



Self Directed Learning Process Of Pre-Service Chemistry Teachers Through Internet-Assisted Education On Renewable Energy

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ABSTRACT

This study aims to examine the effects of computer-assisted education on self-directed learning (SDL) process of pre-service teachers in teaching renewable energy and in increasing their level of knowledge. Student teachers were facilitated from computer-assisted teaching through acquiring information via the Internet. Students' basic knowledge on energy, energy sources, efficient and productive utilization of energy was found to be quite inadequate. Internet-assisted education application resulted in an important increase in the self-directed readiness levels of students together with the improvement in their self-learning abilities and abilities to determine their needs plan their learning and apply their learning plans. The evaluation results of the Renewable Energy knowledge test of 25 questions displayed a significant increase in students' level of knowledge at the end of the internet-assisted education. Moreover, a statistically significant improvement was observed in students' attitudes towards computer (SATC).

Keywords: Self-Directed Learning; Chemistry Education; Renewable Energy.

INTRODUCTION

In order for the individuals to provide qualified work in this century, they have to be well equipped in the understanding and utilization of technology, keeping up with change n in other skills such as; cooperating, problem solving, taking on responsibilities, using their knowledge as well as good communication skills, independent learning, thinking and social abilities (Doğan, 1997; Bates, 1997). The ability of processing and utilizing knowledge is one of the most important abilities which should be acquired by individuals today. With the help of the ability to utilize knowledge, the individual has to use every tool that would provide them with access to knowledge and its subsequent comprehension (Akkoyunlu, 1999).

Information technology has been playing an important role in education by way of the computers that are being used in the teaching environment as products of today's technology. Computers and information technology is becoming more effective throughout human life. In the world of knowledge as the greatest power, it is an inevitable obligation to utilize information technologies in order to access proper information in a

short time. Utilization of information technologies in education has taken the form of a tool to reach this aim. However, it can never fully take the place of a teacher in the classroom. Computers are products of technology, which can assist in increasing the quality of education and enriching the teaching methodologies under the supervision of a teacher. Within computer-assisted education (CAE), computers should be used as effective teaching and learning tools by the way of integration into education systems.

CAE involves the utilization of computers not as the aim but as the tool within the teacher-student-technology triangle. In CAE applications, student acts both as a problem identifier and as a method developer for problem solving. When student obtains knowledge through Information technology, they are more eager to question, investigate and analyze.

In a school environment, where modern computer technology is used, students not only attain knowledge quickly, but they also utilize it in a productive and powerful way. Although you have all the knowledge in the world stored in your library, in order to be a successful individual today, you should have distinguished features such as knowing how to acquire the most correct and up to date knowledge in the quickest way possible, evaluating acquired knowledge, recognizing the problems related to your field, developing problem solving techniques to overcome them, and considering the knowledge, expectations and demands of the other people living in your community.

Today teachers are required to equip students with required knowledge and capacity in order to lead them to become individuals, who can stand strong on their own feet and contribute to solving problems faced in their community. For achieving this, teachers adopt student-centered teaching approach, which supports their SDL and guides them in knowledge acquisition. Teachers required to prepare appropriate learning environments for SDL.

Tough's (1979) learning approach on SDL is also supported by distance-learning specialists. Knowles (1975) defines SDL as a process. In this process, the individual has the ability to decide if he/she is going to do the work by him/herself or ask for help when determining the learning needs, tools and work power, choosing the appropriate learning strategy and evaluating the learning outcomes. The important thing here is the determination of the use of SDL according to the characteristics of the topic. For some topics, a teacher or a trainer is necessary. In order to determine whether SDL would be appropriate, three group variables should be examined. The aforementioned three group variables are the characteristics of the teacher, student and topic. After these are determined, there is a search for answers up to what should be taught, how it is going to be taught and documented, in order to facilitate learning. It is in this way that students can be directed for providing their SDL.

One of the most important environments where SDL is provided is the computer-assisted learning environment. In a study by Yalçınalp (2003), students' using the Internet as an interaction and open-ended information-searching environment for learning was very productive, in which many researchers have also supported this suggestion. Researchers have found that students made use of this environment at different levels according to their individual differences. Therefore, investigation of the differences in the use of the Internet as an information searching and communication environment would provide the design of more efficient web-based classes and contribute to the new approaches in planning and development of the new curricula. Hill and Hannafin (1997) and later Hill, (1999) examined Open-ended Information search processes under three main titles: a) user characteristics, b) system features, c) characteristics of the information. The user, performing the efficient search and surfing within the system has the main role in utilizing and processing the acquired knowledge. The researchers have also emphasized that some

knowledge and abilities are required for problem solving and searching independently and users are usually inadequate in finding the search measures such as keywords.

The search engines on the Internet guide the user only in defining and reaching resources but they do not provide information about the appropriateness of these resources. Information resources such as the Web could play very important role in empowering the efficiency in learning environments. Students' producing new aims and questions by themselves would lead to a search for new information when they find the current ones inadequate in these environments (Moore, 1995). Land and Greene, (2000) stated that the importance of students' being used to utilizing knowledge is steadily increasing. This utilization involves problem-solving processes, definition of the needs, and determination of the resources, acquisition and organization of the related knowledge together with knowledge synthesis among various resources.

