

The incorporation of the AECE 4-D cycle learning system into technological and engineering education

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ABSTRACT: The purpose of this study was to propose the 4-D cycle learning system for Appreciative Environmental Consciousness Education (AECE) for technological and engineering college students, to incorporate the learning system into education and explore the effects of the learning system on students. The Appreciative Environmental Consciousness Education Questionnaire (AECEQ) was administered before and after AECE instruction. The research results showed that students' environmental consciousness improved through the incorporation of the AECE 4-D cycle learning system in technological and engineering courses. Having the knowledge of environmental education and general ecological principles, students began to appreciate their natural environment and cherish natural resources.

INTRODUCTION

The world is currently facing complex environmental problems that have resulted in environmental degradation, such as acid rain, global warming and air pollution. Many environmental problems are caused directly or indirectly by the actions of people, such as the patterns of productions in industries, increasing consumption patterns, etc. It has been shown that the most important factor affecting nature is the lack of public awareness or public concern for the environment [1]. Therefore, the shaping of people's correct attitude and concern for the environment is crucially required.

Over the last two decades, technological and engineering education has played an important role in advancing Taiwan's economic growth and in developing students' professional skills in technological, engineering and management knowledge to satisfy the demand for hi-tech personnel in Taiwan.

While focusing on instilling students' technological and engineering knowledge, universities in Taiwan do not currently pay much attention to students' environmental education. In order to raise students' environmental awareness, it is necessary to integrate appreciative environmental consciousness into school education.

The purpose of this study is as follows:

- To propose the Appreciative Environmental Consciousness Education (AECE) 4-D cycle learning system for technological and engineering college students;
- To incorporate the AECE 4-D cycle learning system into technological and engineering education;
- To explore the effects of the AECE 4-D cycle learning system on technological and engineering college students.

THE AECE 4-D CYCLE LEARNING SYSTEM

The AECE 4-D cycle learning system is a learning system that is intended to identify the best in the natural environment to build up further the vision of *what could be* in Nature. With this vision of Nature, the AECE 4-D cycle learning system has been structured to arouse students' environmental consciousness and to transform their environmental attitude to further identify the beauty of the world.

The key aspects of AECE are as follows:

- Draw on the strengths and values of students; in every class, group, society or organisation, there should be something developed that works to arouse students' appreciation of the environment;
- The focus should become the reality. That is, when the focus is on a vision of Nature's beauty, then this beauty will someday become the reality;
- The vision of Nature's beauty is created in any moment. Therefore, teachers' acts or methods of asking questions in a class, group or organisation influences the attitudes and behaviours of the group in some way;
- Teachers and students should have much more confidence and comfort to journey to the vision (the unknown beauty) if they carry forward parts of the past (the known beauty) to the vision;
- When carrying parts of the past to the future, they should be the best in the past, that is, the beauty in the past.

AECE is derived from appreciative inquiry [2]. There are four phases in the AECE 4-D cycle learning system. These are defined as follows:

- Discovery;
- Dream;

- Design;
- Delivery.

In the *discovery* phase, teachers help students mobilise the whole class to discover a positive change core for the natural environment. In the *dream* phase, teachers help students create a clear and positive result-oriented vision and discover their potential to create an ideal natural environment. In the *design* phase, focusing on the positive core, teachers help students figure out possible strategies to create their vision for Nature. In the *delivery* phase, teachers and students work together to go through the process of learning, adjustment and improvement for co-creating their vision of beautiful Nature. With the shared vision, students engaged in the AECE 4-D cycle learning system would work cooperatively to create the ideal image of Nature.

Through the facilitation of the AECE 4-D cycle of discover, dream, design and delivery, teachers endeavour to help students appreciate the beauty of the natural environment, provide students with a chance to realise the key environmental issues currently endangering the world, and further aim to minimise the negative environmental impacts.

METHOD

In order to explore the effects of the AECE 4-D cycle learning system on technological and engineering college students, two classes (66 students) were selected as the experimental sample. After the literature review, the Appreciative Environmental Consciousness Education Questionnaire (AECEQ) was developed. In order to establish the validity of the questions in the AECEQ, the initial questionnaire was read by 10 technological and engineering students to assure that students could understand the questions without ambiguity. Two questions were deleted because of a lack of clarity and ambiguity. The questionnaire was then reviewed by an expert panel consisting of three people. Based on the panel's feedback, a small revision was required to make the questions clearer. The final AECEQ was made up of 10 items rated on a 5-point Likert-type scale ranging from *strongly disagree* to *strongly agree*. In this study, Cronbach α was used to test the internal consistency reliability. The reliability of this scale was 0.82. Before the experiment, everyone had to fill out the AECEQ to obtain each student's environmental consciousness. The questionnaire was used to investigate students' consciousness of natural resources, environmental protection and their knowledge of environmental education.

After the administration of the AECEQ survey, the AECE 4-D cycle learning system was incorporated into technological and engineering education. This study took place in autumn 2006 and the experimental period was eight weeks.

