ICT-enabled reorienting teacher education to address sustainable development: a case study

Vassilios Makrakis
makrakis@edc.uoc.gr
Department of Primary Education, University of Crete

Abstract

The purpose of this paper is to reveal how a newly advanced concept "WikiQuESD" could be utilized as a scaffolding hypermedia tool to enhance pre-service teachers' education for sustainable development (ESD) project-based learning (PBL). WikiQuESD allowed pre-service teachers to design and upload interactive ESD projects online through collecting, assessing and integrating digital material available in the Web. They could also brainstorm, share and discuss their project ideas, while the instructor could make comments and monitor the development process. These results imply that the learning power of the WikiQuESD and Wiki technology in general can transform teachers from software users to hypermedia authors.

Keywords: WikiQuESD, teacher education, education for sustainable development, constructivism

Introduction: Statement of the Problem

UNESCO (2006) posited that Faculties of Education and teacher training institutions, in particular, are needed to re-orient their study programmes to address the quest for Sustainable Development. The latter is an evolving and dynamic concept in terms of its conceptual definition. According to the World Commission on Environment and Development (1987: 43) "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development is generally perceived as an overlapping of four pillars, dimensions or components, namely environment, society, culture and economy (UNESCO, 2008). Environmental dimension encompasses key areas such as natural resources, climate change, rural transformation, sustainable urbanization, and disaster prevention and mitigation, while societal dimension embraces human rights, peace and human security, gender equality, indigenous knowledge, cultural diversity and intercultural understanding, health, HIV/AIDS and governance. Economic dimension, by contrast, includes poverty reduction, corporate responsibility and accountability, fair trade and market economy. Finally, cultural dimension is referred to as both 'an underlying dimension of and 'inter-linkages' or 'inter-connections' between the other three pillars of sustainable development. In fact, cultural elements are indeed present in each of the environmental, economic and social pillars and often these are regarded as components of the horizontal cross-linkages between the pillars.

The United Nations passed a resolution in December 2002 to adopt the Decade of Education for Sustainable Development (DESD) as endorsed by the Johannesburg World Summit on Sustainable Development (WSSD). The DESD (2005–2014) was adopted as a Resolution 57/254 at the UN General Assembly 57th Session in 2002. Education is considered as a primary agent of transformation towards sustainable development,

increasing people's capacity to transform their visions for society into reality. Education not only provides scientific and technical skills, it also provides the motivation, justification and social support for pursuing and applying them (UNESCO, 2005). UNESCO (2006) stated that, education empowers people to play their role in society effectively in promotion of the global community. UNESCO, as the lead agency spearheading the UNDESD (2005-2014), defines ESD as the promotion of values and ethics through education at different levels to make an impact on people's lifestyles and behaviours and help build a sustainable future. ESD is thus more than just environment education; it encompasses values and attitudinal changes. Education for sustainability is seen as a vision and a mission of personal and social change and involves empowering all citizens to be leaders in the transition to a more sustainable future. Broadly speaking, the principal characteristics of ESD are:

- Interdisciplinary, systemic and holistic in approach;
- Values driven and empowerment;
- Focused on critical reflective thinking and problem solving;
- Multi-methodological;
- Participatory action-oriented; and
- Locally/globally relevant contents and contexts.

Hence, in order to achieve sustainability through education, there is need to develop an ESD conscious teachers' generation (UNESCO, 2006). Prospective and in-service teachers should be turned able to act as agents of change to transform teaching practices into learning to live sustainably. ICTs-enabled re-orienting teacher education to address sustainability needs to be based on three inter-related pedagogical concepts: 1) contextual learning; 2) authentic learning and 3) transformative learning (Makrakis, 2006). School learning should take authentic problems more into account and teach how to solve authentic, ill-structured and often controversial problems within complex, real-life environments. Nowadays, ICTs provide possibilities for personal processing of experiences and information, the opportunity for social interaction and bringing out multiple perspectives as well as opportunities and tools for active involvement, construction, and sharing of knowledge and practices. All of these are critical to transforming unsustainable values and actions into sustainable ones.

