

Development of ICT-Based Environmental Education Materials in Different Media of Learning

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Abstract

The study Development of ICT-Based Environmental Education (EE) Materials which is intended to be utilized by the Department of Environment and Natural Resources (DENR) and the National Network of Normal Schools (3NS) is appropriate for formal learning of college students, and for use of adults in the community. It aims to heighten awareness among learners about the significance of the environment, the natural resources, and their protection. The Agile approach using Scrum was utilized for the development of materials. It was able to come up with 15 video clips focusing on global warming, planets, ozone layer, ecological solid waste management, water cycle, and the likes. Three (3) interactive games were also developed on Chemical and Physical Change, Work, Energy & Machines and Food Chain. All the materials developed were assessed by two sets of jurors who are experts in content and technical aspects of the topics. Of the 18 materials developed, one (1) material is recommended for discard, thus, out of 17 materials, 13 were evaluated as “Appropriate” and four (4) as “Highly Appropriate” for use. With the positive evaluation of the jurors, the next step is to conduct pilot testing for it to be utilized by the educators in delivering their instruction to increase awareness among their learners about environmental concerns. The ICT-Based EE Materials are packaged in CD form and accessible for download in the web repository site.

Keywords: *Computer-Assisted Instruction, CAI, DENR, Natural Resources, 3NS*

Introduction

The Department of Environment and Natural Resources (DENR) is the government agency responsible for the protection of the environment and the different natural resources. Part of their mandate is to heighten awareness among the citizenry about the relevance of the environment and the different natural resources through education. One way of fulfilling this mandate is by injecting this awareness in the class discussions in the different subject areas in any way possible. The best way to raise awareness is by integrating the process in formal education. This may be done through the motivation by the teachers or by injecting the concept during the discussion. It may also be part of the evaluation or through additional activities that the teachers may deem possible. The best method, however, is the creation of learning modules or other education materials which may be utilized in school which are specially designed for environmental education.

With the current trends in technology, one way to

attract the attention of the learners is through the use of advanced techniques and tools during the delivery of the concept. This may be done by using video clips, short movies, digital games, or mobile applications. These may be delivered through television sets, computers, audio equipment, visual devices or mobile gadgets like cellphones and tablets. These may also come in handy when placed in small storage devices such as disks, flash drives, or making it available on the internet (Kaneyema *et al.*, 2015).

With the drive spearheaded by the DENR and supported by the Bicol University Research and Development, the study primarily aimed to develop varied ICT-Based Environmental Education (EE) Materials for formal learning use of college students and adults in the community. To validate its content and technical design, assessment of the developed materials by the jurors was conducted, and necessary revisions based on the suggestions made in finalization of the EE materials were made. The materials may be utilized by the educators in increasing awareness among learners

regarding the concept of the environment and the natural resources among individuals for the protection of the environment and natural resources and for the promotion of environmental education.

ICT presents a powerful learning environment for learners in the classroom. Many countries make investments in ICT integration as ICT is viewed as an effective tool for renewing educational practice in any field. Because teachers are the main characters to employ ICT in educational contexts, they should be trained on how ICT can be integrated into the teaching process (Hismanoglu, 2012). These tools also promote authentic communication in an environment where this input is scarce and at the same time help prepare them for the technological workplace of the future (Gonzales & St. Louis, 2008). The teacher needs to see the real effect that ICT materials have on the learning process.

Furthermore, there should be an appropriate balance between hands-on and other work, and the motivational aspects of using ICT will be effective only with appropriate planning and guidance from the teacher (Kisby, 2011). In brief, ICT cannot itself resolve educational problems in the developing world. If used prudently, ICTs will enable developing countries to expand access to and raise the quality of education. Today's technologically competitive world needs integration of ICT in education. If ICT is aptly adapted, then it will be a lifelong learning process for the learners. The quality of learning with accountability can be improved to enhance the learners to learn things quickly and successfully (Kirubahar *et al.*, 2011).

Without a doubt, technology has revolutionized society in many places around the globe, including how language instruction is taught and delivered. In particular, the internet has become a conduit where people can learn, share, and collaborate in ways not possible years before. However, a great deal of the success comes from preparing students to interact and learn in this online environment (Davis, 2006). Therefore, if we try to integrate technology in our teaching, our new, refocused approach to teaching will propel us a long way to making technology and the internet a more rewarding partner in the teaching and learning process.