Hammond (1992) stated that in multiple environments, where there are many entrance and exit points, students had difficulty in searching through the knowledge and selecting the convenient information. Land (2000) mentioned that starting a search with too open-ended or narrow questions resulted in failure. Land and Greene (2000) highlighted the necessity of pre-investigation in order to be able to construct the effective question and research terminology. Salomon (1986) explained that new learners' determining their incomplete knowledge for further compensation would be beyond cognition. New learners generally have difficulties in independent learning.

Energy production and utilization, which are on the active world agenda, are directly related to teachers and students as important factor for all individuals and their future capacity. A common citizen's unwillingness to learn about energy problems could be considerable; however, it is unacceptable for a student or a student teacher to be unaware of and uninterested in such an important topic for the community. The energy problem is one of the many important issues that affect individuals, of which educators can further contribute to (Tanay, 2004). The energy requirements of today's population and industrialization capacity are in danger of not being met because of the limited energy resources of the world. Observing the rapidly growing space between the production and consumption of energy, seeing how the traditional energy production methods cause environmental pollution, and knowing that these energy resources may soon be depleted, it presents itself as necessary to search for alternative energy resources. Therefore, public energy policies focus on sustainable energy systems and RE resources. RE resources are defined as the "energy resources, which remain the same for the next day in the natural evolution of the world." It is here that there is the logic of producing energy from sustainable and RE resources, which exist in the evolution cycle of nature. Therefore, it is important for the public to comprehend the concept of "RE" and be aware of the studies on this topic. Building RE awareness in individuals has become an important obligation on the usage and characteristics of RE resources. Individuals should experience a process of awareness construction through education in appropriate age groups and contexts.

Recently, interdisciplinary research on RE as a concept (Rowland, 1980; Crelinsten, 1983; Theis, 1982; Sarvis, 1980; Energy Foundation, 1992; 1990), training and support at certain teaching levels as units (Crummet, 1996; Hehn and Newport, 1991; Backler, 1984; Brophy and Fryars, 1983; Wilson and Krasnow, 1983; Anderson and Botinelli, 1981; Nicholson, 1996; Resources of the future, 1985; Allen et al, 1981) and providing these processes in technology-assisted environments have been the main factors that have encouraged the construction and development of RE awareness. The aims of individuals and communities should be to encourage knowledge and sensitivity acquisition in all energy concepts and environmental problems, basic knowledge and experience attainment

in energy concepts and environmental problems, desire for contribution to environmental protection, rational and clean utilization of energy, recognition of environmental problems, gain abilities for the rational utilization of energy (Tanay, 2004; Syed, 2008; Evans, 2008; Alazraque-Cherni, 2008).

In order to achieve this aim, a life-long education should be planned with the help of individual or public efforts, energy and a healthy environment should be considered as a whole, which comprises technological and social features inevitable for human life and welfare, an interdisciplinary approach should be constructed and the value of national and international cooperation should be emphasized together with its necessity. The education system, where passive participation of students is widespread along with ready knowledge that leaves its mark on the new education system, where students participate actively in the lesson, examine the cause and effect relationships, find solutions to problems using learnt knowledge in new conditions within the changing process of globalization in the world. This education system involves different components of learning, which take place in the learning process in certain steps. These components include pondering, requiring, becoming motivated, questioning, suspecting, researching, attempting, applying and comprehending.

These components brought forth the concept of “self-learning readiness” within the process of learning, because; one of the most important tools that contribute to the development of RE awareness is self-learning readiness (Van Till et al., 1997; Colliver, 1999). Knowles (1975) defined self-learning readiness as the individuals’ ability to determine their own learning requirements and targets, find the required human and material resources, and evaluate the results of learning through the right learning strategies by themselves (Long, 1976). The basic principle within the process of students’ self-learning on RE is to provide self-development through taking on responsibilities. In order for a topic to be taught in technology-assisted environments, students should be individuals, who take on responsibilities and possess self-learning abilities. Determining that this requirement was a measurable ability, a readiness scale was created by Guglielmino (1977) with a level determination feature, which was administered toward various topics (Newsom, 1977; Torran and Mourad, 1978; Mourad, 1979; Beitler, 2000; Pachnowski and Jurczyk, 2000). Utilizing technology is very important in the determination of the contribution of self-learning readiness to the awareness construction process, declaration of other factors that possibly affect the development of RE awareness and coming to conclusions..

In this study,

- The contributions of computer-assisted education to the pre-service teachers’ SDL process in teaching RE and
- Increasing the level of knowledge on the same topic was investigated.
- Pre-service teachers made use of computer-assisted teaching through knowledge acquisition on the Internet.
- At the same time, SATC and
- The possible effects of SDL on student achievement were examined within the study.