Study Context

This study examined pre-service teachers' use of WikiQuESD Web 2 environment in an undergraduate education course entitled "Design and Develop Web-based Instructional Material" at the Department of Primary Education, University of Crete during the fall of 2009 semester. Of the 30 pre-service teachers involved in this study, 90 percent were females and 100 percent had access to Internet either at the University and/or at home and all of them had previous experience using ICTs. Only, a 4 percent had previous experience with Wikis. The course activities were designed to promote Education for Sustainable Development across the primary school curriculum through the support of ICTs integrated into the WikiQuESD authoring environment. It was also designed to promote critical reflection and collaborative learning through the affordances (e.g., weblogs, Cmap, Hotpotatoes) integrated into the WikiQuESD platform (Makrakis, 2010).

The concept of WikiQuESD has been developed by the author and combines a Wiki platform and its technologies, the idea of WebQuest and an ESD approach. The template developed is divided into three parts (Figure 1). The left hand side displays five main nodes: 1) activation; 2) learning tasks; 3) learning processes; 4) reflective feedback/assessment; and

5) extensions, each of which can be used for planning and constructing WikiQuESD lesson interventions. There are also secondary nodes, which provide information about the sources (learning objects) used and creators. The main right pane is the screen that holds the HTML content associated with each node. In the upper bar space, the creators place the title of the instructional project and in the right part, the UNESCO Chair's logo as well as additional nodes related to online tools that can be used such as: Cmap; Blog etc.. These mindtools repurpose ICTs to engage learners in critical and reflective thinking (Jonassen, 1996; Jonassen & Reeves, 1996) and education for sustainable development (Vanhear & Pace, 2008). The use of ICTs, can offer exciting new possibilities to promote the changes in teaching methodologies called for in ESD (Fien, 2002; Makrakis, 2008; Paas, 2008). However, when looking specifically for research on the use of ICTs in Education for Sustainable Development, including educational policies, pedagogical approaches and classroom uses of ICTs for ESD, there is not much available to date (Tella & Adu, 2009). WikiQuESD is envisioned to contribute into bridging this gap.

Figure 1. WikiQuESD template

WikiQuESD is based on theoretical insights from critical or emancipatory constructivist research and transformative/reflective learning with particular reference to education for sustainability. Emancipatory constructivism implies that meaning is shaped and knowledge is constructed through discussion with peers and teachers, and through reflection that leads to learning-based change (Kostoulas-Makrakis & Makrakis, 2008). Teachers are encouraged to reflect on their knowledge, personal learning theories and teaching practices. The principal idea behind WikiQuESD is that the starting point for learning should be a real-life problem that the learner wishes to tackle. It is, thus, a learner-centred approach, where the learner takes responsibility for his/her own learning through full participation in all stages of the WikiQuESD process. That includes: activation though various means such as conceptual mapping, Webloging, brainstorming etc. It continues through problem identification, identification of learning needs and tasks, processing and refinement of needs

and tasks, construction and re-construction of new knowledge and continuous reflective feedback. These descriptors clearly call for pedagogical processes that are participatory, reflective and emancipatory. They also lead to the outcomes of personal and professional transformation of learners through merging constructed knowledge and understanding of sustainability issues into action. The main technological and pedagogical characteristics built into WikiQuESD can be summarized as follows:

- Multiple types and levels of scaffolding
- Authentic content, curriculum and learning tasks
- Multimodal texts and literacies
- Reflective feedback/assessment
- Active constructive and meaning making reflective process
- Meaningful cooperation, collaboration and communication
- Transferability and replicability

Assessing the Potential of WikiQuESD

In this course, the WikiQuESD innovation was assessed through a naturalistic inquiry approach implied that meaning was socially constructed by individuals through interaction with the setting environment and their personal beliefs, theories, practices and perceptions. Content analysis was used as a research tool to analyze the presence, meanings and relationships of key words and concepts related to constructs or categories and then make inferences about the messages. "A category is a group of words with similar meaning or connotations" (Weber, 1990, p. 37), which must be mutually exclusive and exhaustive, in a sense, that no unit falls between two data points, and each unit is represented by only one data point. Two types of texts were used: 1) texts derived from 30 participants' answers to a set of open-ended questions and 2) the 16 submitted WikiQuESD projects. Some of the questions asked besides user-interface questions and advantages/disadvantages were: What did you expect from the course? What has changed in terms of pedagogy and personal theory after finishing the course? If something changed, why did it not happen before? The content was coded and then examined using two methods: conceptual analysis and relational analysis. Through conceptual analysis the existence of concepts associated with critical constructivism and the extent it was applied in the WikiQuESD projects was examined. Relational analysis was used to examine the relationships among the identified critical constructivist concepts in the WikiQuESD projects.