After eight weeks of instruction under the AECE 4-D cycle learning system, a post-experimental AECEQ was given to the students involved in the survey. The statistical package used to analyse the quantitative data of the questionnaire was the *Statistical Packages for the Social Sciences (SPSS)*. An independent sample t-test was used to determine whether there was any significant difference before and after the incorporation of the AECE 4-D cycle learning system into technological and engineering education.

The experimental framework of the AECE 4-cycle learning system is shown in Figure 1.

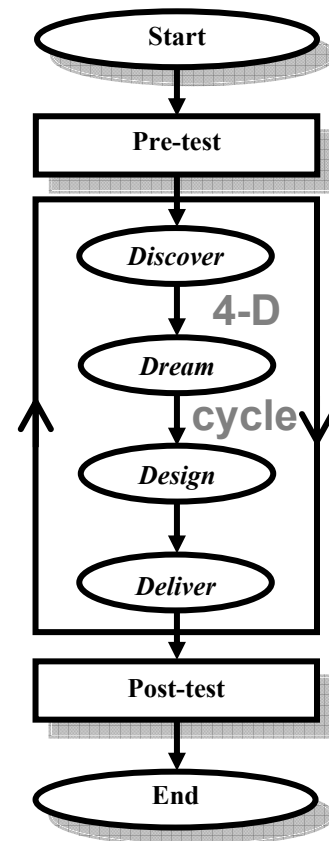


Figure 1: The experimental framework of the AECE 4-D cycle learning system.

RESULTS AND DISCUSSION

After the administration of the post-test AECEQ, the results of the survey were analysed. The research results showed that the AECE 4-D cycle learning system was effective in improving the students' environmental consciousness. The t-tests results of pre- and post-environmental consciousness are shown in Table 1. The table shows that, after the implementation of the AECE 4-D cycle learning system, students had better environmental consciousness than before.

Table 1: The results analysis of pre- and post-experimental environmental consciousness.

Item	Pre-test		Post-test		t	Sig.
	Mean	SD	Mean	SD		
1	2.91	1.03	3.70	0.63	5.816	0.000*
2	3.86	0.76	3.97	0.61	1.187	0.240
3	4.02	0.81	4.02	0.59	0.000	1.000
4	2.98	0.97	3.76	0.66	6.914	0.000*
5	3.02	0.89	3.92	0.62	8.467	0.000*
6	3.03	0.97	3.58	0.73	4.208	0.000*
7	2.77	0.94	3.61	0.68	6.563	0.000*
8	3.83	0.89	3.85	0.81	0.142	0.888
9	3.33	0.85	3.91	0.49	4.947	0.000*
10	2.03	1.02	4.01	0.62	12.778	0.000*

SD=Standard Deviation

Sig.=Significant

*p-value less than 0.01

Based on the above research purposes and data analysis, the research results show that the AECE 4-cycle learning system was effective in improving students' environmental consciousness.

While further investigating the results between the pre-test and post-test, the researchers found that there were no significant differences in Items 2, 3 and 8 before and after the implementation of the AECE 4-cycle learning system. From the above results, it could be inferred that before the implementation of the learning system, although without knowledge of environmental education and general ecological principles, the students did realise the importance of environmental protection for human beings. Also they realised that the advancement of technology would cause harm to the environment, but they also had the ability to protect the natural environment. However, before the incorporation of the AECE 4-D cycle learning system into technological and engineering education, they did not have the intention to cherish natural resources and pay attention to recycling leftover food, paper, glass, plastic, etc. Moreover, they believed that human beings had the right to destroy Nature for their needs.

Through the incorporation of the AECE 4-D cycle learning system into technological and engineering courses, students' environmental consciousness can be changed. Having knowledge of environmental education and general ecological principles, students begin to appreciate the natural environment and cherish natural resources. They believe that they have the ability and can pay attention to recycling leftover food, paper, glass, plastic, etc. Besides, they realise that humans do not have the right to destroy nature for their needs but should instead protect it.

The AECE 4-D cycle learning system empowers students to envision a beautiful natural world that they value and hope for. In the discovery phase, students can begin to appreciate a variety of natural resources and the interactions between living and non-living elements in their daily lives. Once realising that the whole production process – from the extraction of resources through production, products sold and used, and the services rendered to final disposal – may endanger the beautiful natural environment. After graduation and with appreciative environmental consciousness, students can utilise their own technological and engineering expertise and knowledge to decrease the threat of the advancement of technology. For instance, they may stick to some ecological principles and do their best to prevent dust, gas, smoke and harmful chemicals being discharged and dumped into the air and rivers.

