# CASE STUDY

# ICT TO SUPPORT IDEATION VIA GENERAL EDUCATION

By

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***ABSTRACT***

*This paper reports a case study series of four related case study lessons, set up as a course using a Virtual Reality Learning Environment (VRLE) to support the students' ideation skills in Innovation Education (IE) in Icelandic conventional classroom. The IE course content and preparation is described. Overall aims, objectives and research questions for the case study series are stated and specific data collection methods explained. Triangulated findings are reported as categories and results are discussed and analysed. Subsequently, the following research questions are answered.*

1. *How could the VRLE be used with IE material in a conventional classroom?*
2. *What pedagogical factors influence the innovation process, where the VRLE is used?*

*Keywords: Innovation Education, Virtual Reality Learning environment, Pedagogy, Constructivism, Computer supported Communication Learning, Computer Mediated Communication, Ideation, Idea Generation, Ideation Techniques.*

## INTRODUCTION

Innovation Education (IE) is a new subject area in Icelandic schools. The aim is to train students to identify needs and problems in their environment and to find the solutions called as: a process of ideation. This activity has been classroom-based, but now a specific Virtual Reality Learning Environment technology (VRLE) has been created to support ideation. This technology supports online communications between students and teacher and enables them to develop drawings and descriptions of the solutions.

The VRLE is internet connected and the students work online with their ideas in real time. As this learning environment is new it is important to evaluate and explore its use and value in supporting ideation in the context of IE. The author has run a series of research studies in order to identify the pedagogical issues of using a VRLE to support ideation within IE and to identify how it affects earlier pedagogical model.

Many educational researchers believe that VRLE technology offers benefits that can support education. The VRLE's capacity to deliver computer-cooperated supportive learning and constructivist-learning activities is one of its most important values. Another value is its potential to provide different forms of learning to support different types of learners, such as visually-oriented learners (Page et al.,2008). Several research projects have sought to establish learning within a very general educational setting, whilst a few studies have investigated the impact of immersion on the effectiveness of VRLEs. However, most of the studies sought to observe whether a VRLE is an effective educational technology or not (Winn 1993). Some of these research projects involved short-term investigations, whilst others were based on longitudinal case studies that developed virtual worlds for schools.

Many reports and demonstrations have been written on VRLE projects in education. However, studies regarding school education and ideation are still few and tend to be at a pilot level rather than fully developed. So far, none has found that concern supporting ideation in the context of Innovation Education. The article primarily considers the literature; furthermore, the specific software used for the enquiry is described. The content of the IE course is illustrated and overall aims, objectives and research questions for the case study series are stated. Subsequently, specific data collection methods are explained. Finally, results are discussed and analysed in order to answer the research questions and overall conclusion drawn.

### Idea generation

Idea generation or ideation, is a concept derived from Guilford (1950) and is used to describe the pattern of interactions that form when a person works on and produces an idea. Ideation is 'the formation of ideas or mental images of things not present to the senses' (The Oxford Dictionary, 2006). The Webster Dictionary (2005) (http:www.webster.com) defines ideation as 'the faculty or capacity of the mind for forming ideas; the exercise of this capacity; the act of the mind by which objects of sense are apprehended and retained as objects of thought'.

Santanen et al 2004 stated that 'ideation activities are fundamental to the process of creativity'. However, reflection on the definitions in the previous paragraphs shows that the process of idea generation clearly requires ideation skills. In an idea generation session, one or more people work to generate solutions to a problem or opportunity, intending to generate solutions that might otherwise go unrealised.

Osborn (1963) recommended that idea generation be seen as a separate activity from idea evaluation. This approach resulted in an increased emphasis on idea generation, which tended to overshadow idea evaluation (Smith 2001). Maier (1963) concluded that this segregation and increased focus would ultimately improve the quality of problem solving. This approach is consistent with Demerest's (1997) knowledge management approach, where knowledge creation is recognised as a key separate activity, yet supportive of idea generation. These events occur prior to the phase of knowledge embodiment in organisational groups, where filtering rules are applied similar to those of idea evaluation. Miller and Morris (1999) argue that idea generation based on an expansive view of knowledge creation is essentially the grouping and integration of ideas from many sources of accepted knowledge, prior to the viewing of those ideas.

