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# An Instructional Design Module of ICT that Empowers Teachers to Integrate Education for Sustainable Development Across the Curriculum

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## **ABSTRACT**

*This paper presents an instructional design module of ICT that aims to empower teachers to integrate education for sustainable development, with particular reference to the United Arab Emirates (UAE) education system and society. This module is based on a mapping and analysis of the UAE teachers' ICT stage of development. It is argued that the contextualization of school subjects towards an education for a sustainable future and social responsibility supported by ICT implies that teaching integrates a reflective learning approach that engages learners in a continuous discourse and action. Within the ICT in education for sustainability project, 130 multimedia projects were developed by participating teachers. These projects can also be seen as good examples of curriculum innovation and evidence of the changing roles of teachers.*

**KEYWORDS:** *ICT, United Arab Emirates, Teacher training, Education for sustainability*

## **SETTING THE ISSUE**

It is widely believed that two of the major forces shaping and driving the 21<sup>st</sup> century are: 1) the development of information and communication technologies (ICTs) and 2) the drive towards education for sustainable development. The link between ICT and education for sustainable development is being addressed by extensive debates and research which recognize the challenge new technologies bring to the reorientation of education towards learning to live sustainably (Makrakis, 2006). Indeed, there has been increasing recognition of the critical role of education in promoting sustainable development ideas and changing attitudes and behavior of people as individuals, as producers and as consumers. Chapter 36 of the Rio Declaration gave education a special role in preparing young learners to live in a sustainable way. As Bonnett (2002: 14-15) suggests: "education for sustainability can be seen as a frame of mind to reconnect people and reform". The importance of education for sustainable development was re-confirmed at the International Conference on Environment and Society, Thessalonica, Greece 1997 organized by UNESCO and the Government of Greece. The declaration emphasized the reorientation of education as a whole towards sustainability- acknowledged it as a multidimensional concept – with all disciplines having their own importance and significance. According to Combes (2005: 215), education for a

sustainable future is about learning to:

- Respect, value, and preserve the achievements of the past.
- Appreciate the wonders and the peoples of the Earth.
- Live in a world where all people have sufficient food for a healthy and productive life.
- Assess, care for, and restore the state of our Planet.
- Create and enjoy a better, safer, more just world.
- Be caring citizens who exercise their rights and responsibilities locally, nationally, and globally.

ICTs can help learners explore concepts, engage in problem-based and authentic learning, enhance meta-cognitive skills and present information using multiple media. All these are closely related to the goals, themes and learning objectives addressed by education for sustainability (UNESCO, 2005; Summers & Kruger, 2003; Fien & Tilbury, 1996). Education for a sustainable future enables people to develop the knowledge, values and skills to participate in decisions about the way we do things individually and collectively, both locally and globally that will improve the quality of life without damaging the planet for the future (Kostoulas-Makrakis & Makrakis, 2006; Goldman, 1999). Learners should be concerned both about the current state of the planet and also about the future. Problems of hunger, injustice, environmental damage and violence are present in every society. It is increasingly recognized that these issues cannot be seen as separate problems. In addition to that, education for sustainability “does not relate to curricula that are traditionally fairly rigidly separated into discrete disciplines and which are often taught in a reductionist manner. It relates more satisfactorily in many teachers’ minds to a more integrated approach to subject disciplines” (Gayford, 2001:315). These aspects have been taken into consideration in a transdisciplinary project entitled “Educating for a Sustainable Future Supported by ICT”, which was launched in 2002-2004 as part of a larger project for empowering ICT teacher professional development initiated by the author at the Ministry of Education in the United Arab Emirates.

Empowering teachers to address the potential of ICT to education for sustainability is substantially affected by the policy and the practice for the use of ICT in education as well as the training philosophy and practice adopted and implemented. To advance a module of training teachers towards the integration of ICT to education for sustainability, there is need to assess teachers’ stage of ICT competence which in turn will guide ICT instructional designers in planning and implementing education for sustainability. Accordingly, a national teacher survey was designed that was aimed to answer the following two main questions: 1) What are teachers actually doing with technology in the curriculum? 2) To what extent teachers’ technology competence and competencies are linked to learning and pedagogy?

