ICT SUPPORTED EDUCATIONAL MODULE FOR PRESERVATION OF EXISTING ECOSYSTEM

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ABSTRACT
Increasing undergraduate students' understanding of our ecosystems by way of ICT (Information and Communication Technologies) is rather important for the sustainability and future of our world. With this aim, ICT supported educational modules were developed that are oriented toward the preservation of the existing ecosystem in the subjects of a) global environment, b) renewable energy, c) greenhouse effect and d) climate and e) green chemistry. All of the undergraduate students that had an Internet connection could access the website (www.kimyaegitimi.com and http://www.kimegi.hacettepe.edu.tr). ICT supported educational modules for the preservation of the existing ecosystem are educational tools. They incorporate elements that determine the students' readiness along with concept teaching, HOCS applications, and student group activities (groups of three). Target questions and Internet based searching regarding these questions are incorporated into the students' reports and presentations. At the end of the study, the effect of these modules on the students in different branches of achievements was investigated.

KEYWORDS: Preservation of Ecosystem, ICT (Information, Communication Technologies), Educational Modules.

INTRODUCTION

Today, the rapid development of science and technology not only is increasing the living standards of individuals but also modifying or destroying many things in the environment. If such environmental problems cannot be prevented, the life cycle could end. The questions are: what should people do regarding renewable energy resources and their utilization? Additionally, how could education and technological developments serve this purpose? People should care about environmental protection and human health while utilizing energy**,** retain a stable economy, and utilize energy productively and properly together with natural resources. In addition, the social and political system, which could provide equality of opportunities, should be constructed by society. Technology, while continuing with production for global change and the ecosystem, should make use of methods in production, which do not harm human health or the environment, such as solar energy. Moreover, regarding material consumption by people, recyclable and biologically decomposable wastes should be preferred. As the individuals that develop technology are an integral part of society, in order to prevent environmental pollution, they should possess environmental awareness by knowing about energy in their daily lives. Here, the educational backgrounds of the members of society play an important role. Therefore, it is necessary to decide on how to provide education. The interdisciplinary characteristic of renewable energy education, which can be supported with renewable energy practices, allows it to take place at various levels of kindergarten, primary, secondary, and higher education curricula to individuals from all age groups as lifelong learning.

One of the most important aims of science education is to educate individuals who are sensitive to environmental issues, can adopt the learnt topics to daily life problems, and have the ability to think and discuss. Therefore, the consequences of fossil fuel consumption, the definition of renewable energy, its

benefits for human beings, and how it could be utilized should be among the important subjects taught to students in order to create awareness in society.

The number of studies in education on this topic increased after the 1980s, in which research was conducted on what could be done in education, how this topic could be integrated into the curriculum, and which applications should be conducted at what age groups. Many books and reports were written on this issue and many projects conducted. Wenig (1981) prepared 25 lesson modules about renewable energy, the subjects of which were the social effects of renewable energy, utilization of alternative renewable energy resources, economic diversion of energy resources, reducing the energy consumption in houses etc. Mumma et al. (1966), Rowland (1980), Crelinsen (1983), Theiss (1982), Sarvis (1980) also conducted studies on the integration of renewable energy into the curriculum concerning the design of the activities and lessons. Newson (1997) organized a project in order to inform students about renewable energy. Nicholson (1996) united the renewable energy topic with technology in education and ran a project, in which students constructed websites about renewable energy.