### VRLEs at school level

Virtual Reality (VR) can be defined as "the idea of human presence in a computer generated space" (Hamit 1993: 9), or more specifically, "a highly interactive, computer-based, multimedia environment in which the user becomes a participant with the computer in a 'virtually real' world." (Pantelidis, 1993: 23). Virtual Reality systems have been used for many different purposes. Probably the most common are games and occupational simulators. However, Virtual Reality has also been used for educational training and online meetings.

Because the software used in this project is a managed learning environment and includes the InnoEd Virtual Reality, the author has named it a Virtual Reality Learning Environment (VRLE). Hall (2001) defines the managed learning environment or e-learning environment as an all-in-one solution software designed to facilitate online learning for an organization. It includes the functions of a learning management system for those courses within the learning environment in addition to teaching and learning materials. A learning environment is characterised by an interface that allows students to register and partake in courses. The program will usually include self-instructional portions, along with an academic structure. This model is often facilitated by an instructor, where a group can proceed on a week-to-week basis with seminar assignments (Paulsen 2003).

Many educators and researchers support the view that VRLEs offer opportunities to experience environments which, for reasons of time, distance, scale, and safety, would not otherwise be available to many young children, especially those with disabilities (Cromby et.al.1995). A VRLE can be used to support cooperative learning and socially oriented theories of learning, using computer technologies to support collaborative methods of instruction. Instructional design is characterised by a systematic and reflective process of applying principles of learning and instruction to develop instructional materials, activities, information resources, and evaluation (Paulsen 2003).

Many reports and demonstrations have been written on VRLE projects in education. However, studies regarding school education and children are still few and tend to be at a pilot level rather than fully developed. So far, none has found that concern supporting ideation in the context of innovation education. Most of the studies reported included positive indications such as improved motivation and learning, and the enjoyment of using the VRLE (Ainge,

1996; Bricken & Byrne, 1993; Johnson, Moher, Choo, Lin & Kim, 2002). Nevertheless, it is still unclear if VRLE support would appeal to students using the technology frequently over a long period and offer effective curriculum enhancement. Novelty effects might also be dominating at this stage and the positive outcome is therefore not as reliable as long-term research (Cohen et al. 2005).

### The specific software used for the enquiry

The VRLE used for the enquiry was developed to deal with online interactions of various kinds between students and teachers, as a support for ideation in the IE classes(Thorsteinsson & Page, 2004). From the IE classes, the students can access the VRLE with a user name and password, and this is done to protect the participants from any external interruptions. As before, the student brings any needs and problems identified at home into the school and works there, supported by the VRLE.

The VRLE was based on an Icelandic IE pedagogical model, developed from 1992. This model was based on a simple ideation process. The older model used conventional classroom methods of learning, whereas the new model incorporates. the VRLE in addition to conventional methods. This includes the Internet and specific data based software designed by participants in the InnoEd project. (Figure 1).

The main reasons for students using the VRLE in the IE classes were as follows

- To work together around their ideas sharing problems, solving them and developing solutions.
- To enable students to meet each other and their teacher in online.
- To enable easy communication inside virtual 3D spaces, where students and teachers could meet in real time, share information and work together with ideas.
- To give opportunities for developing certain skills within the innovation process (brain storming, drawing and discussion).
- To allow students the opportunity to give online presentations.
- To set up virtual exhibitions.
- To enable virtual meetings between participants.

