TECHNOLOGY ENHANCED LEARNING AS A KEY COMPONENT OF INCREASED ENVIRONMENTAL AWARENESS AMONGST STUDENTS FROM THE UNIVERSITY OF BELGRADE

Veljko Jeremic, Sonja Isljamovic, and Natasa Petrovic
University of Belgrade
Serbia

Abstract

Environmental education fosters skills and habits that students can use throughout their lives to understand and act on environmental issues. The key aspect of this paper shall be focused on the measuring of effective environmental education through "blended learning" among students at the Faculty of Organizational Science, University of Belgrade. In this paper, the activities of students are compared over two academic years; the first without blended learning and the second with a blended learning platform. A closed form questionnaire for measuring individual ecological footprints has been used in this study to determine the students' environmental behaviour modification (through corresponding environmental actions). An analysis of the results has been carried out using the SPSS software package and the results have indicated that a statistically significant increase of environmental awareness had indeed occurred.

Introduction

Population growth and economic development have exerted a considerable impact on the Earth and the human race is coming face to face with a series of incompatibilities among natural resources, the environment and the global economy. These facts demand a new concept of development – one which is sustainable and that takes meeting the needs and desires of every individual of the Earth into account (United Nations, 1972). Significant changes must occur all over the world to ensure rational development — changes that will be directed towards an equitable distribution of the Earth's resources and which will more fairly meet the needs of all humans. This kind of development will also require a maximum reduction in harmful effects on the environment, the utilization of waste materials for productive purposes, and the design of technologies which will allow for such objectives to be achieved (UNESCO-UNDP, 1976).

The reform of educational processes and systems is crucial for the creation of new development ethics (United Nations, 1972). The goal of environmental education is to produce a population aware of the environment and concerned about

problems relating to this concept. Environmental education is based on the knowledge, skills, attitudes, motivations and commitments of individuals and collectives willing to work towards solutions of current problems and the prevention of new ones. This can be further defined as "learning to protect and improve the environment in a systematic, planned and knowledge-based way over the whole human lifecycle in order to spread awareness about basic characteristics of the environment, its structures and relationships that tends to make one protect and improve the environment in a way that will ensure human existence now, as well as in the future" (Petrović, 2010; Petrović & Milićević, 2006, 2007; UNESCO, 1998).

One key characteristic of environmental education is action, as it must promote human responsibility and, in doing so, encourage learners to use their knowledge, personal skills, and assessments of environmental issues. Due to this, the need for an adequate measurement of environmental education is necessary. Ecological footprinting, as an environmental indicator, is an excellent tool for measuring environmental education and actions. Ecological footprints are used to translate consumption and waste flow data into a measurement of the biologically productive area required to sustain this flow. In this study, ecological footprints have been used as an input feature that provides an effective heuristic and pedagogic tool to capture the current resource use of students attending the course of Environmental Management at the Faculty of Organizational Sciences, University of Belgrade, Serbia.

The Ecological Footprint

From this standpoint, the struggle for ecological services and goods will play the most important role in the 21st century. All human activities require the use of the same natural resource: biologically productive land. Nevertheless, this also includes land used for buildings and roads, food production, the production of energy and material resources, as well as land required for waste-disposal and the absorption of emissions. In the early 1990s, the ecological footprint concept was created by Mathis Wackernagel and William Rees at the University of British Columbia (Rees, 1992; Wackernagel & Rees, 1996; Wackernagel, White, & Morgan, 2006), and presently this concept has become established as an important environmental indicator.

Ecological footprinting tracks the area of biologically productive land and water required to provide the renewable resources people use and includes the space necessary for infrastructure and vegetation to absorb waste carbon dioxide (CO_2). An ecological footprint is a calculation framework that tracks humanity's competing demands on the biosphere by comparing human demand against the regenerative capacity of the planet Earth. As to determine whether human demand for renewable resources and CO_2 uptake can be maintained, an ecological footprint is compared to the regenerative capacity (or "bio-capacity") of the Earth.

