significant difference of + 1.36 with , $t(440)= -21.64$, at $p< 0.001$. This is the highest change effect, which shows clearly that the CLIMASP pilot courses did have a great effect across all the 10 critical skill, namely: Critical thinking and problem solving; communication; collaboration; creativity and innovation; connectivity; critical consciousness; critical reflection; cross/inter-cultural competence; co-responsibility and constructing knowledge. Looking into the results of the six learning pillars, it has been revealed that the average total pre-test Means ranged from 2.12 to 2.96 (Total Mean= 2.73) on the four-point scale and the average post-test Means from 3.17 to 3.48 (Total Mean 3.39), yielding an average statistically significant difference of + 0.66. The statistically significant differences across the six sub-scales were for: learning to know, $t(439)= -18.99$, at $p< 0.001$; learning to be, $t(442)= -8.43$, at $p< 0.001$; learning to live together, $t(441)= -5.04$, at $p< 0.001$; learning to do, $t(443)= -11.03$, at $p< 0.001$; learning to transform oneself and society, $t(444)= -9.45$, at $p< 0.001$; and learning to give and share, $t(444)= -7.05$, at $p< 0.001$.

Lastly, with respect to the scale measuring student-centered and instructor-centered learning and teaching methods, the pre-test/post-test analysis revealed a statistically significant difference in their Means. More specifically, on the one hand, the pre-test measurement of student-centered teaching and learning methods revealed a total average Mean equal to 1.67 and the post-test value reached to 2.79 on a four-point scale [Not at all, few times, often and very often], yielding a difference of + 1.12 with $t(444)= -17.88$, at $p< 0.001$. The second highest change effect among all scales and sub-scales. On the other hand, the results of the subscale measuring instructor-centered teaching and learning methods revealed a statistically significance difference but in different direction. The average pre-test score was 2.59 and the post-test score 2.35, yielding a slight but statistically significant decrease of -0.24. These two results show that besides adopting and implementing student-centered teaching and learning methods in the piloting of CLIMASP courses, the instructor-centered teaching/learning methods are clearly giving their way to more suitable sustainability education methods.

Conclusion

Presently, HEIs worldwide are seeking recognition through integrating the concept of sustainability to all disciplines and fields as well as to all other university functions. A major driver for more interdisciplinary approaches to teaching and learning is the dynamic and evolving concept of sustainability itself. Climate change education for sustainable development encompasses a new vision of education that seeks to empower people to assume responsibility for creating more sustainable futures, locally and globally. Through such a kind of education, human agency can lead to increasing people's capacities to transform their visions for sustainability and a climate-free society into reality.

In piloting a number of the CLIMASP courses in the partner universities, we employed a pre-test/post-test instrument that reflects our teaching and learning methodologies conducive to sustainability education. Our aim was both to test reliability and validity of learning models as well as to examine possible changes during the implementation process. The statistical analyses show that the instruments are reliable, although improvement and enrichment is possible, despite the very satisfactory reliability values found. In terms of changes, starting from the apparent shift from instructionist to constructivist and critical pedagogy methods alongside with the significant changes occurred in students' interdisciplinary PBL sustainability skills and competences, it seems that the CLIMASP course revision process achieved its objectives.

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