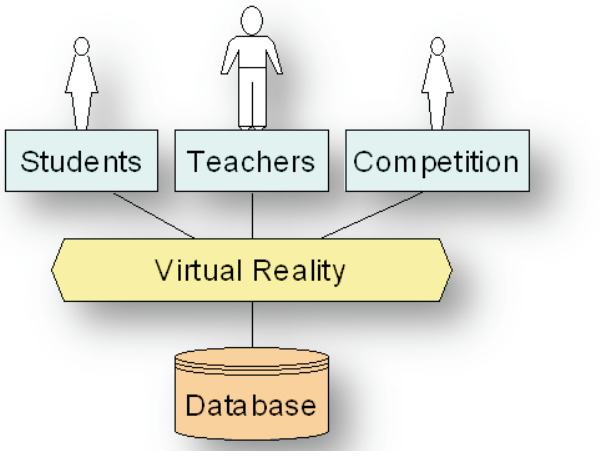


Figure 1. VRLE & Database Support of the InnoEd Model

### The pedagogy of Innovation Education

IE is based on conceptual work that involves searching for needs and problems in students' environments and finding appropriate solutions, or applying and developing known solutions (Thorsteinsson and Denton, 2003). The main emphasis of the pedagogy of IE is to develop students' ideation skills through the innovation process (Gunnarsdottir, 2001). The aim is to ensure that students are better equipped to deal with their world and take an active part in society.

IE is intended to be a simple way to teach ideation skills in the context of innovation activity, and such skills are incorporated at all stages. The flowchart below shows the fundamental steps (Figure 2).

Students learn through the innovation process within the overall IE pedagogical framework, which is managed by the teacher. The process is as follows:

- Finding needs
- Brainstorming
- Finding the initial concept
- Ideation drawings or modelling to develop the technical solution

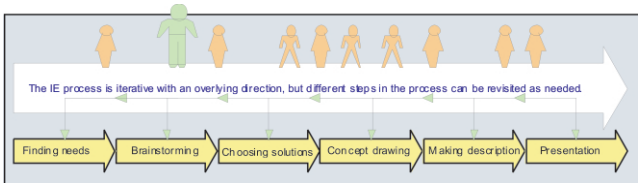


Figure 2. Ideation within the IE innovation process.

- Making a description of the solution, in addition to the drawing
- Presentation

Ideation is at the core of the IE pedagogical framework and the IE innovation process is iterative, with the overlying direction leading from 'finding needs' to 'presentation of solutions'. Innovation is to do with the usefulness of ideas and/or how they can be implemented as solutions to overcome many problems encountered in daily life. In Innovation Education, students use appropriate knowledge and information from different sources to find solutions. This comprises the search for solutions to needs and problems encountered in their own environment, and mirrors (Vygotsky 1978) on the zone of proximal development. Students work with their own concepts, but must learn to work through the innovation process to bring their idea into being (Gunnarsdottir, 2001).

*Aims, objectives, and research questions*

The aim of the project was to identify pedagogical issues involved in using the VRLE in an IE context within the classroom and to test data collection methods.

The objective of the case study series were as follows,

- To develop an understanding of the pedagogy relating to the use of the VRLE in supporting the development of ideation skills within IE.

The research questions for the case study series were as follows,

- How could the VRLE be used with IE material in a conventional classroom?
- What pedagogical factors influence the innovation process, where the VRLE is used?

Preparation for the case study series.

The case study series consisted of a series of four 90-minute related after school, case study lessons, set up as an IE course using the VRLE. The lesson sequence includes.

- Introduction and training in using the VRLE.
- Individual students work out solutions using the VRLE.
- The students test the VR element of the VRLE.
- Individual students develop solutions for an exhibition in the VRLE.

The author sent out a letter to parents outlining lesson plans and containing information, with a request for parent support regarding students' homework. The parents, the teacher and the school's headmaster undersigned their agreement for the research and gave their permission to use any collected data. The teacher was trained in using the VRLE for IE work and the computer facilities in the classroom were tested.