There is special importance placed on choosing RE as the topic in this study in the field of chemistry education. The term “green chemistry” in general chemistry has gained special importance in recent years. The reason being that is the notion of protection of the environment and society as an important factor for human life. Within this, The the proper and effective utilization of energy resources is the most considered factor in environment education. The attention to the topic has also increased because fossil fuels are not only polluting the atmosphere (CO₂ emission) but also being depleted. The world is in a rapid

process of globalization. The borders between the fields of science are also disappearing rapidly. In other words, it has become difficult to say that a topic belongs solely to chemistry, physics, biology, or in short, to scientists or social scientists. Many topics have now become interdisciplinary. RE might look like a topic that belongs to chemistry or environmental chemistry; however it is an interdisciplinary topic that is related to many other fields. Thus, the studies in this field will become contributions to various disciplines. Moreover, with interviews and surveys, chemistry pre-service teachers were determined to have a serious lack of knowledge in such an active subject, and therefore these studies were conducted in order to address the lacking knowledge and to provide changes in the SDL abilities of the students with the help of the method.

METHODOLOGY

a) The sampling

47 volunteer pre-service teachers, which could speak English and German well, and had an Internet connection at home, took part in the study. The sampling consisted of 23 females and 24 males. The student number was limited because the field studies require deep and detailed definitions and investigations. Students were examined in detail. Students were chosen among the ones who had taken the field's courses already and had academic averages of over 2.5 (maximum average was 4.0).

Students were observed to have at least elementary knowledge and skills in using the Internet during the interviews. Students studied "RE" as a Web-based course and did their homework by collecting data on the Internet together with preparing reports and projects. The academic staff trained the students that had difficulty in using the Internet with preliminary courses.

Internal validity was provided through using more than one observer (4 research assistants and 3 academic staff) and more than one data collection instruments (observation, interview, document analysis, pre-posttest evaluation). The data collected were discussed with specialists of education at all of the steps involved and the comments of these specialists were taken into consideration. Using several data collection and analysis methods in the study provided reliability, besides providing the inner validity. Moreover, there was a academic success test of 25 statements, which aimed to assess the changes in the behaviors of students about RE quantitatively before and after the application. The individual progressions were also determined through this method.

b) Data Collection and Assessment Tools

1. In order to assess the student teachers' attitudes towards computers before and after the Internet-assisted study, Selvyn's (1997) scale of attitudes towards chemistry was administered. The scale comprises 21 attitude statements with a reliability of 0.93.
2. Students were firstly asked to answer the 25 questions in the RE knowledge scale (App: 1), which was developed by the researcher. The aim was to seek the answers to the question of "what was going to be learnt within students' SDL process (Beitler, 1999). The feedback provided from the students led to the determination of the incomplete knowledge and the contents of the teaching process.

Beitler's (1999) question of "how is it going to be learnt?" would be addressed through various homework, reports and projects under the supervision of academic staff. Students would be alone in researching in their homework, report or projects; however, they would be able to ask their peers or tutors if required. Therefore, co-operation could be provided.

Another question by Beitler (1999) on “how the learning would be documented and evaluated” would be determined through posttest administration of the RE knowledge test. Through the evaluation of reports, homework and projects at different steps, the incomplete knowledge would be able to be completed at the next step.

1. At the second level of the study, students would be administered the SDLRS by Guglielmino (1977) before the application, in order to determine their SDL readiness levels. After the Internet-assisted knowledge acquisition application, the same scale would be administered as the posttest to determine the direction of the changes in their SDL levels together with the changes in their behaviors.
2. Students searched for the RE subject on the Internet. The interviews were conducted right after the Internet searching process was completed. Students were also observed according to their different aspects while they were performing their searches on the Internet. Some criteria such as how they used the system, possible difficulties in finding keywords, how they evaluated the data, which research strategies were used, were observed by the academic staff.

FINDINGS

a) Data relating to application studies of information test on RE

A survey has been conducted with the students who have never been informed on RE in curriculum subjects during their education. Aiming to determine their level of knowledge and shortcomings on “RE” this survey consisted of 25 open-ended questions concerning the subject before application. The advance of students’ information was limited to the information that they have learnt from printed and visual media. At the end of the survey it was determined that less than 50% of 47 students were able to answer the questions particularly numbered 1, 2, 3, 4, 5, 6, 10, 11, 13, 16, 19 and 20 correctly. Those determinations have helped us in our decision on which point we would start internet assisted instruction activities. In other words, an answer has been found to the question of Beitler (1999) saying “what to be learnt” through this preliminary-analysis. Questions in which students answered successfully fewer than 50% are as follows:

1. What is RE?
2. How many types of energy do you know?
3. What are the RE sources?
4. What are the advantages and disadvantages of RE?
5. Do we need RE?
6. If your answer is yes, can you write the reasons of the need?
10. What is sustainable energy?
11. Sustainable energy or RE? Explain the differences
13. What causes global warming?
16. Can use of RE sources prevent climate change? How?
19. Do you think that RE will have difficulties in production? Why?
20. Can you define bio-fuel, biomass?

It can be seen that all questions are theoretical questions about “RE”. Students do not know energy types completely, majority of them think that fossil fuels are the only energy source, which means that students have limited awareness about RE sources. Student who do not know about RE also were not able to explain it and therefore were not aware of RE resources as well. It can be understood that information shortcomings at the beginning continue in chaining is seen.

