Resource saving technologies in education: A step towards a green society

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Izvleček

Članek obravnava aktualne probleme moderne družbe – degradacijo okolja in neučinkovito rabo virov, kot tudi možne načine ohranjanja virov – z vidika izobraževanja. V prvem delu na kratko predstavimo pregled literature s področja zelenih tehnologij v izobraževanju. Sledi opis didaktičnega modula za usposabljanje bodočih učiteljev informatike v aktivnostih varčevanja z viri. Namen modula je spodbujanje njihove pripravljenosti za uporabo novih izobraževalnih metod v šolah, s posebnim poudarkom na zelenih informacijskih tehnologijah, kot tudi razvoj splošne kulture varčevanja z viri.
Ključne besede: IKT v izobraževanju, usposabljanje bodočih učiteljev, varčevanje z viri, zelena informacijska tehnologija.

Abstract

This article discusses the actual problems of modern society – environmental degradation and inefficient use of resources, as well as possible ways of resource conservation – from the educational perspective. A brief literature review of green technologies in education is presented in the first part. Next, we describe a didactic module for training future informatics teachers in resource--saving activities. The module aims to form their readiness to use novel educational methods in schools with a special focus on green information technologies as well as to develop a general resource-saving culture.
Keywords: Green computing, ICT in education, resource saving, training future teachers.

1 INTRODUCTION

Considering the existing environmental degradation, improving environmental performance, combating global warming and improving the efficiency of resource management are priorities on the list of global problems that need to be addressed very quickly. One of the main tasks of the governments around the world is to control and reduce the negative impact of harmful substances on the environment, and balance consumption of natural resources. However, because of rapid technological progress, just the opposite is happening: more people are using more devices, increasing the energy consumption, and more resources are required to perform any technical action, as they have become more complex. Many governmental programs and initiatives have been prepared all around the world with the main objective of more efficient use of energy and consequently reducing its total costs, which should also have a positive impact on the world economy and society as a whole.

Information and communication technologies (ICT) that are already interweaved into all our everyday activities also represent a major source of environmental pollution. Thus, the new trends are moving towards using eco-technologies or green computing, with the main purpose of creating environmentally friendly and sustainable computer technology. Interest in green information technologies has recently increased in all countries, including Europe and Russia (Dastbaz, Pattinson, & Akhgar, 2015).

2   LITERATURE ON GREEN IT IN SCHOOLS

Green information technology (green IT) as a practice of environmentally sustainable computing is becoming an important issue and the problems associated with it raise growing concerns about the negative impact of digital society on the environment. The problem of environmentally sustainable computing and resource saving is still poorly studied, and there is a limited number of sources in the literature, conferences and seminars on this topic.

Green or sustainable computing helps reduce energy consumption and losses to the environment when using computer equipment, extends the service life of the product, and makes it more energy efficient, while the production waste is easily recycled or biodegradable, with a lower content of hazardous substances. Thus, the sustainable development of information technology (IT) plays an important role in protecting our future. Recently, more attention to the "greening" of information technology and information systems (IS) has become apparent worldwide.

3   COURSES TACKLING THE SUSTAINABILITY ISSUES

In response to growing environmental concerns, more and more organizations are adopting environmental initiatives. In particular, many higher education institutions (HEIs) have implemented various security initiatives on campus through policies as well as teaching and learning. Master's and postgraduate programs provide training in a wide range of information technologies along with sustainable strategies to teach students how to create and maintain systems while reducing their harm to the environment. Universities such as Australian National University, Athabasca University in Canada, and Leeds Beckett University in the UK offer engineering programs *Sustainable ICT development*, *Green ICT strategies*, *MSc Sustainable Computing* in full and partial access (Dastbaz, Pattinson, & Akhgar, 2015).