Such capacity is the total regenerative capacity available to serve the demand represented by the footprint. Both the ecological footprint (which represents a demand for resources) and bio-capacity (which represents the availability of said resources) are expressed in units called global hectares (gha), where 1gha represents the productive capacity of 1ha of land at the world's average of productivity (Ewing et al., 2009). The collective impact of this land consumption determines the limits for the local function in the following (Aall & Norland, 2002; *Living Planet Report 2010*, 2010):

- biodiversity land
- bio-productive land (arable land, pasture land and forested land)
- bio-productive sea space
- built land
- energy land.

Ecological footprinting is a resource accounting tool that measures how much biologically productive land and sea is available on our planet and how much of this area is appropriated for human use (Haberl, 2001). It clarifies the relationship of resource use to equity by explicitly tying activities of the individual and group to ecological demands (Wackernagel et al., 2006). Ecological footprint analysis attempts to measure human demand on nature. It compares the human consumption of natural resources with the Earth's ecological capacity to regenerate them.

In the future, ecological footprints shall be able to be used in the process of identifying and planning strategies, which will help ensure their rational use in a world of limited resources. The world average ecological footprint last year (*Living Planet Report 2010*, 2010) was 2.7 global hectares per person, while the ecological footprint of Europe was 4.7 hectares. The situation in the Balkans is slightly better, the lowest footprint was in Serbia (2.4 ghp), which was followed by Bosnia and Herzegovina (2.7 ghp) and Croatia (3.7 ghp).

The Moodle Platform

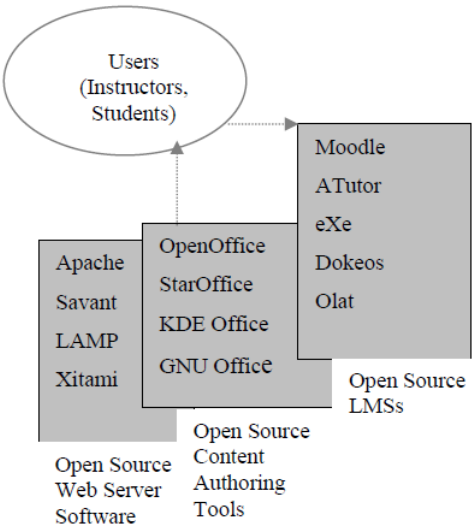
Moodle, a platform for making academic courses, is a software package specially designed to help lecturers and professors create online courses. These systems are usually called distance learning or virtual learning. Combining this system with traditional classroom teaching creates a blended learning environment, which has proved quite successful in many cases.

Moodle is open source software, which essentially means that it can be freely downloaded from the Internet, used, modified, and even distributed (under a GNU license). Moodle is easily run in UNIX, Linux, Windows, MAC OS X, Netware or any other system that supports PHP. All of its data is recorded in a single

database. MySQL and PostgreSQL are best for Moodle; however, Oracle, Access, Interbase and ODBC can be used as well.

In the distance learning process, open source software can be used in many different phases such as application software that performs learning content preparation and in LMS which provides learning content presentation in a web based environment as well as web server software (e.g., APACHE). Due to the advantages of distance learning, schools and companies are adopting these new learning technologies and increasing their investments in them. However, along with the advantages, installation and support costs, there appear to be great disadvantages compared to a traditional learning environment. These are able to be reduced to a great extent by the use of open source software which provides further gains. OpenOffice, StarOffice, KDEOffice, and GNU Office software, which are all under open source content authoring tools, are also among the most widely used content preparation tools. Statistical studies show that open source web server software is again found mostly to be preferred and widely used in learning content presentation in a web based environment such as (*Netcraft Survey*, 2008). Figure 1 shows that open source application and web server software is used in an open source e-learning system (Aydin & Tirkes, 2010).

Figure 1: Open Source Application and Web Server Software



At the present time, university education is strongly influenced by new technology. The impact of the learning management systems (LMS) is particularly significant for science and engineering studies where they are but a particular case of a set of software tools applied in these areas. In general, LMSs provide web-based interfaces that support a wide range of activities. These include forums, content resources, questionnaires, chats, assignments and so on, which are generally sufficient for setting up standard courses. LMS can also integrate other tools of great interest when teaching an engineering course, such as in the automatic checking and verification of a student's lab work.