In the 4th question in which advantages and disadvantages of RE is asked, students think that RE may be advantageous but they explain this as an advantage that may be associated with only environment. Another striking point is that only approximately 50%

of the students give the answer that RE is needed to the question 5, in which it was asked whether RE is needed or not. It may not be possible to consider this answer has been given consciously as students were not aware of the fundamental concepts about RE.

It is not beyond being dreamy to expect students who are not aware of whether RE resources are needed or not to answer the question that “if it is needed, please specify the reasons” in 6th question. When the other questions are studied as well, the answers given to the survey of 25 questions concerning RE issue directly or indirectly are not in a very satisfactory way. Being new in our training programs “RE” issue is still not in the place that it deserves. Because this shortcoming was realized, individuals expected to be chemistry teachers have been informed by using internet aided information method. By this way either technological opportunities have utilized or student centered training and education atmosphere has been created or visual materials on internet have been used.

With the help of the questionnaire of 25 questions an answer has been found to the question “what we will teach”. Following fundamental questions have been set out when internet aided teaching of the subject started. Brain storming has been provided on students by helps of these questions.

- What is RE?
- Why RE?
- What is the need revealing it?
- What are the RE resources?
- Are RE resources endless?
- Aren't they harmful to the environment?
- Are they cheaper?
- Are they obtained easily?

These examination items determined with the students, have been our road map in our internet aided information studies. When sampling features were stated, students were encouraged to use English and German in which selected students are fluent and they were recommended that using these languages will increase their extensive search opportunity on the internet but students mostly preferred to start from resources in Turkish. However, they preferred to follow foreign sites in order to check either if foreign resources support their concerns or not or if is there any other information to learn on this subject as long as researches developed.

• First of all, key words have been determined with students (in Turkish, English and German). The first key words chosen are "energy" and “RE”. Internet addresses visited by students are given below.

1. <http://www.eie.gov.tr/turkce/gunes/gunes.html>
2. <http://www.bugday.org/article.php?ID=79>
3. <http://www.enerji.gov.tr/yenilenebilirenerji.htm>
4. <http://www.tubitak.gov.tr/btpd/btspd/platform/enerji/bolum6.html>
5. <http://www.angelfire.com/scifi/nuclear220/sec555.htm>
6. <http://www.meteor.gov.tr/2005/arastirma/yenienerji/yenilenebilir.pdf>
7. http://www.pbli.org/pbl/generic_pbl.htm
8. [\(29.03.2004\)](http://www.bugday.org/article.php?ID=79)
9. [National RE Laboratory \(NREL\) Home Page](#)
10. [NREL: Lost & Found](#)
11. [EERE: Bookmark Update](#)
12. [REPP: HOME](#)
13. [The Source for RE](#)
14. [NABU | Energie | Windkraft | NABU-Tagung Naturschutz kontra ...](#)
15. [NABU | Umweltschutz | Energie](#)
16. [Wissenskatalog Energie - Informationen zu Solarenergie ...](#)

b) What students have learnt from these resources?

- They have learnt the damages of fossil fuels to the nature and health of livings,
- They have realized that alternatives to fossil fuels should be sought is must,
- They have learnt that as long as the resources which were formed in thousands of years such as coal, natural gas, petroleum are used up in the name of "improvement of mankind", air, water and earth come to an end with wastes of them,
 - Negativities resulted from coal, petroleum and natural gas called as fossil fuels are not only limited with close environment but also they have influence on atmosphere,
 - This pollution at last started leading climate changes and threatening world life,
 - Negativities resulted from the fossil fuels with respect to environment and human health, are increasing with each passing day. They have accomplished documenting them not only as information but also with remarkable photographs on internet.

Thus, in the questions numbered 5, 6, 8, 9, 13, 14, 15, 16, 17 and 22 it has been provided that shortcomings of students have been made up and they have been informed. Again, with help of internet resources mentioned above, a definition has been made concerning RE. Definition of RE has been made:

- RE is an “energy resource that may exactly exist on the next day within the self evolution of the nature”.

Today used widespread the fossil fuels are energy resources which run out when they used and which are not renewed. However, natural resources such as hydroelectric, solar energy, wind energy, biomass energy, RE originated from sea, hydrogen energy and geothermal energy are renewable and they are also clean energy resources. With the help of this information, it has been tried to be realized that the students to complete their shortages in 1st and 3rd questions. Further, students have been provided to realize that each RE resource is not a miracle and they have advantages and disadvantages as well. For example; All types of energy cause damage on air, water and living creatures and environment by their wastes which are difficult to annihilate in all stages from their obtaining to their distribution to the end user. Hydraulic energy leads dams to be built on the rivers and dams lead people who live near river to migrate to other places and river ecosystem to collapses after a while. Wind and solar energy plants mean that habitats to be influenced and natural landscape to be deteriorated. Farms to be used to breed plants that are used to supply biomass energy cause natural areas to become agricultural areas. Since fossil fuels have replaced with nuclear energy, this brings up either concern on nuclear accident or concern on radioactive wastes that may not be stored safely. Attentions have been drawn to the advantages and disadvantages of RE. Another subject in which students had lack of information because they didn't know enough was sustainable energy and its difference. Students have been encouraged to realize what sustainable energy is by benefiting from internet sources on this subject as well. Students have reached this information by themselves. Researches that have been conducted on natural energy resources which are alternatives to fossil and nuclear fuels have brought sustainable and RE resources up as well. It wasn't enough that only the resources to be sustainable in order sustainability of life. Resources must be sustainable so as to ecologic balance. Continuity of something did not mean that it was sustainable. Sustainability was only possible if it was renewable with respect to all. For this reason, energy systems must be sustainable and energy resources must be renewable. In this way, it was provided that shortcomings which were seen on questionnaire questions that were asked in this subject to be completed. Thus, information study that was conducted in order to remove shortcomings on many fundamental issues have tried to be applied within these two weeks. Students have tried to find an answer to the second question by reaching below mentioned information.