Before the students started the course, their teacher gave them a short presentation on IE and the planned IE course was explained. E-mail accounts were set-up for the students on the school server and they were registered in the VRLE with personal logins and passwords. The classroom used was an ordinary computer room with 24 computers and a blackboard; this was a departure from the previous non-VRLE IE lessons, which were typically held in general purpose rooms with tables for drawing and modelling. For computer based IE activities, 8 students were adequate. The author split the room so that half contained the VRLE computers and the other half was used for instruction and brainstorming sessions.

Data collection instruments

The author needed a comprehensive range of instruments. Varied data was needed to triangulate the research and strengthen reliability. The specific instruments were screen captured instruments, interviews to the teacher and the students, logbooks drawings and notebooks from students and video recordings inside the classroom.

Open coding was used in the process of data analysis based on grounded theory principles. In open coding the researcher forms initial categories of information about the phenomena being studied (Creswell, 1998). Creswell stays with an open mind to find as many ideas and issues as possible. Similarities in the outcome are classified into main categories and used for discussions; conclusions and feed forward (Emerson R.M., 1995).

The raw data was collected and translated directly into English. The author tried to retain the Icelandic language style and expression in the English translations, in order to avoid any misunderstanding when analysing the data (with regards to the characteristics of each language).

Data from each source was then summarised; for

example, there were two teacher interviews, which were summarised separately and then used to generate categories together. These categories were then discussed and conclusions were drawn. The process was repeated for all the data sources. Finally, the categories from all data sources were brought together under overall categories. These categories were then used to triangulate the findings and were analysed in relation to each other and the literature and conclusions were drawn. The process is demonstrated as a flow chart in Figure 2.

## Findings

The main pedagogical categories that were established through the analysis of the data were:

- Teacher's preparation
- Teacher's role and teaching handling
- Computer literacy
- Motivation
- Inventor's notebook / homework
- Drawing
- Ideation
- Use of the VRLE
- Collaboration

## Discussion of Categories

### *a. Teacher's preparation*

The VRLE may be relatively user-friendly, as the teacher stated in one of the first interviews. However, he also reported his need for more time to prepare lessons; this is more an issue of teacher confidence. In order to establish the teacher's confidence, pre-training is vital both in managing the VRLE hardware and software within the school environment.

In the case study series, the teacher needed more time to prepare himself, the computer facilities and the VRLE software for the lesson; nevertheless, his own experience in running such lessons can also be informative in training. This includes learning the general operation of the computer system, such as setting up emails. However, this can easily cause a conflict of roles between tutor and administrator. The case study series was an after school activity and thus it was difficult for the teacher to find time to fit it in his schedule. To run such lessons could also be tiring for a teacher in a full-time position and it may be better to run such classes within school time.

### *b. Teacher's role*

The teacher's role is more complicated in the context of using the VRLE in the conventional classroom. In the interview, the teacher talked about role conflicts between being a computer administrator and a tutor. As the students were self-reliant and more capable than he expected, the teacher found he was not always active in lessons.

Johannsdottir (2008) pointed out that teachers need on-going education, especially with regards to the new technologies in schools. The teacher has to switch between being a tutor and a facilitator or supervisor with general knowledge in ICT, Information and communication Technology which will be able to support the students in their studies. Teachers also have to be able to constantly adapt to new circumstances and learn to develop the curriculum accordingly. The focus moves from instructional teaching methods to supporting students' independent studies (Matthiasdottir, 2001b).

The teacher used multiple teaching methods. At the beginning of the lesson he used direct instruction, but also requested collaborative work from the students. He tried to make the students self-reliant by teaching the fundamental skills needed for working on the VRLE; this gave him time to administer the VRLE software and hardware. This was supported by the IE based VRLE, which provided a guiding structure for students. Also, the teacher was always nearby when the students needed help. From this experience, he realised that he could have demanded more from the students had he known their computer ability.

Gunnarsdottir's research (2001) suggests that, if the teacher dominates the classroom, the students tend to stop using their experience and little innovative work will occur. Extrapolating from this, we may assume that the use of the VRLE enables the teacher to adopt a role closer to 'facilitator', and that this would enhance the learning experience and student ideation.