For example, the use of ICT in foreign language teaching has been studied multiple times. Education, especially foreign language teaching, has to adapt and renew itself to be compatible with the globalized

world. One study examined the necessity of ICT and highlighted the positive effects of it in order to keep up with the modernized communities in the current digital world. It stated that integrating ICT in foreign language teaching will have positive effects on both the teachers and students to help them be aware of the modernized world and meet the current demands of the new era (Isisag, 2012).

A similar study of sporadic use of ICT in Kuwaiti secondary schools shows that when employed, evidence is mixed as to whether there is indeed a positive or negative impact from ICT use. The research does suggest that there is capacity in the skills of teachers and students to employ ICT effectively, at least on a fundamental or technical level. There remains a significant gap between possessing these skills and applying them in the school setting. Alongside this, there is some support and recognition of the benefits associated with ICT use, and there are some teachers who recognize the importance of ICT in developing more constructivist methods in the classroom (Alharbi, 2014).

Similarly, Computer-Aided Instruction (CAI), a diverse and rapidly expanding spectrum of computer technologies that assist the teaching and learning process can dramatically increase a user's access to information and can adapt to the abilities and preferences of the individual user and increase the amount of personalized instruction a user receives (Douglas, 2000). Moreover, computer-learning experiences often engage the interest of users, motivating them to learn and increasing independence and personal responsibility for education.

As to the methods used, Agile development methodology provides opportunities to assess the direction of a project throughout the development life cycle. This is achieved through regular cadences of work, known as sprints or iterations, at the end of which teams must present a potentially shippable product increment. By focusing on the repetition of abbreviated work cycles as well as the functional product they yield, Agile methodology is described as iterative and incremental.

Materials and Methods

The best way to develop the target ICT-Based Environment Education Materials is through standard project management methodology. Agile

methodology is an approach that helps teams respond to unpredictability of the development process through incremental, iterative work cadences, known as sprints. The research method used in here is the Scrum Approach as depicted in Figure 1. Scrum is a variant of Agile methodology and has only three (3) roles: Product Owner, Team, and Scrum Master.

The Scrum Product Owner is typically a project's key stakeholder. In this study, they are the DENR, 3Ns schools, and target users as well who will make use of the materials. Part of the product owner's responsibilities is to have a vision of what he wishes to build, and convey that vision to the scrum team. They are commonly a lead user of the system who is constantly consulted by the team for feedback on the subject. The other role is the Scrum Master, often considered a coach for the team, helping the team do the best work it possibly can and creates a balance with the project's key stakeholder. For this project, the Scrum Master is the project leader and study leader of the research team. Further, a Scrum team includes everyone on the project that works together to complete the set of work they have collectively committed to complete within a sprint. They are normally the people who do the actual development of the project at hand under the direction of the Scrum Master and through regular consultation with the Product Owner and this is the research team.

Interactive learning was the goal of the development of the EE materials. This is because Interactive Learning System (ILS) reflects the full range of learning theories which are behaviorism, cognitivism, and constructivism. In this study, ILS was created using Computer-Based Instruction (CBI).

In developing the ICT-Based EE materials, the researchers made use of the following tools: For creating and editing images, Adobe Photoshop CS6 was used. Editing and rendering of videos were assisted by

Photodex Proshow, Microsoft Powerpoint Presentation, Powtoon, Windows Movie Maker, Power Director 12, Adobe After Effects CS5, CyberLink PowerDirector Sund Editor, Audacity, Proshow Producer and Sony Vegas Pro 11.0/13.0.