Energy is discussed in two separate categories:

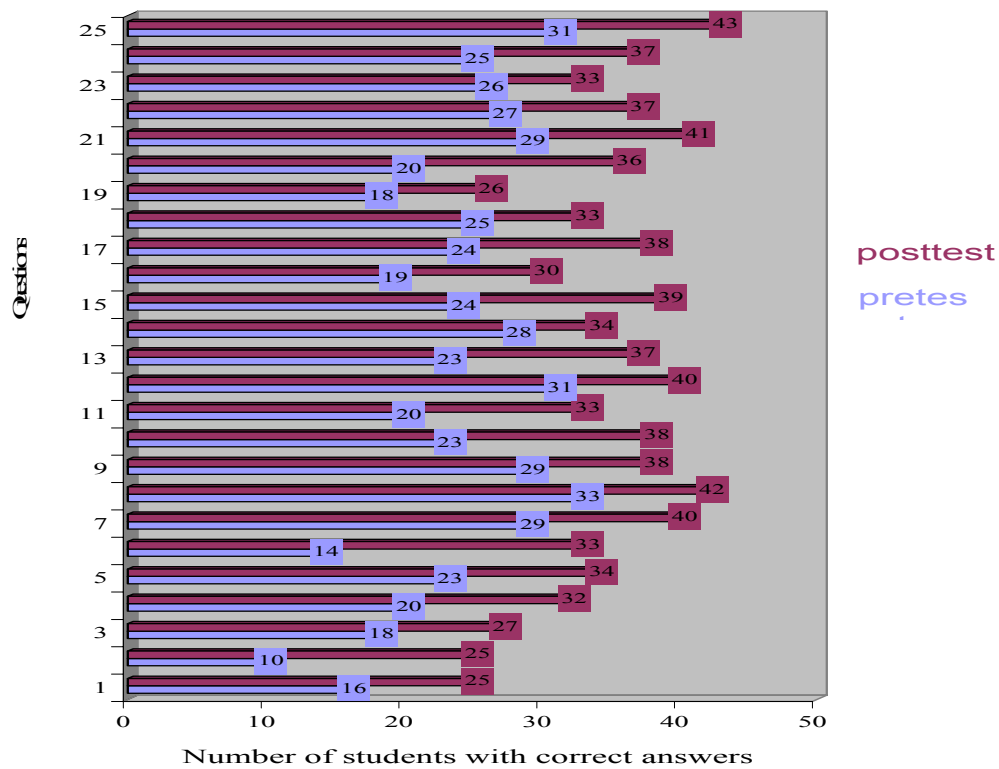
1. Primary energy resources

- a) UnRE resources: fossil fuels such as coal, petroleum, natural gas and nuclear energy.
- b) RE resources: water, geothermal energy, biomass, wind and solar energies.

2. Derived energy resources

c) Findings related to the application of the RE knowledge test

At the end of the Internet-assisted instruction, whether statistically significant increase was occurred or not in the knowledge levels of students determined, according to the analysis of the RE knowledge test of 25 questions. Students' average achievement scores increased from 12.78 to 18.55 ($t_{(46)}= 11.961, p<0.05$). Although these values do not seem to be very high, considering RE as a new and difficult topic, which has just newly been noticed by students and does not take much place much in media or educational settings, they are neither very surprising nor to be underestimated. The achievement average used to be 51.12% before the application, but it rose to 74.2% at the end of the application. Such an increase (of 23.08%) in students' knowledge in such a short term is quite pleasing. If all of the questions of the survey were answered correctly, the score would be 25. Therefore, the score 18.25 indicates a good level of achievement and more importantly, the increase in the achievement rate is promising for future applications. The results of the survey should be examined question by question.



Graph 1. The Score Distribution Of Students' Correct Answers To The Pre- And Post-Tests.