Hreinsdottir (2003) has observed that there has been insufficient discussion on the use of computers in schools

and the role of the computer, the teacher and the students. However, many Icelandic educators have expressed their opinions about the influence of ICT on the students' way of learning and the teachers' role as follows,

- The students become more independent in their studies (Hreinsdottir, 2003) and they are better able to control their own direction (Johannsdottir, 2001)
- The students get more active and conscious participants in their own education (Matthiasdottir, 2001b).
- More possibilities arise to transfer the responsibility to the students and the parents (Karlsson & Hjartarson, 1998)
- It can make the work more cross-curricular (Thorsteinsson et al., 1997; Johannsdottir, 2001) and it is easier to establish more flexibility and diversification (Jonasson et al., 2002).
- More possibilities for innovation in teaching (Jonasson et al., 2002)
- Computers could make the teachers' work more interesting and change them into a facilitator and supervisor (Nordal, 1983: p32), therefore it changes the process of teaching and learning
- Virtual Reality Learning Environments seem to have the potential to affect the way students learn positively (Ainge, 1996). Ainge's research with upper primary students shows that virtual reality learning environment experiences can offer advantages over traditional instructional experiences.
- Many educators thought the teacher would change from an instructor to a guide and overseer (Matthiasdottir, 2001b)

*c. Computer literacy*

The background survey and the interviews with the teacher and the students indicated the students had good computer literacy; this was an important factor that enhanced their work. Students were also able to use the VRLE to guide themselves through the IE process, as it was meant to do. In this case, little training was needed in using the VRLE; students confidence in using the software was apparent. It may have affected the students' interest in IE, as the VRE reminded them of computer games. It is clear that good computer literacy is a pre-condition for using the VRLE for IE.

The students' computer literacy enabled the teacher to operate as a facilitator. It was unnecessary to spend time in teaching the use of the hardware and software. The teacher reported that he needed more training in the using of the VRLE and more preparation time; this was the case, even though this teacher was also the school ICT co-ordinator and, it may be assumed, of above-average computer literacy and with an adequate ability to manage the system and hardware. It may be that, normal subject teachers would find the use of the VRLE more difficult and thus require more training and practice / preparation time.

*d. Motivation*

The students found the IE course interesting, and discussing ideas at home increased this interest. Introducing IE with examples of the students' earlier work was a good starting point, as it contributed (along with other factors) to motivate the students. However, it is not clear whether part of the students' interest was connected to the author's presence as an outsider.

The students enjoyed the course and requested that IE be made a compulsory subject. The students acknowledged that the course was new and different and found the process of IE interesting. However, it is difficult to differentiate this interest from the motivation caused by experimental/novelty effects (Cohen, 2001). Nevertheless, motivation appeared to play a big role in the students' demonstrated capability. The students also showed interest in having the IE-VRLE course as an open and distance course; working at home on their computer. This is an interesting point for the author, as the VRLE has not been used as a tool for open and distance learning; however, it may offer new possibilities for other schools.

*e. Inventor's Notebook / homework*

The study showed the students notebook to be an important tool that supported communication and collaboration with parents and as an important media to transport homework to school; It was also of a great help in starting lessons. The IN (Inventor's Note Book) also increased the students' interest in identifying needs and ideas at home; they found it easy to use and practical.

During the study, the teacher suggested using mobile phones to send IE needs and images directly to the VRLE,

rather than using the IN. This is an interesting suggestion but merits further research.

The students used the VRLE at home; they recorded ideas and solutions and tried to enter the VRE. However, most of them did not possess the appropriate graphics card and thus were not able to use the VRE. The IN was, therefore, particularly useful in this respect.

