# Enabling Idea Generation through Computer-Assisted Collaborative Learning

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**Abstract:** This article puts forward a three related case study series, using a *Virtual Reality Learning Environment* (*VRLE*) with a view to supporting the development of students' ideation skills in conventional primary and secondary education. Since this learning environment is fairly new it is necessary to examine its educational uses and determine if the new learning environment will meet teachers' expectations. Therefore, the overall goal for this research was twofold: a) to explore the ways in which idea generation was developed during students' work in an enjoyable environment b) to assess the way *VRLE* affects students' ability to generate new ideas and pass on knowledge. The data collected was qualitative and the analysis was based on grounded theory principles and an interpretive paradigm.

**Keywords:** Idea generation, collaborative learning, computer-assisted learning, Virtual Reality Learning Environment, pedagogy, ideation process.

## 1. Introduction

Computer-Assisted Collaborative Learning (CACL) is commonly described as a situation in which two or more people learn or work together, usually aiming for dissimilar goals (Dillenbourg, 1999; Chiu, 2000). Students involved in Computer-Assisted Collaborative Learning benefit from one another's resources and skills. This can include assessing each other's ideas, asking one another for information and observing each other's work (Chiu, 2000). CACL can, furthermore, be described as computer-based network systems that upkeep group work for a joint purpose and provide a shared interface for a team to work with (Ellis et al., 1991; Stahl et al., 2006).

In CACL, computers are used within an educational setting to facilitate and support collaborative group learning processes. The main purpose is to support students in learning together effectively, for example, communicating ideas, accessing information and providing feedback on problem-solving activities (Stahl et al., 2006).

The paper reports three case study series which took place in several elementary and secondary school classes (six to sixteen-year-old students; various groups of volunteers, from the seventh class onwards, took part in the research). The background of the *VRLE* is described and the overall aims, objectives and research questions stated. Idea generation is defined and a specific model for idea generation demonstrated. The research methods are explained and findings reported. Subsequently these findings are discussed and conclusions drawn.

## 2. Related Approaches to Idea Generation

The term *Ideation* originated from Guilford (1950), Thompson (2008) that used it to describe the pattern of interactions that arise when an individual produces an idea. As *The Oxford Dictionaries Online* (2011) states, ideation is the formation of ideas or mental images of things not present to the senses. Idea generation is the generation of possibilities, performed at various points in problem solving and innovation episodes (Smith, 2003). Lying at the heart of both invention and design, it is widely acknowledged as a key part of the innovation process (Van de Ven et al., 2000).

Innovation is closely related to idea generation, as the innovation process invariably includes problem-need identification and problem solving (Smith, 2003). Osborn (1967) understood idea generation and idea evaluation as a two separate activities. Demerest (1997), similarly, recognised knowledge creation as a key separate activity supportive of idea generation. Rickards and Freedman (1978) suggest that an additional time separation or deferment of judgement should occur in the idea generation phase, as this time factor allows ideation to develop before idea evaluation takes

place. Titus (2000) speaks of periods of idea generation rather than separated events, suggesting the need for reflection and further development. Similarly, Henry (1991) considers the need for a period of incubation in idea generation: this period is referred to as deferred judgement and is distinct from dormancy. Rather, it should be a period of knowledge creation through dialogue, debates, scanning, etc. Accordingly, ideas are generated and shaped, prior to idea evaluation.

Modern technology can be used to support collaborative ideation. Computer technologies and the Internet are now an everyday part of students' lives and are arguably becoming the preferred mode of both communication and the collection of information (Hennessey & Deaney, 2004; Passey et al., 2004). As the use of the *VRLE* was new and the learning and teaching context complex and dynamic, the focus became the exploration of the use of the *VRLE* to support student ideation work (Thorsteinsson, Page and Niculescu, 2010a). The intention was to identify the issues involved, to use literature and fieldwork to understand how these issues were related and, eventually, to be able to prepare a map of directions for further research.

was an online *VRLE*, linked to a database: this *VRLE* was developed as a combination of the managed learning environment (*MLE*) and the virtual reality environment (*VRE*). The *MLE* provided the framework for teachers to manage student learning, while the *VRE* provided a simple virtual environment that enabled students to meet and communicate through a number of means, such as voice, text, drawings, photographs and presentations. The database enabled these ideas to be shared and recorded and these, as a whole, represented the *VRLE*.