Graph 1 displays significant increases favoring the post-test in some questions. The questions, in which these increases took place, were statistically tested and the discussions focused on these questions. The Paired-Sample t-test results showed the significant increase favoring the post-tests in all 25 questions. This is an important indicator that the study served to its aim.

d) Findings Related To Attitudes Towards Computers

The analysis of pre test and post test applications of “The Attitudes Towards Computers Scale” which consisted of 21 questions prior and after the study, displayed that a significant increase in the SATC as a result of the Internet-assisted instruction. The results of the Internet-assisted application revealed an increase in the average attitude scores of students from 58.87 to 77.78 ($t_{(46)} = 8.328, p < 0.05$). The percent of attitude score, which used to be 56.06% before the application, rose to 74.08% at the end of two weeks, which is a rather pleasing outcome (18.02%) in such a short period. The maximum score of the scale was 105 and the minimum was 21. Although the 74.08% average indicated an attitude at a considerably good level, the increase in the attitude is promising for future applications.

e) Findings Related To The Administration Of The Readiness Test

Guglielmino’s (1977) study focuses on the assessment of self-learning readiness. Guglielmino,(1977) developed and tested the scale of self-learning readiness (5-point Likert-type); the self-learning readiness scale was later improved and reached its final version of 58 statements. It is the most commonly used scale in the assessment of self-learning readiness. The scores of the scale are classified as:

Low	58-176
Below average	177-201
Average	202-226
Above average	227-251
High	252-290

- The individuals with self-learning readiness scores of low or below average generally come from the ill structured learning environments such as from traditional classroom environments.

- The ones with average self-learning readiness scores, despite their tendency towards achieving in more independent conditions, did not have much self-confidence in controlling the whole process of planning their own learning or applying their own learning plans.

- Those with high and above average self learning-readiness scores usually prefer to determine their own learning needs, plan their own learning and apply their learning plans themselves. However, this does not mean that individuals with high or above average self-learning readiness levels never prefer structured learning conditions. As a part of their own learning plans, they may join to the traditional courses or workshops.

Previous literature on this shows that the individuals with improved self-learning abilities had a tendency towards achieving more in assignments, which require problem solving, creativity and change. The classification of the self-learning readiness survey scores is shown below (Brockett and Hiemstra, 1991; Delahaye and Smith 1995; Guglielmino, 1997).

Table 1 displays the distribution of pre- and post-test scores of students’ self-learning readiness within the study.

Table 1. *The Distribution Of Pre- And Post-Test Scores Of Students’ Self-Learning Readiness*

Self-learning Readiness Scale Scores	Number of students in the pre-test	Number of students in the post-test
Low 58-176	–	–
Below average 177-201	2	–
Average 202-226	20	5
Above average 227-251	19	16
High 252-290	6	26

The pretest results in Table 1 illustrate that an important part of the student teachers' received scores of average or below average (22 student teachers, 46.80% of the whole sampling). This shows that 46.80% of student teachers, despite their tendency towards achieving in more independent conditions, did not have much self-confidence in controlling the whole process of defining their learning needs, planning their own learning or applying their own learning before the Internet-assisted instruction. However, after the Internet-assisted application on RE, an important increase in students' self-learning scores was observed, which also indicated an increase in their abilities of determining their own learning needs, planning their learning and applying their learning plans. This is a very important result because Internet-assisted applications significantly contributed to the pre-service teachers' capacity of performing something individually. This is also supported by the t-test results for the statistical evaluation of the situation ($t(46)=11.249$, $p<0.05$).

Self-learning readiness scale consists of 58 Likert-type questions. In order to add a more qualitative meaning to the study, each question was examined in detail and questions with significant differences were determined. According to the dependent variable t-test for the pre- and post-test results of each question, only the increase in the answers to the 11th question was not statistically significant. However, the pre-test score of this question was 250, and its post-test score was 255, which were previously already at the high level of classification of the self-learning readiness scale.

These analysis have shown that an Internet-assisted data collection study on RE as an interdisciplinary topic, made an important contribution to the individual's self-learning abilities. The score average of students on the self-learning readiness scale, before the application was below 227, which increased to 252 after the application. This result displays that the individuals who did not have much self-confidence in controlling the whole process of planning their own learning or applying their own learning plan; significantly gained the abilities of determining their own learning needs, planning their own learning and applying their own learning plans.

DISCUSSION AND SUGGESTIONS

The inadequacy of educational programs, teacher training and resources are brought to the forefront among the reasons for not being at the desired level in environment and energy education. In this study, which was initiated by the awareness of this inadequacy, the pre-service teachers were seen to be rather inadequate especially in the acquisition of knowledge and skills about RE. Pre-service teachers, besides not having recognized basic concepts related to ecology and energy, do not have the required awareness.

The pre-test results of the study revealed that, 34.0 % of pre-service teachers could define RE correctly, only 2.1 % was aware of the current energy resources of the world, 38.3 % knew what RE resources were, and 42.6 % had understood the meaning and importance of RE. The 8th question, which asked whether the currently utilized energy resources could be continued to be utilized, was correctly answered by 70 % of the students. However, it is obvious that the energy needs could not be met with the current resources. Although 70% does not look like a small amount at first, when it is considered that the study was applied on pre-service teachers, the remaining 30% should not be underestimated. Again, 32.85% of pre-service teachers knew what sustainable energy was, whereas the other 67.15% had no idea about it. These numbers display a rather striking result. It can be said that students' knowledge about energy, energy resources, the effective and productive utilization of energy, which are the most common issues of today, are quite inadequate. Pre-service teachers did not know what RE was and did not have the necessary information about types of energy.