Results and Discussion

Developed ICT-Based EE Materials

The ICT-Based Environment Education Materials are designed and developed with the purpose of helping to educate students and the community regarding the significance of environment protection. The purpose of which is to make these materials form part of the usual delivery of instruction in order to make a significant effect on the learners. Literatures showed that the integration of ICT-based EE materials in teaching environment education provides promising outcomes to the students and better delivery on the part of the educators. Vrasidas and colleagues (2007) in their research showed that the utilization of ICT Tools brought communities together and had enriched communications. Kim and colleagues (2012) showed that new approaches, such as focusing on thinking skills rather than technical skills, and providing various contexts different from ordinary classroom lessons, help teachers to develop adaptive expertise. The focus of the study is on enhancing teachers' ICT capacity for the 21st century learning environment. A different improvement was also uncovered by Oliver (2002) in his study about the role of ICT in higher education. He mentioned the use of ICT in education to be more of a student-centered learning setting and expected to be more and more important and will continue to grow and develop during the 21st century. The paper emphasized that ICT tools have influenced educational practice in education and that the impact will improve considerably and that ICT will become a strong agent



Figure 1. The Scrum Method

for change among many educational practices. Fauville and colleagues (2014) claimed that multidisciplinary and knowledge engagement challenges are the key considerations for an Environment Education curriculum designed to harness ICT to support and enhance student learning, which also challenge traditional instructional priorities that are largely based on textbooks. One of the major findings in his study is that there is a rich variety of tools and applications available for teaching Environment Education but there is far less research on their fit and their implications for student learning. This study addressed these concerns and is aimed to become contributory for the betterment of the delivery of Environment Education through ICT-based learning materials.

The study was able to develop 18 ICT-Based EE materials. Specifically, the 15 videos developed and three (3) interactive games made are presented as shown in the succeeding figures.

Ozone Layer (English and Filipino). Shown in Figure 1-A is a short video clip with Earth, sun, ozone as characters. It explains the main function of the

ozone layer as protection from the sun's harmful rays or the ultraviolet rays. The different Ozone Depleting Substances (ODS) and how they affect health, growth of crops and trees, lower the quality of agricultural products, and destroy the primary food source of marine life were also discussed. The last part of the video cites how to protect the Earth's ozone.

RA 9003 (English/Filipino). Figure 1-B is a video clip in English and Filipino that discusses the Conceptual Framework of the Republic Act No. 9003 or the "Ecological Solid Waste Management Act"- which provides the legal framework for the country's systematic, comprehensive, and ecological solid waste management program that shall ensure protection of public health and environment preservation.

Segregation (English/Filipino). Figure 1-C is a short video clip that shows how to properly segregate waste. Each color of the trash can corresponds to the specific waste. Red is for non-recyclable wastes, blue is for non-biodegradables, and green is for biodegradable waste. It also presents tips on how to make new products and useful materials from wastes.



Figure 1. Screenshots of developed ICT-based EE materials

“Makakalikasang Pamamaraan sa Pamamahala ng Basura”. Figure 1-D is an informative video in Filipino that tackles the objectives of RA 9003 or the Ecological Solid Waste Management Act.

Water Cycle. Figure 1-E illustrates the processes by which water circulates between the Earth’s oceans, atmosphere, and land changing to different states involving evaporation, condensation and precipitation.

Brass Instrument. This is a video clip showing brass/wood instruments. A brass instrument is a musical instrument that produces sound by sympathetic vibration of air in a tubular resonator in sympathy with the vibration of the player’s lips shown in Figure 1-F.

Air Pollution (English/Filipino). Figure 1-G is a video clip that shows air pollution facts, causes and effects.

The Planets. Figure 1-H is a video/song about the different planets in the solar system.

Moral Awareness. Here is a short video clip in Figure 1-I about moral awareness on environment. It shows the moral duties we have toward environment are derived from the people’s direct duties to their inhabitants, where we provide social grounds for social policies, aimed at protecting the Earth’s environment.

Biodiversity. This is a video clip discussing the loss of biodiversity. Figure 1-J introduces the concept of biodiversity and how activities of human beings deeply altered the environment. The threats presented are summarized in the following main points: alteration and loss of habitats, introduction of exotic species, and genetically modified organisms, pollution, climate change and overexploitation of resources.

The Face of the Earth. Figure 1-K is a video clip discussing the basic structure of the Earth, cores, land formations and the atmosphere.

The Globe. Shown in Figure 1-L is a short animated video clip showing the seven continents of Earth—Asia, Europe, Africa, Australia, Antarctica, North America and South America. It also illustrates the globe’s grid, tropic of Capricorn, equator, Antarctic circle, prime meridian, north pole and south pole.