The *VRLE* is potentially a tool for experiential learning, as it provides various dynamic and rapid ways to see, experience and generate ideas and information. The *VRLE* can be used as a tool for problem solving and communicating ideas and includes the possibility of promoting a high degree of interactivity and immersion (Ogle, 2002; Bricken, 1991; Johnson et al., 2002; Jonassen, 2006; McLellan, 1996; Osberg, 1993). The *VRLE* is interactive in two ways: firstly, a user interacts with data in the database within the *VRLE* and also beyond; for example, via the World Wide Web (www). Secondly, it allows the interaction of a number of students and staff within the *VRLE*, using a range of modes including speech, drawing and writing.

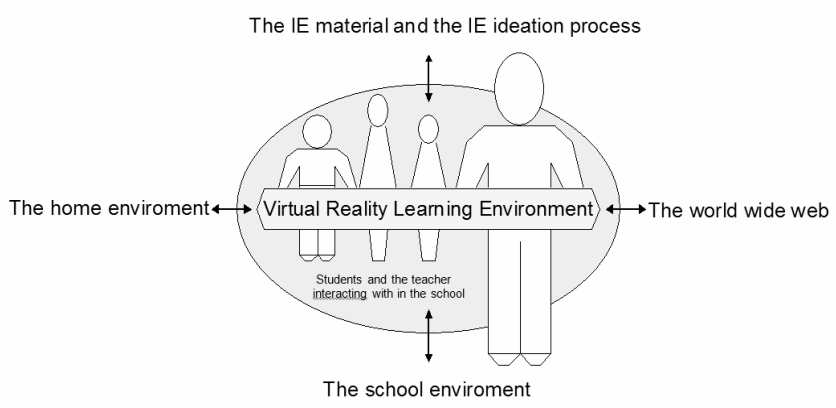


**Figure 1.** The VRLE offers different dimensions of communication

## 3. Using a *VRLE* to Support Idea Generation

The original idea behind the *VRLE* was to find a new way of supporting students' ideation work, using information and computer technology (Thorsteinsson and Denton 2003). The specific *VRLE* was designed to enhance ideation via collaborative learning support and thus creating individual and social educational opportunities. The main output of the project

Students could be from the same class or in other schools or countries, accessing the *VRLE* via the www. Using the *VRLE* within the classroom context offers multi-modal communication and this would be expected to influence students' learning experiences.

The main reasons for students using the *VRLE* were to:

– offer another enjoyable mode of working together, in terms of ideas, sharing

problems, solving such problems and developing solutions;

- enable students to meet each other and their teacher online;
- facilitate easy communication inside virtual 3D spaces, where students and teachers could meet in real time, share information and work together with ideas;
- provide the opportunity to develop certain skills within the ideation process (i.e., brainstorming, drawing and discussion).

## 4. A Pedagogical Model for Idea Generation

The research activities were built on the following model for Idea generation (Thorsteinsson & Denton, 2003 (see figure 2). They were based on a series of steps, iterations and relationships, with the overlying direction leading from 'finding needs' to 'presentation of solutions'.

1. Finding needs;
2. Brainstorming;
3. Creating and choosing initial solutions;
4. Concept drawing or modelling, in order to develop the technical solution;
5. Creating a description of the solution, in addition to the drawing;
6. Presentation.

Ideation skills are employed at all stages of the innovation process and innovation relates to the usefulness of ideas and/or how they can be implemented as solutions to many problems encountered in everyday life. Students learn through the cycles of the innovation process, supported by the collaboration amongst individuals, as a group, and by the teacher. The overall framework is managed by the teacher (see Figure 2).

A course plan and related research plan were established, on the aim and research questions. The teacher set up email accounts and registered them to the *VRLE*; he also took digital photographs, in order to enable the students to personalise their *VRLE* workshops. The classroom used was an ordinary classroom, with 12 network connected computers and digital drawing output devices. For computer-based *VRLE* activities, 8 students were adequate. While this was a small sample, it did enable a close focus on the group and was consistent with enabling pedagogical issues to emerge.

The various collaborative learning tasks designed for idea generation benefit from this virtual learning tool which enables students to connect to each other and the outside world, thus facilitating communication and knowledge transfer. While the *VRLE* has the potential to enable open and distance learning, in terms of co-operation between students and teachers