In the dream phase, after discovering the significance of environmental quality, students begin to dream and envision a positive natural environment. Instead of seeing the natural environment as a problem to be solved, students identify with some positive values in the natural environment and believe that there is a miracle in Nature that can recreate peak experiences from the past. In order to let the miracle come true, with appreciative environmental attitudes, in turn, they look upon their strengths and capacities to restore the peak moments of Nature. That is, based on the vision created in the discovery and dream phases, in order to let the vision come true, students would take some positive actions and positive change in themselves and others for the natural environment. In this stage, students do not focus on environmental problems, but rather pay attention to envisioning their hopes and aspirations for Nature, which they will keep going on into the design and delivery phases.

Based on their vision for Nature, which focuses on strengths and power, sustainable solutions can be determined in the

design phase. In this phase, students can develop strategies for advancement and seek to prevent environmental degradation, while also participating in the resolution of environmental problems. For instance, based on ecological principles, these technological and engineering students can actively design some environmental protection activities or policies in advance so as to protect the natural environment. Unlike conventional environmental problem-solving education in which students are instructed to identify environmental problems and scrutinise a solution to solve them, the AECE 4-D cycle learning system focuses on preventing the causing of environmental problems in advance.

Then, in the delivery phase, students actively take action to exercise the designed environmental protection strategies or policies in order to restore Nature's beauty, such as using energy, water or other natural resources much more efficiently. With the incorporation of the AECE 4-D cycle learning system into technological and engineering education, students are empowered to actively undertake social responsibility and therefore prevent negative environmental impacts on daily lives and on Nature.

Conventional environmental education is designed for *finding and fixing* problems, which focuses on decay [3]. In this conventional environmental education, problem-solving teaching strategies are applied to help students identify environmental problems and scrutinise a solution to solve them. Conventional environmental education may leave students with an understanding of environmental issues. However, it could be possible that students may feel powerless to achieve a resolution to countering environmental degradation. Under this kind of education, students may feel powerless to undertake social responsibility for environmental protection activities. In order to motivate and empower students to develop their levels of environmental awareness and further take actions to change the world, the AECE 4-D cycle learning system was proposed.

Instruction under the AECE 4-D cycle learning system focuses on the potential of replacing conventional problem-solving instruction applied to environmental education. The basic sequence of conventional environmental problem-solving instruction is: identify key problems → analyse causes → find solutions → develop action plans [4].

This contrasts with the sequence of conventional problem-solving instruction. The cycled sequence of the AECE 4-D cycle learning system is: discover and value the best of what has been in the natural environment → dream and envision what might be in the natural environment → discuss and design what can be done to this envisioned world → construct and deliver what will be in the world.

Through the 4-D cycle of discover → dream → design → deliver, AECE implies that there is a miracle in Nature, and people, by appreciating Nature, should empower themselves with awareness and confidence to effectively protect their natural environment, and let the miracle come true. Unlike problem-solving instruction, the AECE 4-D cycle learning system looks upon nature's peak experiences in the past in order to further discuss and determine strategies to recreate those peak experiences.

To sum up, after the incorporation of the AECE 4-D cycle learning system into technological and engineering education,

students can start appreciating Nature and natural resources, and through self-reflection to take action to change their environment.

CONCLUSION AND SUGGESTIONS

The research results show that the AECE 4-cycle learning system is effective in improving students' environmental consciousness. By paying attention to the vision of the future world rather than paying attention to current environmental problems, teachers deliberately create change.

In the discovery phase of the AECE 4-D cycle learning system, teachers help students mobilise the whole class to discover a positive change core for the natural environment.

In the dream phase, teachers help students create a clear and positive result-oriented vision to discover their potential to change the world or create an ideal natural environment.

In the design phase, by emphasising on the positive core, teachers help students figure out possible strategies to create their vision of the natural environment.

In the delivery phase, teachers cooperatively help students go through the processes of learning, adjustment and improvement to co-create their vision of Nature.

Through the AECE 4-D cycle of discover, dream, design and delivery, teachers help students appreciate the beauty of the natural environment. Educators can also provide students with the chance to understand the key environmental issues endangering the world today and help students recognise how they can minimise their negative impacts on the natural environment.

The key to achieving successful AECE lies in its 4-D cycle as well as good teachers. While integrating the AECE 4-D cycle learning system into technological and engineering education, teachers would definitely play an influential role in raising students' appreciative consciousness of natural resources and the

environment. Moreover, while developing students' appreciative environmental consciousness, a combination of sensitive teachers with good teaching strategies and materials would result in a worthwhile interactive teaching-learning situation.

However, there are still some difficulties in implementing the learning system for technological and engineering education. For instance, while integrating the learning system into technological and engineering education, some educators may lack expertise and not know enough about their surrounding environment. Even worse, they may not know how to obtain relevant environmental information or to combine this information with the core knowledge of their course. Therefore, in order to facilitate the AECE 4-D cycle learning system, a qualified teacher is required.

However, with the incorporation of the AECE 4-D cycle learning system into technological and engineering education, students are given a chance to use what they have learned in class. After graduation, based on ecological principles, they can then utilise their own technological and engineering expertise and knowledge to develop strategies in advance to prevent the degradation of the environment or to minimise the harm that the advancement of technology brings to Nature.

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