The question, which asked if they thought energy resources would be used one day (21st question) was correctly answered by 61.70%, whereas the rest 38.30% either gave incorrect answers or had no idea about the issue. The students, who did not know about these, naturally did not know about the difference between fossil fuels and the resources that renew themselves within the natural evolution cycle. This was asked as the 22nd question and was answered correctly by 57.44% of the students. Another striking result is the inadequacy of student teachers in the usefulness of RE resources for environmental protection. The Internet-assisted applications, through providing SDL in the Internet environment, led to a decrease in inadequacy about the issue. The attitudes of students towards computers and their self-learning readiness were found to be significant indicators of student achievement in Internet-assisted education.

Table 2 displays the regression analysis results of the factors affecting student achievement in RE.

Table 2. *The regression analysis results of the factors affecting student achievement in RE*

Variable	B	Std. Error	β	t	p
(Constant)	14,665	5,148		2,849	,007
RDNTPOST	4,140E-02	,028	,352	1,490	,143
COMPATTPOST	-7,654E-02	,031	-,587	-2,489	,017

R= 0,369 R²= 0,136 F= 3,475 p= 0,04

Through the analysis results, it was observed that attitudes towards computers were significant indicators of achievement in RE together with SDL readiness [R= 0,369 R²= 0,136, F= 3,475]. According to Table 2, 13.60% of the total variance of achievement was explained by these two factors. The regression equality related to the commentary of achievement according to regression analysis results is given below.

$$\text{Achievement} = 14,665 - 7,654E-02 \text{ Attitudes towards computers} + 4,140E-02 \text{ SDL readiness}$$

The results of the study showed that the Internet-assisted and SDL applications on RE were summarily effective on achievement.

When Table 2 is examined, it is seen that two factors were important in students' acquired knowledge on RE. Both SATC and their SDL readiness were explanatory factors for their achievement. Many studies have investigated the effects of computers on student achievement. The computer-assisted teaching method was found to be more effective than other methods in increasing the attention level in science courses (Geban and Demircioğlu, 1996). Although there have been many studies on students' SDL, such a study was not seen among them.

Today, the determination of SDL readiness is used for two main aims. Firstly, it is used for the experimental, quasi-experimental or correlation research patterns in the determination of the relationship between SDL and other individual characteristics. Secondly, it is used as a diagnostic tool, which assesses students' perceptions related to SDL readiness. The first study after Guglielmino on adults' SDL readiness was conducted by Torrance and Mourad (1978), in which it was about the structural validity of the scale. The study, which was conducted on 41 students attending the creative thinking class, concluded with a positive correlation between SDL readiness and the three measurements of originality, using analogies in describing photographs, creative personality, creative achievement and correct learning style. Moreover, the writers determined a link between creativity in and tendency towards SDL. This result has similarities with our study.

Mourad (1979) examined the validity of the SDL readiness scale. In the study, the results of the SDL readiness scale were compared according to the assessments of creativity together with the relationship between the class level and age. The SDL readiness scale was administered on 684 disabled primary, secondary and high school students, as well as 185 students from Georgia University, Faculty of Education. Within the evaluation of the applications, the result of the SDL readiness scale was compared to those of the disabled students, which concluded with significant differences. Beitler (2000) proved in his study that individuals, whose SDL readiness abilities improved, experienced improvements also in their problem-solving skills, creativity and abilities to find new things. In this study, the improvement of students' SDL readiness provided an increase in their achievement. Pachnowski and Jurczyk (2000), in their study, assessed the SDL characteristics of students in Web-based classes of distance learning at Midwestern University.

The researchers used the 5-point Likert-type SDL Readiness Scale of 58 statements by Guglielmino. The scale was sent to all of the students via e-mail. The evaluations showed that SDL is an excellent indicator of achievement. A similar conclusion was arrived at in this study. In the study by Owen (1999), the SDL readiness and intellectual levels of 185 graduate students were related to creativity. At the end of the applications, the self-directed learners were also found to be creative. Wood (1996), in a study within the continuous education program, examined the effects of SDL readiness, together with sex and heritage on 181 adults.

In a similar study, Bonham (1991) investigated the relationship between SDL readiness and attitudes towards learning. Cheung (1999) administered the Chinese version of the SDL Readiness Scale to 820 adults and 219 young students; and the modified version to 163 secondary school students. The results of the evaluations showed that the average scores of students were higher than that of adults; the average scores of adults were not related to their gender but to their levels of education. As seen in the related literature, creating SDL environments for students had been investigated according to many variables, and each result had contributed to SDL literature. This study contributed to students' SDL skills through acknowledgement at the Internet environment. Moreover, it provided an increase in the level of knowledge in such an important issue as RE.