### **RESEARCH DESIGN**

A sample of 106 schools was randomly selected from all the educational zones (N=10) in UAE. The target was to achieve a 10 percent sample of the total UAE

teacher population (N=24000). To construct a random and representative sample, the school has been taken as a unit, and the school level and zone as criteria. All teachers in the school random sample received the research instrument. The achieved sample was 2,480 teachers, a number that is 10% of the total teaching workforce. The majority of the sample teachers were from secondary schools (40%), followed by primary schools (36%) and lower secondary schools (24%). A questionnaire survey was designed and piloted consisted of six sections:

1. *Demographic information*: details on teachers' name of school, educational zone, emirate, school level, gender, age, number of years working as teacher, subject specialization, nationality.
2. *Frequency of ICT use in the home and the school*: once teachers indicated whether they had access to ICT (computer, Internet and e-mail) at home and/or at school, they then were asked to indicate how frequently they used a computer in these two domains on a Likert-type scale ranging from 1 to 5 (where 1= never, 2= less than monthly, 3= monthly, 4= weekly and 5= everyday).
3. *Extent of ICT knowledge/competence*: teachers were asked to indicate the extent of their knowledge on 25 items grouped into five sub-categories, namely: integration/developing, applications, higher order thinking skills, technology-oriented, social-oriented. The scale used was based on 4-point (1= never, 2=little, 3=much and 4=very much). Reliability analyses showed very high coefficients, ranging from *Cronbach a*= 0.85 to 0.98. Teachers were also asked to indicate their own self-perception of knowledge on ICT, considering four categories: novice, average, above the average and expert.
4. *Intensity and type of ICT use in class*: teachers were presented with 14 statements mostly rewarded from knowledge statements, covering similar dimensions of ICT use. Teachers rated themselves on each item on a four-point scale ranging from never to very much. Two sub-scales were constructed: 1) ordinary ICT users and 2) innovative ICT users. Reliability analysis of the scale showed a very high *Cronbach a*= 0.98.
5. *Attitudes towards computers*: teachers were presented with 19 statements, most of them divided into main three subscales: self-confidence, anxiety and usefulness. There were also two statements about cooperative practices and one statement about gender. Teachers' ratings were based on a four-point scale that ranges from strongly disagree to strongly agree. Reliability analyses of the total attitude scale showed a relatively strong *Cronbach a*= 0.63. The reliability measures for the attitudinal sub-scales ranged from *a*= 0.57 to 0.70.
6. *Obstacles to using computers*: teachers were presented with 19 statements divided into four subscales: hardware, software, support, and skills. There are also two single items, one dealing with space in timetable and another concerning time availability to use/integrate computers in teaching. Teachers rated themselves on each item on a four-point scale ranging from

never to very much. Reliability analyses of this scale and its sub-scales showed very strong measures, ranging from *Cronbach  $\alpha$*  = 0.76 to 0.92.

## RESEARCH RESULTS

Based on the results of this study, the stages of development that teachers go through on their way to fully integrating technology into their classes were identified as: prospective users (49%), occasional users (30%), engaged users (14%) and creative or innovative users (7%). If we extrapolate from these results, we can anticipate that UAE teachers will “take off” towards the innovative user stage, when 40 to 50 percent of them have reached the stage of engaged ICT users; that is the point at which the concomitant characteristics of this stage become activated. The quantitative distribution of UAE teachers on these stages shows that at present, UAE teachers fall between prospective and occasional users. It has been also revealed that teachers’ ICT uses focused more on surface techno-centric skills associated with applications that do not integrate sound learning principles. More specifically, teachers tended to use more frequently computers for low level uses, such as preparing student tests, demonstrating and explaining the parts of a computer and less on more cognitive level uses such as using computers for creative thinking and problem solving. Most of the inhibiting factors for UAE teachers to learn, use and integrate computers into their teaching were those of space in timetable to use computers, time, support, appropriate software and skills. On the average, the inhibiting factors fell close to the category of “much” (Mean = 2.8) on the four-point scale. As described in the methodology section, five composite variables, measuring ICT competence: applications, integration, higher order thinking skills (HOTS), tech-focus and social-focus were developed. An examination about mean differences among the five subscales composed indicates that, teachers’ highest mean differences concern the pairs between tech-centred vs. HOTS (Higher Order thinking Skills),  $t = 39.7$ , mean dif = 0.41,  $p < 0.001$ , followed by integration vs. HOTS,  $t = 25.5$ , mean dif = 0.33,  $p < 0.001$ , application vs. HOTS,  $t = 25.2$ , mean dif = 0.28,  $p < 0.001$  and tech-centred vs. social focus,  $t = 0.46$ , mean dif = 0.22,  $p < 0.001$ . These results imply that teachers’ competence on ICT issues related to higher thinking skills is much less than competence on tech-focus, integration and application tools.

