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Co-operative Learning in a Virtual Reality Environment (VRE) Through Idea Generation: A pilot study from Iceland

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Abstract

A pilot study was undertaken in an Icelandic elementary school, using a Virtual Reality Environment (VRE) to facilitate co-operative idea generation within the context of the classroom; this technology supports online communications and enables students to develop drawings and descriptions of their solutions. The VRE was connected to the Internet, and students worked both online and face-to-face during the lesson. The aim was to explore the ways in which idea generation was developed in students during their work; the produced data was qualitative and analysis based on grounded theory principles and an interpretive paradigm. Three data instruments were used to enable triangulation: observation, screen captured videos and the teacher's logbook. Also, using remote observation software allowed the collation of a rich record of actual computer work activity in its natural work setting. A qualitative and inductive methodology, developed by Glaser and Strauss (1967), was used to analyze the data.

The researcher based his research around the following questions:

1. How could collaborative idea generation be incorporated within the VRE?
2. How does this relate to teaching and learning within the lesson?
3. How do communications during the lesson support students' work?

Key words

idea generation, Virtual Reality Environment, multiple communication, co-operative idea generation, co-operative learning, user interface, remote observation, screen captured videos

Introduction

The paper reports a pilot study, undertaken during the spring of 2004, within a secondary school in Iceland. The author tried to gain experience of using a Virtual Reality Environment (VRE) in a school context for co-operative idea generation; this was

based on observations within a complex social/educational context, in the classroom. Data was collected in a naturalistic way and analysed, according to the principles of the grounded theory of Glaser and Strauss (1967).

Conventional learning comes in a range of forms and is therefore difficult to characterise. However, learning is usually based on the idea of information provided by an instructor during lectures and printed course materials (McInerney 2002). The primary modes of learner interaction, therefore, are learner-instructor and learner-content (Bricken 1990), with almost no learning taking place between the students. The VRE enables multiple online communications and thus supports different forms of learning within the classroom context (Thorsteinsson & Denton 2008).

The rapid rise of computers and networks has seen the introduction of novel forms of communication to education: computer-mediated communications (CMC) can take many forms, but asynchronous threaded discussions give learners the time to think about problems and allows them the opportunity to discuss possible solutions within a group (McInerney 2002). With Virtual Reality Learning, students can access other student's responses and add to them over time (Thorsteinsson & Denton 06), and actively participate in constructing new knowledge (Thorsteinsson 2002). This allows students to discuss ideas in groups and solve any problems, thus extending classroom time (McInerney 2002).

Co-operative Learning is a teaching arrangement that refers to small, heterogeneous groups of students working together to achieve a common goal (Kagan, 1994); students work together to learn and are responsible for their team-mates' learning, in addition to their own.

Hundreds of studies (including Kagan, 1994 & Johnson, Johnson, & Stanne 2000) have been undertaken to measure the success of co-operative learning as an instructional method with regards to social skills and student learning and achievement across all levels, from primary grades through to

college. The general consensus is that co-operative learning can and usually does result in positive student outcomes in all domains (Johnson & Johnson 2001).

The purpose of this study was to examine the possibilities of using a Virtual Reality Environment for cooperative learning during idea generation. The process attempted to understand the relationship between a student's co-operation and the design process, learning experiences and the pedagogy employed by the teacher. The methodology was designed to develop a set of categories to provide an explanation for this social phenomenon.

The author observed the impact of students' communication on their joint design during their work. Students' different roles and initiative were studied, as was their ability to draw inside the Virtual Reality Environment.

The author firstly introduces the pilot study and reviews the literature. Then, he discusses the research design, the undertakings of the pilot study and the findings. Finally, he analyses the outcome and draws his conclusions.

Idea Generation

Ideation, or idea generation, 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 (<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 (p23) 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.

Co-operative Learning

Co-operative learning is generally defined as a teaching arrangement in which small, heterogeneous groups of students work together to achieve a common goal (Kagan 1994 & Ravitch 2007), with each student having a specific responsibility within the group. Advocates believe that cooperative learning enables students to acquire both knowledge and social skills, and that those students try harder because they are members of a team; they also contend that students have more opportunities to ask questions and clarify confusions than they do in a whole-class setting (Kagan 1994 & Slavin 1991). Critics complain that group work wastes time and that high-performing students end up doing most of the work (Ravitch (2007).

Millis (1996) outlines five characteristics associated with co-operative learning:

- Students work together in small groups of 2-5.
- Students work together on common tasks or learning activities that are best handled through groupwork.
- Students use cooperative, pro-social behaviour to accomplish their common tasks or learning activities.
- Students are positively interdependent and activities are structured so that students need each other to accomplish their common tasks or learning activities.
- Students are individually accountable or responsible for their work or learning.