To make valid inferences from the content of the projects examined, double checking has been carried out and no ambiguity of word meanings and category definitions had been revealed. To cross-validate the findings, two techniques were employed: first, the results were communicated to a sample of respondents to get a sense of the extent to which they are truly reflected in the project works and second, the project works and the open-ended questions upon which analysis was made were cross-referenced (Miles & Huberman, 1994). Both revealed a high consistency with the constructs developed and the interpretations and inferences made.

Results of the Case Study

The themes or main categories that emerged from the content analysis related to WikiQuESD and the experience gained through the projects they developed refer to concepts such as: motivation, multimodal, distributed resources/learning, visibility, user-friendliness, accessibility, transferability, empowerment and meaningfulness. The frequency

of occurrence was not of any particular interest in this case study. What was mostly mattered concerned the meaning of the concepts identified. Through the relational analysis, that is, interpreting these concepts in relation to the content of WikiQuESD projects, it was revealed that motivation was related to using stories, videos, pictures or cartoons that stimulate the learners' curiosity about the topic, challenge their perceptions and motivate them to explore further the sustainability issue. Multimodality was concerned with using various types of media in an integrated and meaningful way. To ensure that content is authentic and learning is meaningful, pre-service teachers participated in the study were encouraged to select and/or negotiate an ESD local/global topic and engage in learning tasks which are real-world and situated within realistic contexts. Themes developed dealt with types of energy, desertification, renewal resources, overconsumption, bioclimatic schools, climate change. Analyzing the WikiQuESD projects submitted, it is evidenced that content was inter-disciplinary and hypermedia largely build through multimodal open education resources available in the Web. A sample of representative projects developed that show these principles can be accessed from the following URL addresses:

http://aioliki-energeia.wikidot.com/
http://desertification-energy.wikidot.com/
http://overconsumption.wikidot.com
http://bioclimatic-schools.wikidot.com/
http://renresources.wikidot.com/start
http://energy-ngos.wikidot.com
http://recycle-saveenergy.wikidot.com/
http://energy-green-health.wikidot.com/
http://bioclimatic-houses.wikidot.com/
http://energy-globalwarming.wikidot.com/
http://energy-airpollution.wikidot.com/
http://saveenergy-recycling.wikidot.com/
http://climatechange1.wikidot.com/

Analyzing the content of the WikiQuESD projects, it is evidenced that the "Distributed" resources were associated with an extensive use of the ICT affordances integrated into the WikiQuESD environment and use of Web-based open education resources (OER) related to the themes of the projects. Across all submitted projects, the range of open access learning objects integrated range from 40-50 percent. Another dimension of distributed resources concerned peers, instructors and course facilitators/mentors. Support was coming from online instructional material (www.wikitipsgr.wikidot.com) that was monitored by a mentor or facilitator to assist pre-service teachers' engagement in producing WikiQuESD learning activities. In terms of distributed learning, WikiQuESD allowed pre-service teachers to be engaged in collaborative work and learning independent of time. All of the participants used both home and university campus networked facilities for collaborative development of their projects. Although collaborative networking facilities were available, none of the participants made use of it. As explained by most participants, there were not accustomed to this type of interaction and was not demanded by the course.

Analyzing pre-service teachers' instructional design models elicited at the beginning, in the middle and at the end of the course through focus group discussions, a clear shift has been revealed. More specifically, the common framework of previous instructional design models was largely divided into five stages: stating goals and objectives; turning objectives into learning tasks; using mostly ready-made content; deciding on methods; implementation and learning assessment delivered mostly through structured tests. This reflects a

traditional objectivist instructional design model that has the following characteristics: The process is sequential and linear; pre-defined learning objectives guide lesson planning and development; didactic material is prescribed; implementation is largely teacher-centred and summative learning assessment is dominant. The alternative instructional design model that is evidenced in the WikiQuESD projects developed can be characterised by the following principles: The design process is recursive, non-linear; learning objectives are negotiated (emerge through activation and learning processes); didactic material is constructed and re-constructed based on OERs; instruction focuses on contextual and meaningful learning; learning process is integrative and collaborative; authentic assessment is dominant (combining diagnostic, formative and summative assessment). Looking into the WikiQuESD projects, it is evidenced that a mixture of assessment tools such as concept mapping, weblogs, interactive exercises were used. It is clear that pre-service teachers participating in this course made a radical shift in their thinking and developed rich learning projects, applying major principles of constructivism into pedagogical practice.

