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Additional Information:

• This is a conference paper.

Metadata Record: https://dspace.lboro.ac.uk/2134/2887

Publisher: © DATA

Please cite the published version.
Innovative Design and Technology Education in a Virtual Learning Environment.

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Abstract
The Iceland University of Education is currently directing the three-year European Union project InnoEd, which is sponsored by the Minerva Project. InnoEd is a cooperative venture of four countries in the area of Innovation Education: Iceland, Finland, England and Norway. In this project the course in Innovation Education is set up on the Internet (www.innoed.is) and the students work online with their ideas in real time instead of an earlier classroom based model. In addition, the participants have developed a specialised data driven website used for communication and teaching as well as storage and research for all participants. Here the envelope of Information Technology will be pushed to new extremes in the area of Innovation Education.

Key words: Innovation Education, Design and Technology, Information and computer technology, research, InnoEd, National Curriculum, Virtual learning environment, Creativity, practical use of knowledge, Internet, inventions, design.

Introduction to the InnoEd project
Iceland University of Education is directing a three-year European Union project called InnoEd which is sponsored by the Socrates/Minerva fund. This project is focused on the practical use of information and computer technology for open and distance learning in ‘Innovation Education’. The project’s aim is to find out how these technologies can be used to encourage creativity, practical use of knowledge, communication and cooperation in school design and technology education. The project is based on Gisli Thorsteinsson’s visions about the future education and innovation education (IE). This paper is based on the collaboration and co-operation of Gisli Thorsteinsson, lecturer (Iceland University of Education), Miika Lehtonen (University of Lapland) and Tom Page (Loughborough University) for brainstorming the idea further in different phases from the early stages to the present situation in focus group-type sessions at Rovaniemi in Finland or by email since the project was started. The many participants in the InnoEd project in different countries have established a community to nurture the innovative spirit in school children as well as embedding Innovation Education in the different education systems within Europe (Thorsteinsson, 1998). The project provides a niche, in the form of an interactive internet-based ODL (Open Distance Learning) environment, where students are provided with the tools, materials and necessary interactions for creative thoughts to become ideas and eventually products (see figure 1.).

Figure 1: Virtual reality and database support of the InnoEd model

This work involves schools, teacher training institutions and companies in four countries building on successful and culturally different work on innovation education already taking place in these countries. The European Young Inventors competition has been a sustainable outcome of the project and forms part of the web-based ODL environment. The objective of this project is to develop future approaches for all sub-disciplines of design and technology education (Alamäki 1999; Dugger & Naik 2001). Furthermore, this work aims to develop specific data-driven software technologies in support of innovation education. In addition this work uses virtual reality technologies for integrated communication to support the process of idea generation, development and assessment of the process and products. InnoEd is a cooperative venture of four countries in the area of innovation education namely Iceland, Finland, England and Norway and has its roots in eleven years of experience of such Innovation Education in Iceland.
In this project, a distance-learning diploma course in Innovation Education has been developed and implemented over the Internet http://www.innoed.is. Here, the students work online with their ideas in real-time as opposed to the classroom scenario with handouts and teaching and learning activities (Page and Thorsteinsson, 2003). The supporting companies have developed a specialised data-driven web-based system located on a remote website used for communication, learning and teaching whilst providing storage of research in support of students work. Here the boundaries of Information Technology are pushed to its extremes in the area of VR supported Technology Education.

What is Innovation Education (IE)?
Innovation school activities arose from the original Design and Craft subject in Iceland. It is based on a creative emphasis in both teaching and learning (Gunnarsdottir 2001). The basis is conceptual work in its broadest sense which involves the search for solutions to needs and problems in our environment. In IE, students call upon their knowledge from all sources to find solutions (Aðalnámskrá grunnskóla, 1999). In many respects IE is a specific approach to problem-based learning (PBL) (Albanese & Mitchell, 1993). In addition, innovation exercises can provide a context for the research into further understanding of physical phenomena. The primary aims are:

1. To stimulate and develop the creative abilities of students.
2. To teach students certain processes; from identifying a context, developing their own concepts and realisation with appropriate models.
3. To teach students to use their creative ability in daily life.
4. To encourage and develop the student’s initiative and strengthen their self image.
5. To make students aware of the ethical values of ‘objects’ while teaching them ways to improve their environment (Thorsteinsson, 1996).

The ideology behind innovation and its ethical values
Innovation work is based on the concept that everyone is creative. Through creative abilities the student uses his/her creative power to form the world (Thorsteinsson, G, 2000). Creativity and problem solving are intrinsic to design and technology education (D&T). D & T and Innovation Education are inextricably linked – the creative process of problem solving is paramount because it enhances the quality of solution(s) to life’s problems ( also Kimbell 2000a; Kimbell 2000b.). Creative thinking results in original solutions to problems that continually arise in personal spheres (Runco and Albert 1999). The ideology behind Innovation work concerns an individual's abilities to use their creative powers and creative intelligence to modify their environment (Kuo & Levis, 2002). Furthermore, innovation projects are intended to augment those strengths or qualities in a child’s makeup and thus strengthen society in the future (Thorsteinsson, 1998; Lehtonen 2002a; Lehtonen 2002b).

Research in Innovation Education
The InnoEd project is based on much experience of Innovation Education in the Icelandic school system. The old model is based on the classroom environment whereas the new model uses virtual reality, the internet and specific data-base software designed by the participants in the project (see Figure 2).