In Sweden, the University of Chalmers has created a special course (Chalmers, 2017), which aims to inspire and encourage students to think about how they can contribute to sustainable development, in everyday and professional life. A basic understanding of the concept of sustainable development is needed, and knowledge of how the current use of natural resources and ecosystem services by humans is unsustainable, as well as possible strategies and

solutions to enhance sustainability. Thus, this course should arouse great interest in sustainability issues, and provide the student with the knowledge and tools necessary to address the complex sustainability issues in their future professional lives.

4   GREEN EDUCATION

The review of the literature on the green IT research reveals the fact that ensuring the implementation of the necessary requirements should begin with the formation of human needs for the rational use of resources at the initial stage of education. That is, school education should enable the students to develop the type of thinking, which will be aimed at resource saving and respect for nature, while based on modern teaching methods. The authors of the book *Green Teaching and Learning in Schools* (Blendinger, Hailey, & Shea, 2015) justify the importance of creating a culture of teaching and learning in the school to achieve a strong impact on students in relation to the preservation of the environment. They present successful and practical examples, "teaching green" in action, which have been provided to practicing teachers in primary and secondary schools.

In their study on Green Education, Aithal and Rao (2016) show that educational institutions are also working to achieve sustainability. They discuss that growth or learning should only take place in an environment that promotes development in children's lives. Teachers and students need to be aware of and apply environmentally sound practices in their learning, and a culture of preservation should be an integral part of the curriculum.

In the article on green IT at HEI, researchers Suryawanshi and Narkhede (2014) argue that green information and communication technologies are an innovative approach to the use of ICT related to environmental protection and ICT sustainability in the future, and represent a practice of achieving corporate social responsibility by minimizing carbon footprint, ICT waste and energy savings. The rational use of green ICT in education is also analysed, and critical success factors of their implementation are identified based on a survey of individual educational institutions and interviews with the key academic experts in India. The study identify seven critical success factors that are important for the sustainability of ICT in the future: optimal use of resources, stakeholder participation, renewable energy, energy

conservation, institutional policies, green ICT Committee activities, and legislation.

Against the background of the global development of green technologies, also China made the environmental protection a key state policy and included it in the strategy of national sustainable development (Ximing & Chunzhao, 2011). The study of Ximing and Chunzhao (2011) shows that students at universities contribute to environmental awareness, but they are not motivated to participate in environmental programs and activities. They conclude that HEIs need to combine theory with practice to make the process of learning more interesting. To improve the quality of environmental education, universities should also update and improve the philosophy of teaching, personnel training plan, contents and methods of teaching, and teachers training. More needs to be done to explore effective methods and ways of introducing green education and highly skilled staff in the new environment.

Another researcher Lu Chen (2017) discusses in his paper on resource saving higher education development that the thorough exploration of the concept of resource saving and a comprehensive study of its internal meaning and intrinsic value are the key to the optimization and integration of higher education resources. In order to save resources, it is possible to effectively optimize the concept of industrialization and integration of higher education resources, and promote the integration and optimization of regional industrialization resources, thereby forming a significant impact on the diversity and multi-channel of the development of higher education resources.

With the aim of better understanding the research area of green IT, Asadi, Hussin, & Dahlan (2017) conducted a literature review from 2007 to 2016 on the green IT research. They note that current research covers numerous topics within green IT, especially initiation, approaches and strategies, adoption frameworks and benefits, but other topics receive insufficient attention. By asking research questions, they help scientists identify rigorous research areas for further study. The results of their research provide a roadmap to guide future research on green IT and highlight areas for successful implementation of green IT.

Researchers Singh and Sidhu (2016) conclude in their review article that green computing seeks to reduce the unwanted and harmful effects of computers on the environment by reducing air, water and soil pollution. With ever-increasing research in science and technology, it is possible to overcome obstacles. They also argue that each of us has to take small steps towards taking green computing measures in order to enable a healthy growth of our environment.

5 RESOURCE SAVING AND EDUCATIONAL MODELS

Information and communication technologies incorporated into the modern teaching methods have significantly changed the educational system, but have not reduced the value of traditional learning. The best part of digital education in the 21st century is that it combines two aspects: traditional classroom learning and learning with innovative technologies. Both approaches are complementary and support each other. The use of ICT in education is also a way to save resources. For example, a platform for online training restricts frivolous use of paper, directly reducing the felling of trees, while a free software might save material resources of users. Cloud storage and intelligent search engines make it easier for students to access a wider range of information sources, without time (and money) consuming browsing through a large number of books to find specific information.