This shift in instructional design paradigm also reflects a "change agency" principle that can be interpreted in a three-fold way. First, all the pre-service teachers in this study expressed a positive image about themselves that is characterised by confidence in their engagement with WikiQuESD technologies and in their ability to integrate various types of learning objects found in the Web. Indicative expressions supporting this assumption are the following: "Feel more confident", "can do things without support", "I will use wiki in class" etc. Second, merging ICTs with critical reflective pedagogies enabled them to see technology as a tool that can empower learners to address real-life problems. The following replies seem to be indicative in supporting this assumption: "using themes that reflect real-life problems, teachers take investigative roles that help them discover and construct new understandings and knowledge", "real-life problems made me think over of my personal beliefs and actions". Third, being engaged in learning themes dealing with sustainable development enabled them to reflect not only on their previous values and beliefs but also on the ethics dimension of teaching. Data analysis revealed that most of the participants before the intervention perceived teaching as technical process. It is worth pointing out, that most of the participants revealed that constructivist concepts were known to them, but they were not familiar with the critical dimension of constructivism. Their engagement with WikiQuESD gave them the opportunity to reflect on the various strands of constructivism and be able to differentiate according to the role they perceive education should have.

Discussions put emphasis on the moto that "teaching is an ethical and political praxis". This was connected with discussions on the three dominant paradigms of learning (transmissive, transactual and transformative) seen in the context of three corresponding models of curriculum (product, process, praxis). This analysis was related to an analysis of values underpinning everyday choices and of action for change in order to explore a socially critical orientation of education for sustainability. This process had a positive impact on pre-service teachers' perceptions of learning. Learning was conceived by participants as the process of creating new knowledge and understandings through the transformation of experience. Reflection played a critical role in this process by providing a bridge between practical experience and theoretical conceptualisation. Through the inherent component of reflective feedback, participants were encouraged to reflect on the whole process of their WikiQuESD project development. ICTs used in the WikiQuESD platform seemed to foster reflection practices as evidenced in the instructional materials produced. Peer-to-peer and peer-instructor-facilitator assessment was also used as a technique for introducing reflective practice into their work assignments. In terms of problems encountered, the great majority

of participants indicated that the most demanding in working with WikiQuESD is the learning of codes, mostly because of previous inexperience and the perception that wiki environments can work in a more simplified way. Despite that, all participants revealed that it was very worthy working with the WikiQuESD environment.

Discussion

As we move into the second-half of the UN Decade of Education for Sustainable Development (2005–2014), educational institutions and teacher education in particular should play key roles in addressing sustainability. ESD calls for giving people knowledge and skills for lifelong learning in order to help them find new solutions to their environmental, economic, and social issues (Hopkins & McKeown, 2002; McKeown, 2002). While increasing the quality of education through ESD, the use of ICTs pose many challenges for innovative and creative ways in reorienting teacher education to address sustainability. From this study, it is quite clear that building constructivist learning environments enabled by ICTs had an important influence on the pre-service teachers' learning-based changes both in terms of what and how to teach and envisioning what is education for in the context of ESD. Optimizing the effective utilization of ICT resources and open access learning objects dealing with sustainability issues entails designing and implementing innovative pedagogical scenarios. Analyzing the content of the examined WikiQuESD projects, it is evident that pedagogical scenarios were innovative and firmly based on a constructivist learning paradigm which assert that knowledge is a process of social construction, supported by learning environments focusing collaborative, reflective and conversational tools.

By encouraging them to create and develop WikiQuESD interactive multimedia projects via authentic sustainable development themes, they were able to harness several salient constructivist attributes. In particular, it enabled participants to engage in collaborative lesson planning through virtual modes of interaction. WikiQuESD with its ICT affordances became an enabler for them to become actively involved in their learning process and experience high motivation levels that as future teachers is expected to have considerable impact towards re-orienting teaching, learning and curriculum to address sustainable development. Hence, instead of adopting a linear and 'building-blocks' approach to instructional design, participants were encouraged to act as constructivist designers, giving due emphasis on real-world context, meaningful learning, collaborative learning and critical reflection. They did not view their projects simply as part of their assessment process, but rather as an experience acquired for real life situations that was meaningful socially and pedagogically. Projects developed were conducive to the four pillars (environmental, social, economy and cultural) of sustainable development that seemed to help them understand better the systemic and interdisciplinary nature of real-life problems. By designing an authentic learning project dealing with key sustainability issues, they had an active interest in the outcome of the task at hand and they were empowered to see the interplay of school learning and social learning.