A typical Moodle installation is made up of three elements: a directory for the PHP files constituting the source code of the application, another directory with files containing data on the courses and users, and a database which defines the different objects that integrate the system. A Moodle basic organizational unit is the course, which is accessed through a web page. A course is organized into sections that may correspond to topics or weeks, appearing in the middle column of the page. It is possible to include different resources and activities in all sections. The last are to be assigned as home or class work to be further developed on by the students. Other elements can appear on both sides of the page, such as blocks, containing different shortcuts or control elements. Users are another essential Moodle object: they can enroll into different courses as administrators, teachers or students. Each role is defined by its capabilities in a certain context, meaning that they have set of privileges when performing certain actions.

In this particular paper, this type of blended learning module and its possible contribution in improving student's environmental awareness shall be explored. This approach combines face-to-face instruction with computer-mediated instruction (Moodle platform).

Results of the Statistical Analysis

A survey was conducted at the Faculty of Organizational Sciences, University of Belgrade over a two-year period with 44 students of the 2009/2010 academic year and 55 students of the 2010/2011 academic year. Students were asked to provide answers for 14 closed-type questions. Several questions were focused on dish and food consumption, others dealt with spending money, goods, some regarding household matters (electricity, etc.), while the rest were about transportation. The EF value for each student was calculated according to their answers to all of these questions (Išljamović et al., 2009, 2010; Jeremić et al., 2010). The creation and evaluation of this survey was based on the Global Footprint Network standard.

The study was carried out in two stages. During the winter semester of the 2009/2010 academic year, 44 students (a traditional learning group) attended classes under traditional methods: classes and lectures and case study projects. Before they took lectures and classes, students had undergone pre-testing and had completed an EF survey. After successfully completing the course, students were then graded and took part in the survey one month after the completion of their academic obligations. This was done for several reasons; first of which was that by using this approach students were better able to freely express their thoughts, as they had already passed the exam and had already been graded. Moreover, they had one month to implement new habits into their lifestyle.

For the winter semester of the 2010/2011 academic year, 55 students (a blended learning group) attended classes under a blended learning module. Before they took lectures and classes, students had undergone pre-testing and had completed

an EF survey. In addition to more traditional methods, such as classes and lectures, students were engaged in continuous case study projects performed using the Moodle distance learning platform (http://myelab.net/moodle/ login/ index.php). Students were encouraged to extensively participate in case studies and Internet resources were made easy accessible to them. After successfully completing the course, students were then graded and they took part in the survey one month after the completion of their academic obligations.

In order to evaluate the results of this survey, the statistical software package SPSS 17 was used. In the first year (2009/2010) of research (the traditional learning group), 44 students (20 males and 24 females) participated in the survey. They completed an EF pre-test and an EF value for each student was calculated. The first item that was examined was if women are more ecologically aware then men; consequently, as to whether males and females differ on value of EF was tested. The results therein showed no significant difference between genders, $p > 0.05$. The same conclusion was also determined in pre-testing the second (2010/2011) group (the blended learning group).

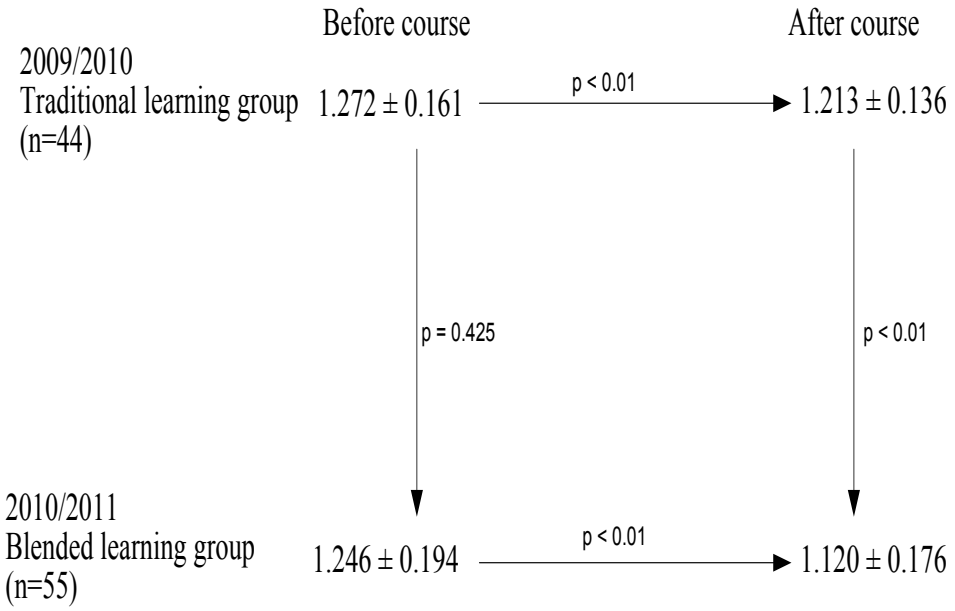
An important issue that has been sought to be raised by this study is the possible difference between genders in answering each of the 14 questions on the survey. The results have shown that there is no statistically significant difference between males and females when it comes to answering this issue at all. For instance, males and females significantly do not differ in their use of automobiles, neither in answering to question "What is the fuel consumption of the car you most often use for travelling?"