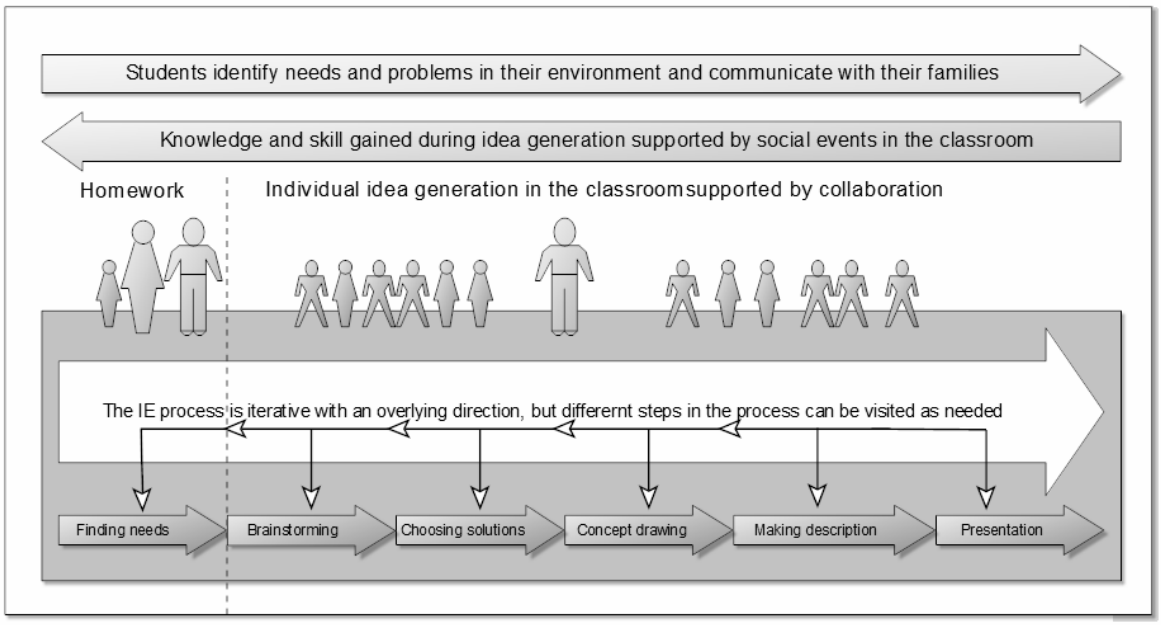


**Figure 2.** A basic pedagogical model for idea generation that illustrates innovation as a 'process', with appropriate feedback loops and options.

across continents, it was decided that this would be too large a dimension for this research. Thus, the focus was limited to the use of the *VRLE* within the conventional classroom context.

## 5. Research Methodology Development

As the research took place in a complex social/educational context, grounded theory (Glaser and Strauss, 1967) principles were used as a way of observing, describing and interpreting settings as sources of data (grounded theory is a principle based on the systematic building of theory, using qualitative or/and quantitative data). The key points in the data are marked with a series of codes, which are then grouped into emerging conceptual categories. These categories are related to each other as a theoretical explanation of the action(s) that continually resolve the main concerns of the participants within a substantive area (Denzin, 1984).

Grounded theory focuses on obtaining an abstract analytical schema of a phenomenon that relates to a particular situation (Creswell, 1998). However, Strauss & Corbin (1998) explicitly pointed out that the value of grounded theory lies in its ability not only to generate the theory, but also to ground that theory in data. This inductive method is particularly helpful in identifying patterns of behaviour or thought in a particular group of people, as in this study.

Further reading on the principles of grounded theory and specific research methods appropriate to this educational context (Glaser & Strauss, 1967; Cohen et al., 2005) led to the design of a programme of case studies intended to explore the research questions. Three case studies were undertaken, each based on a programme of lessons, and these were used iteratively, in that a period of analysis and reflection followed each case study and led into the next. An action research phase was used to further develop the pedagogical model. Issues were identified and tested in terms of the use of the *VRLE* in classroom environments.

Specific techniques were used for data collection including interviewing, observations and document analysis. The use of different data sources helped the researcher to 'validate and crosscheck findings' (Patton, 1990:244). In the case study series, different types of qualitative data were collected in the form of interviews with the participating teacher and students; classroom observations; video recordings of students' activity when using the *VRLE*; screen video recordings; student work samples and the teacher's and researcher's logbooks. These multiple perspectives offered a good degree of triangulation (Denzin, 1984; Cohen et al., 2005).

## 6. General Findings

Throughout the research the *VRLE* worked well in general; it was stable and easy to register the students. However, dealing with the *VRLE* technology might have been more difficult for a teacher without strong information technology skills. Probably due to good computer literacy, students learned to use the *VRLE* through direct experience. Using the *VRLE* network inside the classroom made it possible for students to learn from one another both face-to-face and online. They also got some instruction from the teacher. They quickly became self-reliant but the teacher considered they needed more concrete learning material and a traditional instructional phase.

The teacher's role was to help students to understand the innovation process. Training them via the *VRLE* was beneficial for their idea generation. Normally, students quickly understood the innovation process and were able to identify needs and problems in their own environment. Identifying problems and needs at home played a significant role in the first stages of the innovation process that took place at home. This was intended to trigger idea generation in lessons, helping students to generate the content of the course, make them self-directed and give a personal value and meaning to their work.