As green chemistry steps forward as an alternative protector of global change and the environment, it has been defined as the designing, developing, and administering of chemical products and processes in order to reduce or discontinue the utilization and production of highly dangerous and toxic substances (Hjeresen et.al.., 2002; Kirchhoff, 2001). Reed and Hutchison (2000) developed experiments to be used in organic chemistry lab courses at Oregon University . In the study, it was aimed at to engage the students about adipic acid synthesis with the cyclohexen oxidation under environment-friendly conditions. This practice sets an example for the types of experiments that teach green lab techniques for green chemistry labs. While introducing the students to the benefits of an approach where green reagents, their reaction conditions and products are used, it was aimed to teach basic organic synthesis lab skills. There is a green chemistry class at Central Queensland University. The contents of the lesson are the definition of green chemistry, atom economy, chemistry tools, the principals of green chemistry, the resources of chemistry, its effects on the environment, types of reactions, safe chemical designing techniques, samples of green chemistry, biotechnology, solvent or without solvent alternatives and green chemistry Internet resources. Another green chemistry class is instructed at Monash University. It is taught in the first semester of the 3rd year and it involves the definition of green chemistry, green chemistry in history and its relationship with the modern chemical industry, the principles of green chemistry, life cycle in relation to chemical industry, green chemistry technologies, green products, chemicals, reactions, catalysis, and the aims of green chemistry (Tundo, 2002). A summer school program was organized in order to train a new European generation of researchers. The program supported friendship, cooperative research on practice webs, conferences, and several lessons, which were open to all disciplines. The conferences and classes were so important that the activities that are supported by this program are held throughout Europe nearly every day. The topics chosen for these summer schools were green reactants and atom energy, the protection of the atmosphere, industrial green catalysis, alternative reaction conditions, biocatalysts, and green chemistry (Tundo, 2001). Next to these studies, “Global Climate Change” is defined as the changes in global climate as a result of the greenhouse behavior of the gases collected in the athmosphere. The idea of the increasing temperature of the earth, in turn melting the glaciers, and making the oceans rise, makes people panic. For this reason, Global Climate Change Agreement, first signed in 1992 in Rio and signed in 2005 by 144 of 150 countries, and in 1997 Kyolo Protocol was effectuated by the United Nations. However, when the developments in the last 20 years were invesitigated, it was observed that countries in the world have significant economic and technological obstacles in opposition to greenhouse gases. When the latest data gathered in the last 45 years in the content of the United Nations Global Climate Change Agreement were investigated, it was observed that the ratio of CO_2 emmision is related to gross national product. For this reason, the studies in education about this subject increased after the 1980s, in which the things that can be done in education, involving these subjects in curriculum are investigated. Some projects were conducted, books, articles, and reports were written on this subject. The research unit of Ohio State University (1993) investigated the changes in the inside layers of earth. The reasons that cause these changes are: (1) more usage of technology in order to improve living standards (2)

increasing usage of fosil fuels and (3) an increasing human population. Some global change activity titles: -greenhouse effect, -global warming, - ozone depletion, -decreasing water sources, - climate modelling, volcanic explosions, and special data for global climate change. Pat et al. (1992) conducted research on measuring the carbon dioxide amounts in water in different temperatures.

The Internet-assisted education technique is a newly developed technique that has been widely used in recent years (Patterson, 2000; Donovan and Nakleh, 2001; Murov, 2001; Boschman, 2003). This educational technique has significant advantages when compared to traditional teaching methods (Treadway, 1996; Whisnant, 2000; Chasteen, 2001). With the Internet, in contrast to some fixed tools such as course textbooks, multimedia contents can reach larger audiences (Olsen, 2000). In a study conducted by Çarpi (2001), a web site was designed, in which scientific concepts for science lessons in higher education combined with links related to courses. In order to introduce innovation in curriculum, Daniel and Saat (2001) developed an approach from Internet sources. In this approach, students reach solutions of given problems by using the computer and intensify their knowledge by performing exercises (Pfeifer, Lutz, & Bader, 2002). Computer-assisted applications have been developed in the subject area of environmental education. The source which was prepared by the North American Association for Environmental Education (NAAEE) and was entitled "Computer-aided Environmental Education", involves the problems and promises of environmental hypermedia, computer simulation/modeling interactive software (Rohwedder, 1990). In other studies by the same author, the usage of multimedia and online education in environmental education will be very useful (Rohwedder, 1999; Rohwedder & Alm, 1995). The factors affecting students' environmental knowledge, attitude, awareness and behaviors are investigated beginning in kindergarten at all levels of education by scientists. According to the results, educational models and curriculum suggestions are prepared. As an example we can cite the studies of Gillespie and deHaals (1979) and deHaals and Gillespie (1979) and deHaals and Gillespie (1979) that relate to planning environmental change and measuring environmental awareness. Palmer (1995) studied the effect of early childhood experiences, family and education on environmental conception and behaviors. Howe and Disigner (1988) investigated the variables in improving the responsible environmental behaviors. Musser and Diamond (1999), in their study on the environmental awareness of kindergarten students, examined the factors affecting the improvement of environmental knowledge and awareness. They found that the behaviors of the students were not related to the private applications that the parents actualize at home.