Further on, a few interesting observations came to be noted in the study. The results have also shown no statistically significant difference between males and females in the number of new clothing items they buy. The same conclusion was made when the variables for "What is the percentage of food you throw away and what percentage of food you buy is locally grown or seasonal" was compared. The results implied no statistically significant difference between genders. This may arise due to the fact that a great number of students in Serbia are dedicated to the trend of healthy and organically grown food. Their diet is also mostly based on locally grown food. The result is that over 70% of students consume such food in their daily diet, which implies a high level of ecological perception upon the part of students and their families. As a rule of thumb, buying local food will generally result in a lower ecological footprint, since the purchase of locally grown meat and vegetables can reduce one's food footprint by as much as 10%.

The key aim of this study has been to determine whether a significant reduction in the students' ecological footprint value occurred after an entire semester of this course, and if it was improved through the use of the Moodle platform. The results (Figure 2) clearly show that the students were able to substantially raise their level of environmental awareness. Before taking the course of Environmental Management, students of the 2009/2010 traditional learning group

had an Ecological Footprint value of 1.272 ± 0.161. After completing the course, their EF was 1.213 ± 0.136, for which a statistically significant reduction of EF value occurred ($p<0.01$).

Figure 2: Pre-course and After-course EF results,
Traditional and Blended Learning



Before taking the course of Environmental Management the following year, the students of the 2010/2011 blended learning group had an Ecological Footprint value of 1.246 ± 0.194. After completing the course, their EF was 1.120 ± 0.176, for which a statistically significant reduction of EF value occurred ($p < 0.01$).

A crucial point in this work has been determining whether a blended learning module can achieve better results than a traditional learning module. Therein, it was first determined as to whether these two generations of students were similar according to their prior environmental awareness level; for which no statistically significant difference was found ($p = 0.425$). In respect to these results, it can be concluded that these two generations of students have a similar ecological awareness background. Consequently, the crucial research question is whether a statistically significant difference exists between these two learning modules. The results have shown that students who have worked under a blended learning module have a statistically lower EF value (a greater environmental awareness level) than students who have learned under traditional learning modules ($p < 0.01$). It can therefore be concluded that both ways of learning provide students with enough knowledge to substantially raise their level of environmental awareness, however blended learning modules prove to be far more successful in this task.

Conclusion

Slightly more than 60 students enrolled into the course "Environmental Management" taught in the final (senior) year of undergraduate studies at the Faculty of Organizational Sciences, University of Belgrade. This study has been based on a sample of 44 and 55 students, which is by far a representative sample. The average value for the EF of the students was 1.213 ghp. Compared to Serbian (2.4ghp) and EU (4.7ghp) averages, this represents an impressive achievement and demonstrates a high level of environmental awareness among Serbian students. The core of these impressive results comes from adequate and permanent environmental education and high environmental education accomplishments, as well as knowledge acquired from the abovementioned course.

This research project has shown that Ecological Footprints is an excellent tool for measuring levels reached in objectives and aims for higher environmental education. However, this project also leads to the conclusion that a proper higher environmental education must contain curriculum that is focused on environmental science, as well as on personal and social connections with the environment, which represents an effective educational model for moving towards sustainable changes. Additionally, one of the conclusions of this research project emphasizes the importance of future research on developing a formal environmental education curriculum in Serbia, especially on the graduate and postgraduate level, as directly investigating factors of proper higher environmental education represent the support needed for the future adjustment of academic behaviour.