It has been also found that the more frequently teachers use computers at home, the less their perceived anxiety towards computers ( $F = 18.8$ , at  $p < .0001$ ). Teachers with more frequent use of computers at home have been also found to express more positive perceptions towards the usefulness of computers in teaching and learning ( $F = 4.6$ , at  $p < .01$ ). The same trend has been also revealed regarding the impact of the frequency of using computers at school on their attitudes towards computers ( $F = 12.5$ , at  $p < .01$ ). ICT use at home exerted a much higher impact on ICT knowledge ( $F = 45.2$ , at  $p < .001$ ) and frequency of ICT use in class than school use of computers did ( $F = 65.1$ , at  $p < .001$ ). In terms of age and working years, younger teachers were found to have higher ICT knowledge ( $F = 23.1$ , at  $p < .001$  and  $F = 29.3$ , at  $p < .001$ ), make more use of computers, the Internet and e-mail both at

home and at school than older teachers ( $F= 19.7$ , at  $p<.001$  and  $F= 23.1$ , at  $p<.001$ ). These results may be explained by the fact that younger teachers were much more exposed to technology at their pre-service education than older teachers. It was also found that upper secondary school teachers have higher ICT knowledge ( $F= 6.7$ , at  $p<.01$ ) and make more frequent use of computers, the Internet and e-mail than preparatory and primary school teachers ( $F= 3.3$  at  $p<.05$ ). Upper secondary school teachers also possess more positive attitudes towards computers than primary school teachers ( $F= 5.8$  at  $p<.01$ ). These results may be explained by the fact that upper secondary school teachers are more exposed to computers both at home and at school. In terms of gender, male teachers, in general, were found to have significantly higher knowledge scores ( $t= -2.7$ , at  $p<.01$ ), use ICT more intensively than female teachers ( $t= -3.6$ , at  $p<.001$ ), have more positive attitudes towards educational computing ( $t= -8.5$ , at  $p<.001$ ), and lower anxiety towards computers ( $t= -5.4$ , at  $p<.001$ ), but no gender differences were found on their perceived confidence towards computer use in teaching and learning both at home and school.

### THE IMPLICATIONS OF THE RESEARCH RESULTS

Generally speaking, UAE teachers are lacking the knowledge and skills as well as the resources for realizing the potential of ICT in the educational restructuring/reform change, especially if the current reform efforts would also be directed towards sustainability. The simplest and most common teacher professional development activities undertaken in the ICT area were those aiming to develop skills in using specific software packages or applications, such as word processors, an operating system, or spreadsheet, or Internet access software. Such a kind of training neglects trainees' experiential learning that is directly linked to personal change and growth and, thus, becomes disconnected from its context, that is, classrooms, curriculum and students. Instruction that is confined to a limited range of contexts leads to inert knowledge in which facts and procedures remain isolated and are not activated in different problem-solving situations (Hasselbring & Moore, 1996) that are highly needed for integrating sustainability issues across the school curriculum. There was also no correspondence between UAE teachers' previous knowledge and skills on ICT and the use and integration of ICT in class. This controversial finding might be associated with the inappropriateness of previous training experiences to meet teachers' teaching demands. It was hardly to find training activities focusing on the integration of the use of technology into the curriculum with which a teacher is working, especially with issues related to sustainability. The UAE research findings, in a sense, reflect the general trend evidenced in many Western countries (van den Dool & Kirschner, 2003; Jacobsen, Clifford & Friesen, 2002). Transferring only technical knowledge may lead to the maintenance of the old way of instruction, which will have as focal point the instructor and not the learner. On the other hand, change in attitudes and perceptions regarding the didactic process, in combination with the absence of the appropriate technical knowledge, may lead to more anachronistic models of instruction and learning. These results may imply