Ballantyne (1998) examined the improvement of the students' environmental knowledge through interactive study recordings. Musser and Malkus (1994) developed a scale to assess the attitudes of school children towards the environment. Ballantyne (1996) designed an environmental concept improvement model in co-operation with environmental knowledge, attitude and behaviors. Ballantyne et al. (2001) developed environmental education programs focusing on the students' knowledge and attitudes related to the environment and their environmental activities. Similarly, Thomas (1989-1990) and Hites (2001) discussed the context of environmental education curriculum, educational techniques, educational tools and how to improve student motivation. Wenzel and Austin (2001) evaluated an introductory chemistry course that had an environmental awareness prior to 2001 in the field of environmental chemistry in the undergraduate laboratory. They suggested that the students needed to address sensitive issues more carefully. Randall (1997) recommends that environmental education should be supported with activities that could be done within the natural environment. Lee (1974), Davis (1974), Chrotowski (1985) and Stearns (1988) prepared sample lesson plans on various suggestions and applications of environmental chemistry in high school curriculum. Carlson (1993) describes a three-week intensive course in a general chemistry class, which consisted of two distinct phases: a oneweek introduction to environmental chemistry and a two-week project involving a particular environmental program. In his research related to science, technology and society, Zoller emphasized the global environmental issues and importance of environmental chemistry in this context (Zoller, 2000, 2001; Tal, Dori, Keiny, & Zoller, 2001). Byerly et.al. stated that young children understand intuitavely the need to do those simple things that will make he earth a beter place to live and play. And they suggested some web sites on the environment that can be used with ad/or by childern. The main aims of the above-mentioned studies were to inform people about the environment and to create awareness in them about

the environment that they live in. This clearly demonstrates the importance of the environmental awareness (Klemmer, Hütter-Klemmer, & Howard, 1996). It is very important to assess the knowledge of individuals on the environment, ecology, or pollution and their attitudes towards these issues during or after periods of education (Maloney, Wand, & Braucht, 1975). The environmental concept that the individual attains is the most important factor that explains their attitudes towards the environment and environmental protection (Weigel & Weigel, 1978; Kuhlemeier & Bergh,1999; Banerjee, 2001). Morgil et.al. (2004) investigated the effect of computer-assisted education on students' knowledge and awareness about environment.And in the same study they prepared educational modules for preservation of global environment (http://old.stockholmchallenge.se/projectdata.asp?id=1&projectid=371).

AIM OF THE STUDY

The aim of this study is to acknowledge and create awareness about the ***"Preservation of the ecosystem"***, which has been highly emphasized in recent years with its increasing importance as a common issue for all countries and societies. For the process, university students, who would soon become chemistry teachers, were chosen as the sample. This was to show how its effect would be widespread in the following years. On the other hand, the utilization of ICT (Information and Communication Technology) appears to be the most important factor in creating awareness and instilling knowledge in individuals, which could be widely used by university students throughout their education.

Educational modules, which were prepared in order to clarify the secondary effects of ICT- supported educational modules, were served for the usage of undergraduate students attending a second branch. The effects of ICT supported educational modules on students' (attending to Hacettepe University, Department of Economics) knowledge and awareness related to the preservation of the existing ecosystem were invesitigated (see fig.1)