The results of this study clearly have shown that students are able to substantially create new, better patterns of behaviour in relationship to the environment, and decrease their EF value EF by using their newly adopted environmental actions. Students here were successful the most aspects which significantly improve their understanding of the connection between their way of life and the environment (throwing away less food, responsible money spending, smaller diet modifications, etc.).

References

Aall, C., & Norland, I. T. (2002). *Report no. 1/02, The Ecological Footprint of the City of Oslo — Results and Proposals for the Use of the Ecological Footprint in Local Environmental Policy.* Program for Research and Documentation for a Sustainable Society (ProSus), Centre for Development and the Environment University of Oslo, Western Norway Research Institute.

Aydin, C. C., & Tirkes, G. (2010). Open source learning management systems in distance learning. *TOJET: The Turkish Online Journal of Educational Technology, 9*(2).

Ewing, B., Oursler, A., Reed, A., Moore, D., Goldfinger, S., & Wackernagel, M. (2009). T*he Ecological Footprint Atlas 2009.* Global Footprint Network.

Haberl, H., Erb, K., & Krausmann, F. (2001). How to calculate and interpret ecological footprints for long periods of time: The case of Austria 1926–1995. *Ecological Economics, 38*(1), 25–45.

Išljamović S., Jeremić V., & Jovičić S. (2009, September). *Primena statističkih metoda u cilju utvrđivanja ekološke svesti studenata Univerziteta u Beogradu.* SYM-OP-IS 2009, Ivanjica.

Išljamović S., Jeremić V., & Petrović N. (2010, September). *Merenje "dobrog" ekološkog obrazovanja.* XXXVII Symposium on Operation Research, SYM-OP-IS 2010, Tara.

Jeremić V., Išljamović S., & Petrović N. (2010, September). *A one concept for measuring results of environmental education for sustainability: Ecological footprint.* 13th Toulon-Verona Conference, Organizational Excellence in Service, Coimbra, Portugal.

Living Planet Report 2010. (2010). D. Pollard, R. Almond, E. Duncan, R. Grooten, L. Hadeed, B. Jeffries, et al. (Eds.). WWF International.

Netcraft Survey. Retrieved April 10, 2011, from http://news.netcraft.com/ archives/ 2009/01/16/january_2009_web_server_survey.html

Petrović, N. (2009). *Ekološki menadžment*. Beograd: Fakultet organizacionih nauka.

Petrović, N. (2010). *Development of higher environmental education program, Managemen.* Belgrade: Faculty of Organizational Sciences.

Petrović, N., & Milićević, M. (2006, September). *Education for sustainable development.* Collection of Works, 9th "Toulon–Verona" Conference, Paisley, Scotland.

Petrović, N., & Milićević, M. (2007, September). *Higher good environmental education.* Collection of Works, 10th "Toulon–Verona" Conference, Thessaloniki, Greece.

Rees, W. E. (1992). Ecological footprints and appropriated carrying capacity: What urban economics leaves out. *Environment and Urbanization, 4*(2), 121–130.

UNESCO. (1998). Environment and society: Education and public awareness for sustainability. *Proceedings of the Thessaloniki International Conference,* Paris: UNESCO.

UNESCO-UNEP. (1976). The Belgrade Charter. *Connect: UNESCOUNEP Environmental Newsletter*, *1*(1), 1–2.

UNESCO-UNEP. (1978, October). *Final Report Intergovernmental Conference on Environmental Education.* Organized by UNESCO in Cooperation with UNEP, Tbilisi, USSR. Paris: UNESCO.

United Nations. (1972). *Action plan for the human environment.* United Nations Conference On The Human Environment, Stockholm

Wackernagel, M., Monfreda, C., Schulz, N. B., Erb, K. H., Haberl, H., & Krausmann, F. (2004). Calculating national and global ecological footprint time series: Resolving conceptual challenges. *Land Use Policy, 21,* 271–278.

Wackernagel, M., & Rees, W. E. (1996). *Our ecological footprint, reducing human impact on the earth.* Gabriola Island, BC: New Society Publishers.

Wackernagel, M., White, K., & Morgan, D. (2006). Using ecological footprint accounts: From analysis to applications. *International Journal of Environment and Sustainable Development, 3*(3/4), 293–315.