Figure 2: The preliminary VR innovation process and assessment model (Based on Lehtonen ym. unpublished manuscript in process)

The student has the same freedom to bring their realities in to the school and work with them there. The virtual reality essentially provides a shared virtual space and a mental tool (Lehtonen 2003b Vygotsky 1978; Jonassen 2000; Lehtonen 2003a; Lehtonen (in press)) for sharing ideas and thoughts on a symbolic level. In addition, it is a tool for communication, sharing knowledge and feelings or emotions as well as linking the participants together and motivating them in the ideation process.

Work done to date has focused on the development and implementation of the Virtual Learning Environment. This work has been disseminated through in-service teacher and initial teacher training in innovation education across the UK, Iceland, Norway and Finland. The virtual learning environment has been used in lessons and in after-school activities within the framework of innovation education. A sustainable outcome of this work has led to the launch of the young
inventor’s competition. There has been an increased participation in this work from other countries such as Denmark, Romania, Estonia and Saudi Arabia. Open and long distance learning courses for primary and secondary students have been organised.

One of the authors of this paper is undertaking PhD research at Loughborough University using the InnoEd Virtual Learning Environment. The main purpose of this research work is to explore the use of the Virtual Learning Environment and identify those factors within this pedagogy which relate closely to the quality of teaching and learning (see figure 3). In addition, this research will contribute to the overall academic discussion on the alternative view of ideation (idea creation). The research focus is to use an action research approach to explore and develop ideation in students when using IE materials within the InnoEd VLE. (Gunnarsdottir, 2001).

The main research questions are:

• What are the essential factors of IE?
• What are the essential factors of the VLE as used with in the project?
• How can the IE / VLE be used to reinforce ideation?
• How do the students get their ideas and how do they manage to express them?

The research methodology is based on action research that focuses on developing the VLE as a tool for ideation. The research includes a series of three case studies. One case study involving the author in action research to improve IE/VLE effectiveness. These case studies will be mainly focused on after school activities, comprising of one teacher and eight - twelve children. This will be supported by case studies by teachers and academics from several other countries who form a Delphi group within the project. One case study has been completed thus far and demonstrates that the virtual learning environment can be used effectively in IE. The methods of teaching and learning within the virtual learning environment do, however, require further development in order to be tested and observed in the next case study.

The innovation process or methodology is simple, but a powerful tool to teach the student to identify needs in their environment and come up with new ideas. After they have learnt the process they can work independently and start to apply the innovation methodology as a tool in solving general problems that occur in everyday life. The innovation model has not been aimed at specific age but been very much practiced in the age range of nine - sixteen years, but the methodology can be used in all levels.

The VR system plays a big role in the new innovation model. The model has been in development for the last two years and has been tested with children and student teachers this school year. In the beginning students will have a lesson to introduce and learn the fundamental skills of using the virtual environment as a tool for the subtasks within the innovation education process as well as part of the innovation education (IE) process in general (see figure 5). Prototypes of student work within the VR system are illustrated in figure 4, they demonstrate creative solutions to problems. They have been made by the students and images scanned to host in the InnoEd database.

An example lesson in the VR
The lesson started with a short introduction. The teacher informed the group about the lesson content. The group used their notebooks which contained needs that they had found as part of their homework preparation for this lesson. The teacher wrote all the needs identified by the group on a blackboard. The teacher then divided the students into two groups, of...
four students. Each group had to choose one need and meet each other inside of the Virtual Reality system, they developed and presented common solution to the need. The students met up in front of a big whiteboard (see figure 5) where they drew their solutions together. At the same time they communicated on the VR text panel and with headsets.

Figure 5: The researcher with a class of twelve year old students inside of the Virtual Reality

In the end, the students saved their work which was added to the database, inside of the VR workshops, together with a description. Before the group left they came together in the classroom and the teacher informed them of what would be required in the next lesson.

Figure 6: Students in classroom working inside of the VR

Concluding discussion
The main aim for the InnoEd project is to find out how new technology can be used to encourage creativity, practical use of knowledge, communication and cooperation in school education. The first case study has provided an insight to the effectiveness of these technologies in enhancing the innovation education process. It is also acknowledged that the mode of teaching and learning support requires adaptation to fully meet the aims of this project. Current work focuses on this proposed mode of teaching and learning which will be included as part of the planned case studies. However a future vision on further possibilities has been gained as using the Virtual Learning Environment for other project and setting up other research networks.

The virtual reality system offers the participants in the InnoEd project new opportunities for ideation. They no longer have to be passive spectators but can experience and work in the virtual world in a number of ways. The data-driven software provides opportunities for recording every step taken in the system and makes it possible to research the ideation process inside of the virtual learning environment.

Modern society and its economic implications are more and more built on knowledge and working with ideas. The team work, shared experience and building ideas together in European wide markets is going to be one of the future trends (e.g. Alamäki, Mäkinen & Lehtonen 2003). The modern environment is always changing because of new technology and knowledge. In order to manage with that modern environment the individual must be able to adapt to novelty and to see possibilities in using new knowledge to produce new products. As design and manufacturing technologies advance it could be claimed that traditional workshop skills are less relevant. If accepted as a premise, this implies that the approaches used by IE are increasingly relevant in that they focus on initial ideation rather than prototyping.

Future research
Other work in this field includes an action research project in using the new Innovation Education model with focus on the approaches to the training of children and teaching creative skills inside of the VR in order to improve upon their ideation. The process will be done in collaboration with several partners. The focus of the research will be mainly upon children’s learning, planning of teaching; teaching and using techniques and the communication inside of the VR and in the classroom.

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