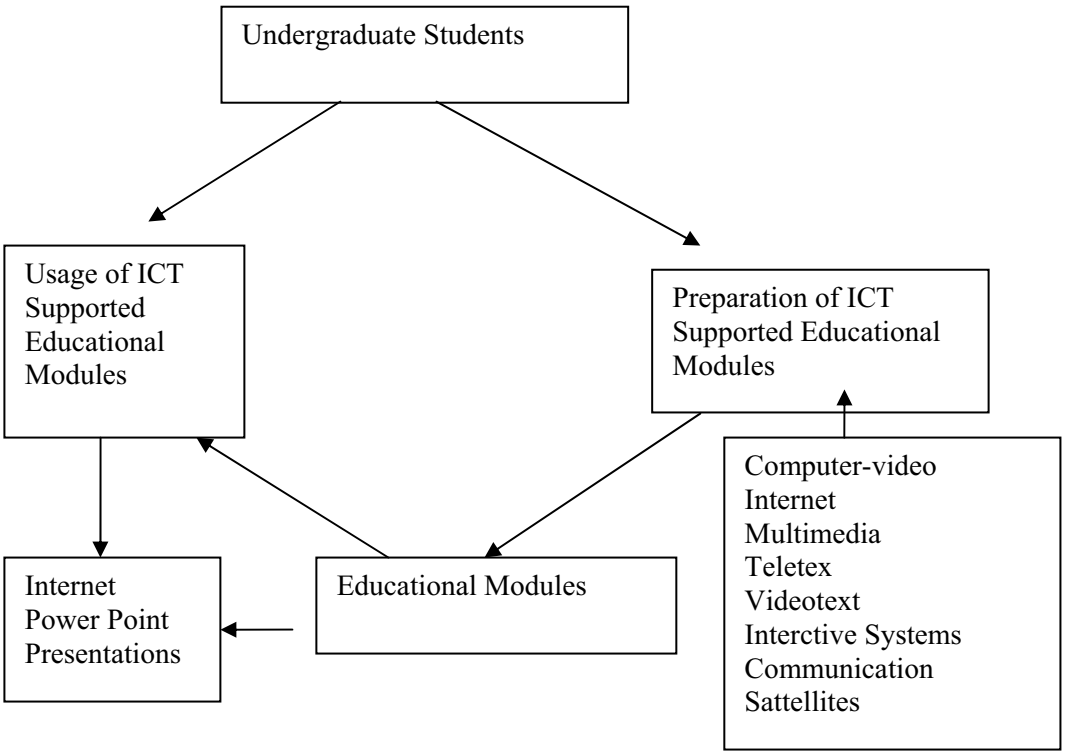

Figure 1. Usage of ICT supported educational modules

"**P*reservation of the Ecosystem Education Module"***, which was prepared by the students of Hacettepe University, Faculty of Education, Department of Chemistry Education within the study. After it had

been further developed, it was put into use on the web at www.kimyaegitimi.com and www.kimegi.hacettepe.edu.tr-belonging to Department of Chemistry Education and the researchers- for individuals with Internet access. Therefore, the "**P*reservation of the Ecosystem Education Module"***, which involves the required educational tools and materials in order to build knowledge and experience on renewable energy, was prepared in such a way to make maximum use of the ICT. The university students were trained about renewable energy by using ICT-assisted "**P*reservation of the Ecosystem Education Module"***.

Additionally, the changes in the knowledge and awareness levels of university students, who prepared the ICT-assisted "**P*reservation of the Ecosystem Education Module"***, were studied. The study presented here is complex research that assessed the knowledge and awareness of university students in renewable energy over the pre and posttest pattern of the education module. Students made use of the globalizing information communication websites during the studies together with the active learning models such as problem or project-based learning models.

EXPERIMENTAL DETAILS

The subject

The subject of the study comprised:

a) 33 students attending their 4th class in the 2006-2007 spring semster at Hacettepe University, Faculty of Education, Department of Chemistry Education. These students formed 11 groups of 3 and developed the modules.
b) Also 33 volunteer students attending the 2006-2007 spring semster at Hacettepe University, Faculty of Economics, Department of Economics realized the second part of the ICT supported applications.

MEASUREMENT TOOLS

As data collection tools these two measurement tools were used.

Preservation of Ecosystem Knowledge Test *(PEKT):*

Preservation of Ecosystem Knowledge Test consists of 25 open ended questions. The questions were chosen from global environment, fossil fuels, renewable energy, and green chemistry subjects.

Preservation of Ecosystem Awareness Scale (PEAT):

Preservation of Ecosystem Awareness scale is a 5 point Likert-type scale and consists of 39 items. 20 of these items were positive and 19 were prepared as negative.