that teacher training did not follow adult learning principles and that training materials often lacked theoretical background and did not consider pedagogical principles and theories. The limited professional development offered before had been restricted to very basic and redundant workshops on ICT skills related to certain applications ignoring all or most of the new pedagogy principles. This approach to teacher professional development adds very little to educational reform and change, especially the one that addresses sustainability. Accordingly, ICT teachers' previous experiences on ICT did not match the needs for the educational demands prescribed by the Education Vision2020 (MoE, 2000) strategic plan. Thus, teachers were left without answers to persisting questions such as:

- How can I merge new technologies with new pedagogy?
- How can I integrate ICT into my subject teaching?
- How can I manage and organize ICT in the classroom?
- How can I enrich the prescribed knowledge of the curriculum towards sustainability?

The search for answers to these questions becomes even more compounded when teacher training is left to the hands of training sources that rely upon business examples and know little or nothing about education. The development of a synergy between learning, teaching, curriculum and ICT should be inextricably connected to teacher professional development. This requires a fundamental and continuous process of rethinking what is taught, how it is taught and why: an aspect that is usually neglected or at best tackled marginally and superficially in teachers' training programs. Educating young learners for the development of social consciousness and responsibility towards sustainable living means also posing a set of self-reflective questions such as:

- What is my vision of what I would like our world to be?
- Are my actions consistent with the way I would like the world to be?
- What does the way I lead my life mean for the lives of others?
- How can I contribute in creating a more just, peaceful and ecologically sound world?
- What can we do together as a local community, as a country and as a global community to promote sustainable development and global/international understanding?

In light of the above findings, there is need to merge new technology with new pedagogy that addresses sustainability. In particular, teaching local/global sustainable issues requires teachers to be creative, critical, resourceful and informed on these issues. Young learners are needed to become responsible and participating members of their communities and develop their social consciousness and critical thinking through reflection, cooperation and inquiry. As textbooks tend to be limited in their coverage of these issues and, even the ones integrated are tackled on the surface both in terms of breath and teaching method, teachers must turn to more recent sources of information for designing lessons and for engaging learners in this process (Makrakis & Kostoulas-Makrakis, 2005). ICT can play a critical role towards this end. The contextualization of school subjects towards an education for

a sustainable future and social responsibility supported by ICT implies that teaching integrates a reflective learning approach that engages learners in a continuous discourse and action. Critical discourse that leads to action, which in turn leads to discourse and so on, is firmly connected to political literacy. This is also related to cross-curriculum and interdisciplinary approaches to teaching and learning. These principles were taken into consideration in designing and implementing a teacher training ICT module that was geared towards integrating education for sustainability across the primary and secondary school curricula in the United Arab Emirates education system. The training syllabus was based on four units, amounted to 100 training hours in total, which corresponded to the goals and expected outcomes set as well as to the training philosophy and methods adopted.

1. Learning multimedia authoring tools
2. Creating futures for a sustainable society
3. Selecting sustainable futures
4. Developing interdisciplinary and cross-curricular thematic lesson plans for sustainable futures supported by ICT

Teacher ICT professional development was organized in three phases: 1) train-the-trainer (first cohort of trainers); 2) train-the-trainer (second cohort of trainers) and 3) train all teachers. In the first phase, 30 teachers were trained, receiving 200 training hours who in turn trained about 600 trainers for about 120 hours in the second phase. In the third phase, about 5000 teachers of all subjects were trained which averaged 40 hours. An example related to the above instructional design module is best represented by 130 multimedia instructional projects, developed by those trained in the second phase. These projects were based on collaborative learning that crossed interdisciplinarity and grade levels. The ultimate goal of these assignments was not targeted to the product, but to the process.