However, data centres are vast consumers of electricity and therefore under an increasing pressure to reduce carbon dioxide emissions. In response, cloud service providers have begun to set sustainable development goals by using renewable sources in their services (Mann, 2016).

6 RESOURCE-SAVING EDUCATION

We can argue that the resource saving is a modern stage of evolution in the context of transformation of the education model. Based on the universal principles, it is currently possible to form a comprehensive resource-saving education. The innovative task of resource saving is a professionally- and problem-oriented educational task of saving and optimizing costs and reserves. It contributes to the formation of relevant components of the resource saving competencies. Its result also determines a set of measures for introducing new technologies to improve the efficiency of education.

Innovative tasks of resource saving can be a means of literacy formation of future graduates. The professional education, based on the competences, should

approach the complexity of resource saving tasks by focusing on updating the resource values and rising awareness of the need for reducing their consumption.

An efficient solution to these problems can be obtained only through information and methodological readiness of teachers for the use of new resource-saving forms of education (e.g. distance, electronic, mobile, co-education), the creation of electronic educational resources, and providing access to these resources to a wide range of students, consequently improving the availability and quality of education (Konopko & Pankratova, 2017).

7 A MODULE FOR TRAINING TEACHERS ON RESOURCE SAVING TECHNOLOGIES

The North Caucasus Federal University (NCFU) in Russia introduced key concepts and ideas of green IT in the educational process of undergraduate students majoring in Computer Science. A distance-learning module, available on a learning management system of NCFU training (https://el.ncfu.ru), allows lecturers to apply the practice of e-learning and blended learning in the classroom. The educational module titled *European resource saving trends in Computer Science teacher training* was developed within the Erasmus+ Jean Monnet project.

The module implements an individual approach in the formation of various components of readiness for resource-saving activities of students (i.e. future teachers of computer science). At the theoretical level, axiological and cognitive components of readiness are formed via video lectures, webinars and on-line discussions, while the activity and management components of readiness are formed at the practical level. Axiological components of readiness relate to the system of values of the individual, motivating the student for resource-saving activities, consequently forming a positive attitude to it and grow the desire to spread the experience of resource saving. Cognitive components of readiness represent the necessary competencies on the theoretical and methodological foundations of resource saving. Activity components of readiness relate to formation of skills and resource-saving activities, while management components of readiness refer to the development of student skills to predict, plan, organize, control, analyse and reflect resource-saving activities.

Practical work (in the form of project activities, debates, discussions or round tables, organized with the use of remote technologies) contributes to the acquisition of students' skills of resource-saving activities. In addition, the methodological novelty of the project is the partnership of lecturers and students in the form of project activities, forums, online discussions, webinars, blogs, scientific consultations and joint publications. The virtual platform of the module allows students to have unlimited online access to all educational and methodical materials of the module. Besides, it provides an opportunity to share the results of applied research and experimental educational work to students and lecturers.

The actual effects of the module can be assessed only after the practical application of acquired knowledge and competences, with the new generation of teachers of Informatics in secondary schools (Konopko & Pankratova, 2017).

8 CONCLUSION

Applying green IT leads to lower energy consumption, carbon emissions and environmental impacts, as well as lower costs for organizations on the long run. The ultimate goal of going green is sustainability and addressing adverse environmental impacts. However, using green technology should be the motivation from the point of view of social responsibility. By combining traditional learning with green IT, it is possible to use the best of what green and human-driven education has to offer, creating a learning experience that keeps pace with technology while minimizing the consumption of various resources. It is important to remember the role that the human teacher will always play in the classroom. After all, teachers have unique and personal information about each student's progress, act as role models and local experts, and provide inspiration in ways that technology cannot.

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