Applications Related with ICT Supported Preservation of Existing Ecosystem:

33 students form Hacettepe University, Faculty of Education; Department of Chemistry Education, who would soon become teachers of chemistry, participated in the ICT-assisted "***Preservation of Ecosystem Education Module"*** development study. These students worked in 11 teams. They were firstly administered the ***"Preservation of the ecosystem knowledge test"*** of 25 open-ended questions, which was developed by the researchers together with the ***"Preservation of the ecosystem awareness scale"*** consisting of 39 statements, which is a 5-point Likert-type scale. They were administered as pretests in the Internet class, in which the students of 11 teams were asked to choose target questions on the preservation of the ecosystem.

Table 1. The 11 questions chosen by the students

1. What are the fossil and renewable energy sources used today, how are they formed, how can they be used, what are their benefits and disadvantages?

2. Why are preservatives used in nutrients? Are all of them harmful? How can the harm be eliminated? What are the preservatives used in Turkey and under EU regulations?

3. What damage is caused by military bases and nuclear reactors? Are their more benefits than disadvantages?

4. What are pesticides? With which aim are they used? In what way do they damage the environment and how can they be eliminated?

5. What are the recycable and unrecycable wastes in our environment? What are the ecological effects of these wastes?

6. What harm comes from disposable batteries and medical waste? How can the harm be eliminated?

7. What does genetic reconstruction mean? What vegetal and chemical organisms have their genetical structures reshaped? How can positive and negative effects be categorized?

8. In what way does asbestos harm the environment and other living things? How can these effects be avoided?

9. What is toxicology and environmental toxicology? In what way do chemical pollutants harm human health?

10. What are the effects of deodorant, sprays, and cosmetics on the environment and human health? How can they be eliminated?

11. In our country, which chemicals are used as manure, agricultural medicine, and hormones? What harm do they cause? How can they be eliminated?

The required discussion for the determination of students' readiness for the target questions chosen was actualized together with the project group. Students had ICT applications related to their topics in the Internet class for a total of 8 hours in three weeks.

The ICT-assisted green chemistry education module is an original design that follows these steps:

- Formation of the teams into groups of three or four and the determination of the target questions,
- Determination of the students' readiness through the discussion method,
- Determination of the challenging concepts,
- Concept teaching and dealing with misconceptions,
- High order cognitive skills applications,
- Searching on the Internet for the target questions and elimination of the data collected,
- Submission of the search reports on the target question to the project team via the Internet,
- Oral discussion on the Internet search reports related to the target questions,
- The instruction of how to prepare electronic slides and presentations to be shown to the students,
- Preparation of the final products by the students,
- The actualization of the oral and electronic presentation on the target questions related to green chemistry.

The ICT-assisted study was finalized with the uploading of the presentations to the www.kimyaegitimi.com and www.kimegi.hacettepe.edu.tr websites, which belong to Hacettepe University, Faculty of Education, Department of Chemistry Education. In the second part of the study, 33 volunteer students attending Hacettepe University, Faculty of Economics, Department of Economics participated in the study. In the beginning, the importance of their full undivided attention was explained to the students. These students located the educational modules from the web sites: www.kimyaegitimi.com and www.kimegi.hacettepe.edu.tr and viewed information about the subject. The Preservation of Ecosystem Knowledge Test and Preservation of Ecosystem Awareness Scales were applied before and after the applications as pre and post-tests.

RESULTS

The preservice chemistry students increased their awareness levels when they had knowledge about the subject while preparing the ICT-supported preservation of ecosystem modules.
The paired-samples t-test analysis was conducted in order to determine whether there is a significant difference between the scores of 33 students in 11 teams in the preservation of ecosystem knowledge test before and after the ICT-assisted application as pre and posttest. The results are shown in Table 2.

Table 2. The paired sample t-test results related to the knowledge test scores of the participating students (Department of Chemistry Education) at the ICT-assisted education module.