Global Warming. Figure 1-M is a short video clip that explains global warming and its main causes.

Polygons. This is a video clip that defines polygons and shows different types of polygons using figures of

the environment.

Job Interview. Here is a video clip in Figure 1-O on interview tips and pointers when applying for a job. It shows the do’s and don’ts during a job interview. The applicants (actors) are applying for an environment-related job position and some questions asked by the interviewer are about environmental concerns.

Physical and Chemical Change. Here is a fun quiz about chemical and physical reactions, in a form of game. Upon loading the game, the name of the player is asked, then the game mechanics is prompted. There are 20 questions to answer; the player will identify if physical change or chemical change took place in the given scenario. Right after the answer is submitted, the player will be prompted if the choice made is correct or wrong and explanation will be displayed.

The Food Chain Game. Here is a fun game in Figure 1-Q applying the concept of food chain. The player has to eat identified smaller species to move to the next level and has to avoid eating bigger species to retain life.

Work, Energy and Machines. Here is an interactive learning tool on work, energy and machines in Figure 1-R. It is a point-and-click game. To advance the game, just click near the text that appears on the screen. The game can be played on a web browser with Shockwave Flash installed.

Juror’s Evaluation

The study was able to develop 18 ICT-Based EE materials and was evaluated by two sets of jurors as to the appropriateness of the materials in terms of content and technical features. The two groups of jurors for content and technical features were invited to assess the materials developed (May 11, 2016) as shown in Figure 2. The content jurors were represented by a personnel from the DENR Region V, and Land Management, Agroforestry and Upland Farming Technology Research Center, Ecosystems and Research and Development Bureau, and Bicol University Extension Service Center. The technical jurors were the select faculty members of Bicol University Computer Science and Information Technology Department.

It could be noted in Table 1 that out of the 18 ICT materials, four (4) materials obtained Highly Appropriate ratings and these are Physical and Chemical Change (4.75), The Globe (4.34), Polygons (4.29), and Brass Instrument (4.22). The following 13

EE materials got Appropriate ratings: Global Warming (4.15), Work, Energy and Machines (4.14), The Planets (4.01), The Face of the Earth (3.99), Segregation (3.97), The Food Chain Game (3.96), Water Cycle (3.95), RA 9003 (3.92), Ozone Layer (3.85), Air Pollution (3.83), Moral Awareness (3.81), Biodiversity (3.77), and “Makakalikasang Pamamaraan ng Pamamahala ng Basura” (3.75). Only one (1) which is the Job Interview (2.84) EE material was found to be Moderately Appropriate and was recommended for discard by the jurors.

Revision and Finalization of EE Materials

Series of small gathering presentations with the project leader and the team were made prior to the jurors’ evaluation, showing the progress reports made

for the study. Their comments and suggestions were considered in the revision of the materials. Two groups of jurors for content and technical features were invited to assess the materials developed.

The technical suggestions were the following: convert to MP4 format; change the font style; provide subtitles/short caption of narration; improve the text color and background; simplify the text presentation instead of an animated one; adjust the frames movement to move along with the audio; and change the pixelated pictures into a refined one. Further, based on the content jurors’ evaluation, the revisions made on the 17 ICT-based EE materials developed are the following: cited the links/sources at the end of each video; included other important discussions and examples on each video. Thus,

Table 1. The Results of the Assessment of ICT-Based EE Materials

Item	Title	Content		Technical Feature		Overall Rating	
		Numerical Rating	Adjectival Rating	Numerical Rating	Adjectival Rating	Numerical Rating	Adjectival Rating
1	Ozone Layer	3.78	A	3.93	A	3.85	A
2	Polygons	4.21	HA	4.37	HA	4.29	HA
3	Water Cycle	4.00	A	3.90	A	3.95	A
4	Brass Instrument	4.20	A	4.23	HA	4.22	HA
5	Air Pollution	3.80	A	3.87	A	3.83	A
6	The Planets	4.01	A	4.00	A	4.01	A
7	Moral Awareness	3.81	A	3.82	A	3.81	A
8	Segregation	4.21	HA	3.73	A	3.97	A
9	Biodiversity	3.71	A	3.83	A	3.77	A
10	Physical and Chemical Change	5.00	HA	4.50	HA	4.75	HA
11	The Face of the Earth	4.11	A	3.87	A	3.99	A
12	The Globe	4.38	HA	4.30	HA	4.34	HA
13	The Food Chain Game	4.23	HA	3.70	A	3.96	A
14	Global Warming	4.38	HA	3.93	A	4.15	A
15	Work, Energy and Machines	4.41	HA	3.87	A	4.14	A
16	RA 9003	3.88	A	3.97	A	3.92	A
17	Makakalikasang Pamamaraan ng Pamamahala ng Basura	3.34	A	4.17	A	3.75	A
18	Job Interview	2.96	MA	2.7	MA	2.84	MA