Students usually defined their findings spontaneously and tended to record solutions in their notebook, instead of needs and problems. However, the teacher was able to help them to define needs rather than solutions by means of discussions held while they worked inside the *VRLE* without imposing his own value judgements.

The *VRLE* directed students' idea generation as it was structured upon the idea generation process. The *VRLE* facility for sharing needs, solutions and brainstorming during classroom activities was identified as beneficial. Students

frequently shared needs and problems with each other, both face-to-face and online. There was a balance between needs identified at home and at school. However, most ideas were generated when students were working collaboratively inside the *VRLE*. Students worked individually but supported each other by sharing their knowledge via the *VRLE*. The students generated similar amounts of needs and solutions and there was a balance between boys (20) and girls (20). Just one in the group shared their needs with one or more individuals and two shared their needs with the group. Four students shared nine solutions with individual students and with the whole group. Forty solutions were delivered in total and 35 needs. The students established two group needs and sixteen group solutions. Most often, there was a congruency between the students' needs and solutions.

## 7. Discussion and Conclusions

The *VRLE* guided the students work, gave structure and reflected the role of the computer as a tutor, tutee and tool (Blom and Monk, 2003; Taylor, 1980) and enabled both CSCL and CSCW (Thorsteinsson and Denton, 2008 and Thorsteinsson, Page and Niculescu, 2010b). The *VRLE* worked as a tool students used to enable their work. It included help pages and was structured on the innovation process. This structure and help pages guided and directed students during their work and was therefore a form of tutee.

During the research, students had no major problems in using the *VRLE* and quickly became self-reliant (Thorsteinsson and Denton, 2008). Their confidence and IT ability enabled them to start using the *VRLE* easily. However, the case studies showed that additional training was needed to comply with the hardware requirements (specifically the graphical input devices) and the *VRLE*. The teacher also considered students needed training in using the *VRLE* for cooperative idea generation (Thorsteinsson, Page and Niculescu, 2010a).

Social presence was an important aspect of using the VRLE and enabled a community of learners to grow as Hamburg et al. (2003) Hauber et al. (2005) have indicated. Playing informally in the VRLE was shown to promote the students' skills and confidence in using the VRLE, and familiarity with each other (Prensky, 2005; Hussain et al., 2003). The case studies indicated that being physically together and being able to speak to the teacher both inside the classroom and over the Internet at the same time appeared to assist students learning, probably via having multiple modes of communication (see also Loiselle et al., 1998 & Schrum & Berenfeld, 1997; Thurlow, Lengel, & Tomic, 2004; Romiszowski & Mason, 1996). The capability of students personalising the interface of their virtual workshops appeared to be important in relation to increasing their perception of relevance and ownership of the *VRLE*, echoing Oulasvirta and Blom, (2008) and Blom and Monk, (2003).

It was the teacher's role to help students to understand the innovation process (Gunnarsdottir, 2001) both with and without the *VRLE* (Thorsteinsson and Denton, 2008). They quickly became familiar with the innovation process in so far as they can bring basic ideas to school to act as start points for effective collaborative idea development. However, it was evident that students in the case studies did not understand the fine differences between problems, opportunities, needs and initial ideas. This may be due to their relative immaturity (age 11 – 12) but is certainly an area that merits further specific research.

Collaboration played an important role, both at home, in the classroom and inside the *VRLE* to facilitate idea generation, supporting the position of Hamburg et al. (2003). Training students in idea generation via the *VRLE* and in the classroom appeared to be encouraging self-reliance and independence and appeared to be beneficial for idea generation. It furthermore gave the teacher a little more freedom to stand back and observer the group carefully. This supported him in adopting the role of a facilitator to a greater extent (Thorsteinsson and Denton, 2008).

The *VRLE* was structured upon the innovation process and included a facility to brainstorm and share needs and solutions. It can be seen as an interactive, collaborative, learning tool supporting idea generation. Students often shared needs and solutions inside the *VRLE* (Thorsteinsson, Page and Niculescu, 2010a).

Students in the case studies were generally self-reliant and worked most often individually inside the *MLE* part of the *VRLE*, but also collaboratively inside the *VRE* at the same

time. This collaboration was supportive for individually based idea generation (Dennis & Valacich, 1993). However, students were still less productive and fewer ideas were generated as it was time consuming (as with Taylor et al., 1958 and Paulus et al., 1995). Being able to play inside the *VRE*, when working in the MLE, was a form of informal "edutainment" that supported collaboration and skill (O'Quin and Derks, 1999). A light-hearted spirit in lessons appeared to positively influence idea generation, supporting the position of O'Quin and Derks (1999).

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