In co-operative learning groups, students encourage and support each other, assume responsibility for their own and each other's learning, employ group-related social skills, and evaluate the group's progress (McInerney 2002). The basic elements are positive interdependence, equal opportunities, and individual accountability (Kagan 1994 & Ravitch 2007). Human beings are social creatures by nature, and thus cooperative learning groups should be used more within schools as a teaching method (Ravitch 2007).

Co-operative learning as a teaching method began to be developed during the 1960s and was evaluated in a wide variety of teaching contexts (Ravitch 2007). Thorough research into co-operative learning found that co-operative learning strategies improve the achievement of students and their interpersonal relationships (Slavin 1991).

Johnson, Johnson, & Stanne (2000) stated that co-operative learning strategies are widely used because they are based on theory validated by research, and almost any teacher can find a way to use co-operative learning methods that are consistent with personal philosophies. Factors contributing to the achievement of cooperative learning are group goals and individual accountability; providing students with an incentive to help and encourage each other increases the likelihood that all group members will learn. In addition to individual grades and evaluations, there is strong evidence that group grades and team rewards are the most successful motivational tools (Slavin 1995). Some educationalists, however, argue that group grades and team rewards allow some students to 'free ride', which means they do not participate to the fullest extent of their abilities (Joyce 1999 and Cohen 1998). It has also been argued that group grading de-emphasises the importance of hard-work, personal ability, and perseverance (Kagan 1995).

Co-operative learning enhances social interaction, which is essential to meet the needs of at-risk students (Slavin, Karweit, & Madden 1989; Johnson 1998). In co-operative learning groups, students learn how to interact with their peers, thus increasing their participation within the school community (McInerney 2002). Positive interactions do not always occur

naturally, and social skills instruction must precede and run alongside the co-operative learning method. Social skills include communicating, building and maintaining trust, providing guidance, and handling conflict (Goodwin 1999).

The Virtual Reality Environment Used in the Study

The virtual reality environment used was part of an Icelandic Virtual Reality Learning System that included both a managed learning environment (MLE) and virtual reality environment (VLE) (Thorsteinsson et al. 2005). The VRE element was developed as a communication tool to enable co-operative idea generation; it allows participants to utilise synchronous virtual communication with sound, pictures, and movements. It also offers the possibility of using CAD for communicating ideas in the form of drawings and the formation of 3D objects (Thorsteinsson & Denton 2006). The use of the VRE element was established, incorporating security requirements; it was possible to enter the VRE from inside a personal workshop after the user had passed all the security requirements (Thorsteinsson et al. 2005). When the user entered the VRE, they could choose from a range of avatars (see figure 1), representing both adults and children.