*f. Drawing*

The students quickly learned to use the CAD program and the drawing tablets through experience, but their drawings were inaccurate; but showed sketches of initial solutions. However, further training might give a better outcome and increase the students' ability to develop the solutions. Graphics tablets were better than using a mouse, but there may be much better equipment available, closer to the traditional method of sketching with a pencil. The students experienced difficulties drawing inside of the VRE, because they were not used to using the CAD programme. There might possibly exists better computer-based drawing equipment that might bring students closer to the natural way of sketching.

*g. Ideation and Innovation Education*

The teacher was convinced that the students' motivation for the course positively affected their ability to find new ideas. They had quickly understood the Innovation Process and were able to identify needs and problems in their own environment. Therefore, they found their ideas easily. The novelty of the students' ideas was doubted by the parents, and this implied that some of the parents might not have understood the educational value of the IE course for the students. The identified needs and solutions at home were useful in starting the IE lessons, as input for the brainstorming sessions. Short brainstorming sessions were also useful to refresh the students when they got tired. An interesting input from the teacher referred to the usefulness of ideation skills for subjects other than IE. In fact, IE is now part of the general chapter of the National Curriculum in Iceland and can be incorporated into all subjects of The icelandic National Curriculum (1999).

*h. Use of the VRLE*

Good computer facilities enabled the students' work in the case study series. The students had no difficulty in using the Managed Learning part of the VRLE, once they got their email accounts open. The teacher gave them basic training, but their own experiences helped them in using the VRLE and the drawing tables. It was, however, more difficult for them to use the VRE part of the VRLE, when they were asked to design together; using an avatar inside the VRE is difficult at first. However, the students were happy, as it was fun for them. Being able to speak between computers via headsets helped the students to work inside of the VRLE, as it enabled their collaboration. However the teacher had to be aware of the possibility of outsiders manipulating the VRE´s security. (Figure 3).

*i. Collaboration*

The students were communicative and collaborated well together inside the MLE: the multimodal possibilities for communications may have will enhanced communications and collaboration. The group did have problems working as a group inside the VRE; the smaller the group and the better the students were able to work together.

The students used the possibilities for sharing needs and problems with each other inside the VRLE. They could also use brainstorming to communicate needs and ideas, both inside the classroom and inside of the VRLE as two parallel worlds.

When using innovative teaching methods, instructors need to be supported by their authorities and colleagues. The teacher in the case study series, whilst an experienced user of ICT, reported that he needed more time to practice and prepare (Bailey et al. 2004). The headmaster of this school supported the IE course and was interested in making IE a compulsory subject.

**Answering the research questions**

Using various data collection methods provided evidence

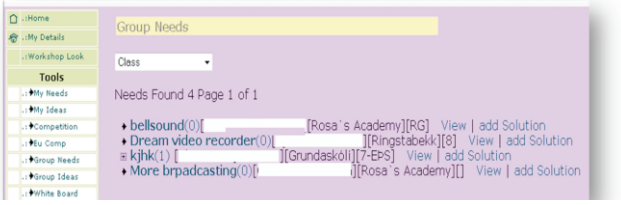


Figure 3. The students share their needs and ideas inside the VRLE

which enabled triangulation inside the established categories. In the following sections, the research questions for the case study series are answered as follows,

The research questions for the case study series were:

1. How can the VRLE be used with IE material in a conventional classroom?

2. What pedagogical factors influence the innovation process when the VRLE is used?

*Question one*

The teacher's observations and the lesson plans, the interviews with the students, and the teacher, the logbooks and the students work in the VRLE database all provided information about how the students used the VRLE for the IE work: Figure 4 shows the process of VRLE. The arrows show the path the students took; they incorporated methods from the traditional IE. As the diagram shows, there are many other possibilities for IE to work: one would be to use the VRLE tool for open and distance educational IE courses.