Considering computers as important educational and teaching tools, the results of this technology in RE have revealed a very important fact. The individuals, who would soon become chemistry teachers, are inadequately aware of RE, energy resources, their utilization and effects on the environment, which are primarily important for the world and ecology. In the light of these conclusions, it is suggested that environment and energy education should be involved within the education system with an "Extensive Model" approach; and that students should be acknowledged in Internet-assisted learning environments under the supervision of teachers on these and many similar issues of the agenda. The extensive model is used not to express the integration of a certain course with the principles related to environment or energy, but the preparation and presentation of all basic, applicatory, social and occupational course contents with energy and environmental awareness within the curriculum. According to the results of the study, this process could be reinforced with computer and Internet-assisted applications. However, during such an application, students' computational skills, attitudes towards computers and their SDL abilities should be determined just as was performed in the study. Here, the teacher training institutions and especially chemistry educators are primarily responsible.

For pre-service teachers, learning environments that could provide the construction and conceptual comprehension of basic concepts were related to ecology and energy. Environment and energy education should start from the family before school life and last

lifelong. Secondary education is the most important period in this process. Therefore, the training of educators also gains great importance. Environment and energy education should be an inseparable part of the pedagogical formation for educators. Students, who gain energy and environmental awareness during secondary education, no matter which discipline they choose, should be educated within programs involving education on energy and environment through the extensive model as in secondary education (Tanay, 2004).

This study on RE, which was conducted in the light of this awareness, would contribute to the sensibility of education faculties that train pre-service chemistry teachers for secondary schools. Equipping pre-service teachers with RE knowledge via technological environments such as the Internet would not only reap benefits for their future students but also have important contributions in improving SDL skills. It increased students' abilities of designing, analyzing and evaluating skills. These skills have great importance especially for the teachers to be. Since the topic was multidisciplinary, it contributed to the working skills of teams, which work on interdisciplinary studies. The awareness that continuous education is necessary was empowered through the topic being very active supported and related to not only today but also future years.

The achievement of the study was also provided by students' SDL readiness levels as well as their attitudes, perceptions and preferences (Yalçınalp, 2003); information resources and information searching strategies (Land and Green, 2000); and their searching styles (Draft and Weick, 1984). According to the observations of nine academic staff, students had no problems with their system information and they were also observed using search engines successfully. Their field information (Hill and Hannafin, 1997) was determined through the survey to be 52.08% before the study, which indicates that they had intermediate field information. This prevented students from performing any possible failure in data collection, choosing keywords, self-directing or selecting data on the Internet. After the application, important improvements were observed in students' achievement and attitudes. That was because the students used target-oriented information searching strategy, which enabled them to not use rough styles that involve unnecessary target determination and planning. These altogether, not only contributed to the improvement of students' SDL skills such as problem solving, searching on the Internet, but also assisted them in acquiring new information related to RE.

At the end of the study, 53.2 % of the students could define RE correctly, 85.1 % could compare and contrast the costs of renewable and other energy resources, 89.4 % could become aware of what currently used energy resources brought and took away from the environment, and 91.5 % had various information about how RE resources contributed to energy conservation. What could be the benefits of learning or teaching these? Since we are aware that current energy resources are limited; the demand for alternative energy resources has increased; teachers have a great responsibility regarding these issues and there are many things that could be done by them; we believe that such awareness could be diffused via teachers. That is because the study showed that through target-oriented self-directing, acquiring knowledge is as quick as a "click" today, and individuals could be acknowledged through their SDL abilities. Within the study, students were asked to express which topics in which they experienced the most change. These were listed as follows:

- Many of them said that they had hardly heard about RE before, but they were knowledgeable about it at the end of the study.
- They mentioned that they hesitated doing research on the Internet on such a topic. That was because they had the worry of finding the necessary concepts, doubts about selecting data, and fears related to language problems.

- They stated that it was fun to participate in such an application in the classrooms where a traditional teaching approach usually ruled, and that they had shared a lot with their peers.
- They indicated that they had understood how important the topic was, and there was really much to do and learn about.
- They emphasized that the increase in their achievement also increased their self-confidence.
- They declared that the Internet was a very important information resource when used and directed properly.

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Appendix 1: RE knowledge test

1. What is RE?
2. How many types of energy do you know?
3. What are the RE sources?
4. What are the advantages and disadvantages of RE?
5. Do we need RE?
6. If your answer is yes, can you write the reasons of the need?
7. What is the cost of RE, if you compare it with other types of energy production?
8. Can we continue using the energy types that we use today forever?
9. What are the important energy types for the environment?
10. What is sustainable energy?
11. Sustainable energy or RE? Explain the differences.
12. Do you think that there will be problems associated with using RE? If your answer is yes explain the problems.
13. What causes global warming?
14. What are results from global warming?
15. What are the reasons behind climate change?
16. Can use of RE sources prevent climate change? How?
17. Can you explain RE and its contributions to the environment?
18. Is sustainability of energy sources enough for the sustainability of life?
19. Do you think that RE will have difficulties in production? Why?
20. Can you define biofuel, biomass?
21. Do you think that RE sources will come to an end one day?
22. What are the differences between fossil fuels and RE sources?
23. What is the contribution of RE sources to environmental protection?
24. How can you define Turkey's position regarding RE sources?
25. Can RE sources contribute to saving energy?