The multimedia projects developed by teams of trainees can be fallen into three categories: (1) Multimedia projects that further enrich instructional units or themes from the curriculum of all educational levels, starting from kindergarten up to secondary education, (2) Multimedia projects that integrate new themes across the curriculum related to local history and current social issues related to the environment, drug addiction and health, (3) Multimedia projects that can fully support new subjects such as the introduction of Web-page development, Access and Visual Basic in upper secondary schools. Besides the learning outcomes gained by teachers while developing these projects, they can also be seen as good examples of curriculum innovation and evidence of the changing roles of teachers. These projects can also provide a useful teaching resource for other teachers as well as resources to be used for modeling similar developments in the subsequent training efforts at various levels and stages. By working on their projects, trained teachers were inherently encouraged or motivated to use ICT tools for information access, organization and processing, as well as focus on epistemology, pedagogy, school subject area content and ICT tool use in creating multimedia-based instructional units by applying collaborative learning and constructivist principles of learning. It is interesting to point out that in a number of cases, teachers formed groups to discuss

about constructivism and active learning. Also, one group developed a multimedia project about constructivism and its teaching and learning implications posted online. In conclusion, this project shows that ICT teacher training should be in context, taking into consideration adult learning principles, reflective teaching, meaningful learning and above all be contextualized to issues that concern society, both at local and global level.

## REFERENCES

- Bonnett, M. (2002). Education for Sustainability as a Frame of Mind. *Environmental Education Research*, 8(1), 9-20.
- Combes, B. (2005). The United Nations Decade of Education for Sustainable Development: learning to live together sustainably. *Applied Environmental Education and Communication*, 4(3), 215-219.
- Fien, J. & Tilbury, D. (1996). *Learning for a Sustainable Environment: An Agenda for Teacher Education in Asia and the Pacific*. Bangkok: UNESCO.
- Gayford, C. (2001). Education for sustainability: an approach to the professional development of teachers. *European Journal of Teacher Education*, 24(3), 313-327.
- Goldman, H. (1999). *Sustainability Education: Teaching Sustainability in Every Classroom*. South Lake Tahoe, CA: Tahoe Center for a Sustainable Future.
- Hasselbring, T. S. & Moore, P.R. Developing mathematical literacy through the use of contextualized learning environments. *Journal of Computing in Childhood Education*, 7(3/4), 199-222.
- Jacobsen, M., Clifford, P. & Friesen, S. (2002). Preparing teachers for technology integration: creating a culture of inquiry in the context of use. *Contemporary Issues in Technology and Teacher Education*, 2(3), 363-368.
- Kostoulas-Makrakis, N. & Makrakis, V. (2006). *Interculturality and Education for a Sustainable Future*. E-media, Heraclion: University of Crete (In Greek).
- Makrakis, V. (2006). *Preparing United Arab Emirates Teachers for Building a Sustainable Society*. E-media, Heraclion: University of Crete.
- Makrakis, V. & Kostoulas-Makrakis, N. (2005). Techno-sciences and Mathematics: vehicles for a sustainable future and global understanding. In: *Proceedings of 2<sup>nd</sup> International Conference on Hands-on Science, HSc2005*. E-media: University of Crete (103-108).
- Ministry of Education (MoE) United Arab Emirates (2000). *Education Vision2020: Pillars, Strategic Objectives, for UAE Education Development*. Dubai: Ministry of Education.
- Summers, M. & Kruger, C. (2003). Teaching sustainable development in primary schools: theory into practice. *The Curriculum Journal*, 14(2), 157-180.
- UNESCO (2005). *Guidelines and Recommendations for Reorienting Teacher Education to Address Sustainability*. Paris: UNESCO.
- van den Dool, P. & Kirschner, P. (2003). Integrating the effective functions of Information and Communication Technology (ICT) in teachers' and learners' toolboxes: a reflection on pedagogical benchmarks for ICT in teacher education. *Technology, Pedagogy and Education*, 12(1), 161-179.