PEKT	N	X	t	p
Pre test	33	73,24	8,81	0,000
Post test	33	84,91		

The analysis proved that there is a significant increase in the knowledge levels of students about the preservation of the ecosystem, at the end of ICT-assisted education module applications ($t_{(32)}$=-8,81, p<0,005). The average score of students in the preservation of the ecosystem knowledge test before the ICT-assisted application was X_{pre}= 73,24, whereas it increased to X_{post}= 84,91 after the application. This finding shows that ICT-assisted applications have an important effect on increasing students' knowledge levels in the preservation of the ecosystem.

Additionally, in order to determine any possible difference between the preservation of the ecosystem awareness scale scores of the participating students before and after the ICT-assisted application, the paired samples t-test analysis was administered. The results are shown in Table 3.

Table 3. The paired sample t-test results related to the awareness scale scores of the participating students (Department of Chemistry Education) at the ICT-assisted education module.

PEKT	N	X	t	p
Pre- test	32	77,91	11,59	0,000
Post test	32	90,42		

The analysis results displayed a significant increase in the awareness levels of students related to the preservation of the ecosystem at the end of the ICT-assisted education module. ($t_{(32)}$=-11,59, p<0,005). Before the ICT-assisted applications, the average scores of students in the preservation of the ecosystem awareness scale was X_{pre}= 77,91, whereas it increased to X_{post}= 90,42 after the ICT-assisted application. This finding shows that ICT-assisted applications have an important effect on increasing students' awareness levels related to the preservation of the ecosystem.

Parallel evaluations were conducted with 33 students from Hacettepe University, Department of Economics. Table 4 and Table 5 show the results of these students.

Table 4. The paired sample t-test results related to the knowledge test scores of the participating students (Department of Economics) at the ICT-assisted education module.

PEKT	N	X	t	p
Pre test	32	61,33	9,90	0,000
Post test	32	79,55		

The analysis proved that there is a significant increase in the knowledge levels of students about the preservation of the ecosystem, at the end of ICT-assisted education module applications ($t_{(32)}$=-9,90, p<0,005). The average score of students in the preservation of the ecosystem knowledge test before the ICT-assisted application was X_{pre}= 61,33, whereas it increased to X_{post}= 79,55 after the application. This finding shows that ICT-assisted applications have an important effect on increasing students' knowledge levels in the preservation of the ecosystem.

Additionally, in order to determine any possible difference between the preservation of the ecosystem awareness scale scores of the participating students before and after the ICT-assisted application, the paired samples t-test analysis was administered. The results are shown in Table 5.

Table 5. The paired sample t-test results related to the awareness scale scores of the participating students (Department of Economics) at the ICT-assisted education module

PEAT	N	X	t	p
Pre test	32	60,45	18,55	0,000
Post test	32	86,24		

The analysis results displayed a significant increase in the awareness levels of students related to the preservation of the ecosystem at the end of the ICT-assisted education module. ($t_{(32)}$=-18,55, p<0,005). Before the ICT-assisted applications, the average scores of students in the preservation of the ecosystem awareness scale was X_{pre}= 60,45, whereas it increased to X_{post}= 86,24 after the ICT-assisted application. This finding shows that ICT-assisted applications have an important effect on increasing students' awareness levels related to preservation of the ecosystem.

CONCLUSION

In the prepared modules, more importance was placed on the daily life problems and visualization. The opportunity of being active and dynamic in learning environments was provided to the students. In other words, the opportunity for meaningful learning was provided to the students using Internet and computer technology. The results are consistent with the studies of Comeaux and Huber (2001) and Marks et.al. (2002).

In the evaluation of the results, the sentences that awareness increase about preservation of existing ecosystem are observed are given below:

- Spreading environmental awareness formed in Chemistry lessons in global level is very important.
- I blieve that Chemistry Lessons will contribute to forming a clean environment.
- Solutions to the environmental problems in global level can be found with the studies conducted with environmental institutions and chemistry educators.

There was an increase in preservation of ecosystem awareness and an increase in the preservation of ecosystem knowledge of the students. The students learned the instructional content and activities

related to the preservation of ecosystem during this application. Similar results were determined in the studies of Brooks, Lui, and Walter (1997).

All of these results showed that common effect is realized when ICT supported modules developed by chemistry educators are use by individuals in Social Sciences. By this way the given education is achieved.

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