Such approaches should not be seen as isolate "Good Examples" but as enablers for re-orienting teacher education as whole. This can be taken several forms, such as incorporating ESD into existing teaching methodology courses, and/or offering ESD as a stand-alone course, be it at undergraduate or postgraduate level. For example, a course on Didactics and Education for Sustainable Development has been introduced and a course "ICT in Education for Sustainable Development" has been introduced as an obligatory course in the teacher education study programme at the Department of Primary Education, University of

Crete. At the Master in Education programme, a new strand has been also introduced in the field of Education for Sustainable Development. It is worth pointing out that these curricular changes have been largely influenced by the results of WikiQuESD assessments.

References

Fien, J. (2002). Teacher education for sustainability: A case study of the UNESCO multimedia teacher education programme. In van Dam-Mieras, R., Michelsen, G. & Winkelmann, H-P (eds.), *Higher Education in the Context of Sustainable Development and Globalization* (pp. 71-91), Verlag fur Akademische Schriften, Frankfurt.

Hopkins, C., & McKeown, R. (2002). Education for sustainable development: An international perspective. In D. Tilbury, R. B. Stevenson, J. Fien & D. Schreuder Gland (eds.), *Environmental education for sustainability: Responding to the Global Challenge,* Switzerland and Cambridge, UK: IUCN Commission on Education and Communication.

Jonassen, D. H. (1996). *Computers in the classroom: Mindtools for critical thinking*. Columbus, OH: Merrill/Prentice-Hall.

Jonassen, D. H., & Reeves, T. C. (1996). Learning with technology: Using computers as cognitive tools. In D.H. Jonassen (ed.), *Handbook of research for educational communications and technology* (pp. 693-719). New York: Macmillan.

Jonassen, D.H. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development,* 48 (4), 63-65.

Makrakis, V. (2006). *Preparing United Arab Emirates teachers for building a sustainable society*. University of Crete: E-Media publications.

Makrakis, V. (2008). An instructional design module of ICT that empowers teachers to integrate Education for Sustainable Development across the Curriculum, In C. Angeli & N. Valanides (eds.), *Proceedings of the 6th Panhellenic Conference with International Participation on Information and Communication Technologies in Education* (v.1, pp. 391-398), University of Cyprus.

Makrakis, V. (2010). The challenge of WikiQuESD as an environment for constructing knowledge in teaching and learning for sustainable development. *Discourse and Communication for Sustainable Education,* 1 (1), 50-57.

McKeown, R. (2002). *Education for sustainable development toolkit*. Tennessee: Energy, Environment and Resources Center, University of Tennessee.

Miles, M. B., & Huberman, A. (1994). *Qualitative data analysis: An expanded sourcebook.* Thousand Oaks: CA: Sage.

Paas, L. (2008). How ICTs can support education for sustainable development: Current uses and trends. Retrived 10 June 2010 from http://www.iisd.org/pdf/2008/ict_education_sd_trends.pdf

Salite, I. (2008). Educational action research for sustainability: Constructing a vision for the future in teacher education. *Journal of Teacher Education for Sustainability*, 10, 5-16.

Tella, A., & Adu, E. (2009). Information communication technology (ICT) and curriculum development: the challenges for education for sustainable development. *Indian Journal of Science and Technology*, 2 (3), 55-59.

Vanhear, J., & Pace, P. J. (2008). Integrating knowledge, feelings and action: Using vee heuristics and concept mapping in education for sustainable development. *Journal of Teacher education for Sustainability,* 10, 42-55.

UNESCO (2005). *Guidelines and Recommendations for Reorienting Teacher Education to Address Sustainability*, UNESCO Education for Sustainable Development in Action Technical Paper No 4. Retrieved Nov. 13, 2009 from http://www.unesco.org/education/tlsf

UNESCO (2006). *Higher education for sustainable development education. United Nations Decade, 2005-2014- Section for Education for Sustainable Development.* (ED/PEQ/ESD) Division for the Promotion of Quality Education, UNESCO. Place de Fontenoy: UNESCO Publications.

UNESCO (2008). *Culture and sustainable development: Executive summary.* Netherlands National Commission for Unesco.

World Commission on Environment and Development. (1987). *Our common future.* Oxford: Oxford University Press.