This model connects the home environment and the school together; the students originated their ideas at home by identifying needs and problems and brought them to school. They recorded ideas in the IN and uploaded them to the VRLE database from their home. This highlights the underlying IE pedagogical background and

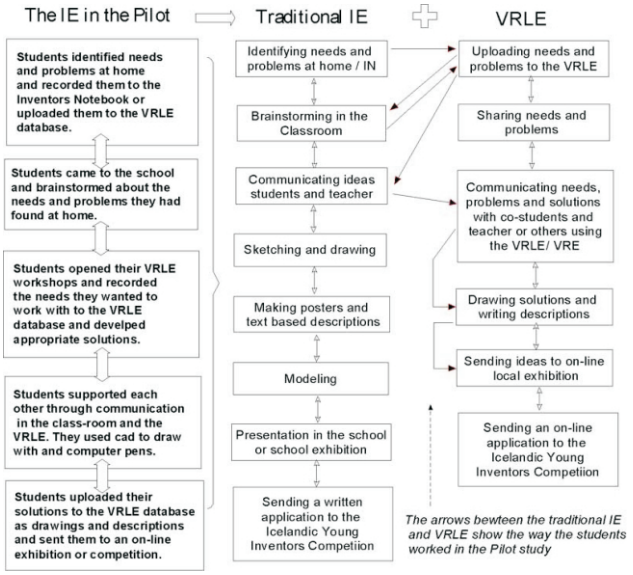


Figure 4. The way students used the VRLE to support their work inside of the innovation process (note the arrows between traditional IE and VRLE).

the relation to the constructivist theories identified in the literature.

*Question two*

The main pedagogical factors that arose in the data were: computer literacy, managing the VRLE in the school context, and the role of the teacher.

*a. Computer literacy*

Interviews with students and teacher, in addition to observations, indicated that the students easily learned to use the VRLE and the CAD software: little teacher assistance was needed. However, the students did experience difficulties in using their computer mouse to draw, and the CAD they used was too basic. At the beginning of the course they used a mouse, and later on a pen that connected to the computer. With this, the students had to look at the screen as they drew, which shows how the new VRLE technology can be used in schools for pupils from class seven upwards.

*b. Managing the VRLE within the school*

The interviews with the teacher, his logbook, and classroom observations showed the importance of the teacher managing the VRLE hardware and software in the school. Appropriate facilities are needed to run the system, such as graphic cards, headsets, and digital pens. However, this represents extra cost for the school. Introducing such new approaches and technology does require a great deal of effort on the teacher's behalf. Training would be necessary, in order to enable the teachers to manage the hardware and the software.

*c. The teacher is the key to successful IE lessons*

In the interviews with the teacher, and in his logbook, he mentioned the importance of being trained to use the VRLE. Also, it is necessary for him to understand the innovation process, to be able to guide the students. In his observations, the author could see a lack of teacher understanding of the innovation process. However, he was usually in the role of facilitator rather than instructor. The teachers' self-confidence was identified as important. This teacher had experience as an ICT teacher and was the schools administrator, but it was noted that he often lacked confidence in running the IE course and when dealing with

the software and hardware.

The VRLE was found to be user-friendly and enabled the students to be self-reliant. Nevertheless, the teacher still had to use familiar pedagogical principles, such as giving clear instructions. It was important to link the students' homework with their activities inside the VRLE through brainstorming sessions in the classroom. After this, the students could work independently. When they had to undertake their work in the VRLE, they sometimes got tired after 20-30 minutes, but, by using short brainstorming sessions, the teacher found it was possible to refresh them.

## Conclusion

Our pedagogical understanding of using this VRLE for Ideation has to be developed further. Many possibilities lie in the application of the VRLE software. The basis of the technology is already part of the daily lives of young people, but to date, is less advanced in general education. Using the VRLE depends largely on the teacher's ability to manage it. Work has to be done to develop course material for training teachers so they can manage to use it and fully adopt it in schools. It is also necessary to explore the possibilities that lie in the usefulness of such technology for open and distance education in the context of ideation in IE. As seen from this project the VRLE can be useful to reinforce the process of ideation. However, the indications from the research are that we need to explore and understand the application of the VRLE to support brainstorming and ideations further.

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