Legend: 4.21-5.00 = Highly Appropriate (HA); 3.41-4.20 = Appropriate (A); 2.61-3.40 = Moderately Appropriate (MA); 1.81-2.60 = Slightly Appropriate (SA); 1.00-1.80 = Not Appropriate (NA)



Figure 2. Jurors' evaluation

results showed that based on the jurors' assessment, out of the 18 materials developed, 17 materials were found to be "Appropriate" for use by its intended users and one (1) material was discarded, that is the video on Job Interview. Upon scrutiny and evaluation of the jurors, the comments and suggestions made by the jurors were incorporated on the ICT-based materials developed.

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References

Alharbi, E. (2014). A Study on the Use of ICT in Teaching in Secondary Schools in Kuwait. Doctor of Education (PhD), Cardiff School of Education Cardiff Metropolitan University.

Davis, R. (2006). Utopia or chaos?: The impact of technology on language teaching. *Teaching English with Technology*, 6(4), 1-6.

Douglas, A. (2000). The AGILE Movement. <http://agilemethodology.org>, Retrieved: June 25, 2016 2:30pm

Fauville G., Lantz-Andersson, A. & Säljö, R. (2014). ICT tools in environmental education: reviewing two newcomers to schools. *Environmental Education Research*, 20(2), 248-283.

Gonzalez, D., St. Louis, R. (2008). The use of Web 2.0 tools to promote learner autonomy. *Independence*, 23, 28-32.

Hismanoglu, M. (2012). Prospective EFL Teachers' Perceptions of ICT Integration: A Study of Distance Higher Education in Turkey. *Educational Technology & Society*, 15 (1), 185-196.

Isisag, Korkut Uluc. 2012. ICT for Language Learning, 5th Edition. International Conference, Gazi University, Turkey.

Kaneyama, T., Goto, T. & Nishino, T., Methodology for developing ICT-based course material for children with a developmental disability based on EPISODE. 2015 IEEE 13th International Conference on Industrial Informatics (INDIN), Cambridge, 2015, 1654-1658.

Kim, H., Choi, H., Han, J., & So, H.-J. (2012). Enhancing teachers' ICT capacity for the 21st century learning environment: Three cases of teacher education in Korea. *Australasian Journal of Educational Technology*, 28(6), 965-982.

Kirubahar, J. S., Subashini, A., Santhi, V.J. (2011). ICT-Enabled Language Learning Using Handphones - An Experimental Study. *Language in India, Strength for Today and Bright Hope for Tomorrow*, Volume 11(3), 464-480.

Kisby, N. (2011). The Role of ICT in EFL Teaching: An action research project with young learners in the Czech Republic.

Locke S., Russo R., & Montoya C. (2013), Environmental Education and Eco-literacy as Tools of Education for Sustainable Development. *Journal of Sustainability Education*, 4(1).

Oliver, R. (2002). The role of ICT in higher education for the 21st century: ICT as a change agent for education. Retrieved from www.researchgate.net/publication/228920282

Root-Bernstein, M., Root-Bernstein, M., & Root-Bernstein, R. (2014). Tools for thinking applied to nature: An inclusive pedagogical framework for environmental education. *Oryx*, 48(4), 584-592.

Vrasidas, C., Zembylas M., Evagorou, M., Avraamidou L., & Aravi C. 2007. ICT as a Tool for Environmental Education, Peace, and Reconciliation, *Educational Media International*, 44(2), 129-140.