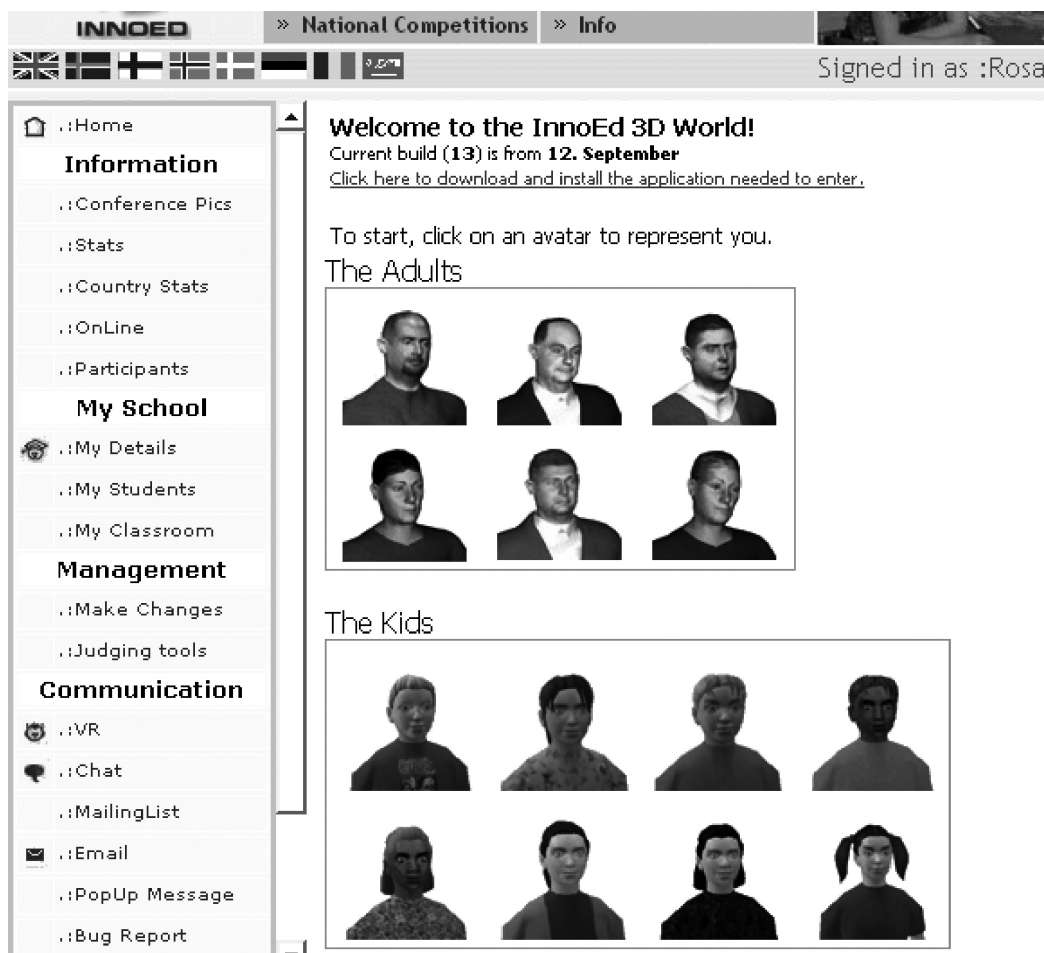


Figure 1: The available avatar range



Figure 2: Students and their teacher at work, using the VRE in the classroom



Figure 3: Students and their teacher at work inside the VRE

The VRE was designed in the form of a house, with many rooms and a garden. The students could walk about and communicate by using voice over IP, or by sending text that appeared on the screen; they could also interact and communicate using their avatar's body language. Each room in the VRE had big screens for playing videos, browsing the Internet, showing PowerPoint presentations, along with whiteboards that enabled the participants to draw together (Thorsteinsson & Denton 2006).

Research aims, Objectives and Questions

The purpose of the pilot study was to gain an experience and understanding of the pedagogy of using VRE for co-operative idea generation within the school context.

The objectives were to:

1. Observe co-operative idea generation within the VRE.
2. Gain experience of using screen captured video data.

The research questions posed were

1. How can a VRE be used for co-operative idea generation?
2. How do communications during the lesson support students' work?
3. How does co-operation relate to teaching and learning within these lessons?

The Pilot Study Lesson

Four students, two boys and two girls from class seven, took part in the study; they were randomly selected from a group of interested students. A lesson plan was established by the participating teacher, who took responsibility for running the lesson, whilst the author took care of data collection. The plan was based on:

1. Introduction and training in using the VRE.
2. Brainstorming on a selected need, as determined by the students' own environment.
3. Students developed solutions as a group within the VRE.

The teacher explained the lesson plan to the students and also recorded the needs on the blackboard he had asked the students to find at home. The teacher then asked the students to work together in a group: he trained them to use the CAD application within the VRE. The students had to choose one need from the blackboard, brainstorm on it, and meet in the Virtual Reality Environment to work on a solution together.

The group worked together on a joint drawing of their solution, then, finally, they saved the drawing to the VRE's database.

Measuring instruments

The pilot study was founded on an interpretive paradigm: the data was qualitative and the analysis based on grounded theory principles. This focused on understanding co-operative idea generation inside a virtual reality environment in a school context, and was done by describing and interpreting human communications, learning performance, and use of the VRE technology.

The data instruments were selected to enable triangulation and reliability; these were the teacher's and author's observations and screen captured videos. In order to analyse the data, the qualitative and inductive methodology, as developed by Glaser and Strauss (1967), was used.

Data Sources
1. The teacher's logbook
2. The researcher's observations
3. Screen captured videos

Table 1: Data Collection Methods Used in the Pilot Study

Data Collection and Analysis

The data collection methods used for the pilot study are shown in Table 1. Screen captured video was taken inside the VRE during the students' interaction, using the software *Camtasia 3.0* (<http://www.camtasia.com>). The specific software *Transana* (<http://www.transana.org/download/index.htm>), which analyses videos in qualitative research, was used to enable the data analysis. The video had no sound, only showing the text and graphics that the students communicated with: this was not an issue, as the students were not discussing during their work inside the VRE; rather, they were writing text to each other, which appeared on the screen.

The data was treated as follows;

1. Raw data collected and translated.
2. Raw data summarised.
3. Summaries analysed and classified into categories.
4. Findings discussed and conclusions written for each data source.
5. All the categories from the three data sources brought together and classified.
6. Overall discussion written in the light of the literature and triangulation established.
7. Conclusions drawn relating to the research questions.

Summary of Data Analysis

The students decided to design a device to help them to wake up in the mornings during their summer vacation. This was done collectively, on the virtual whiteboard, for a period of 18 minutes. One of the students started to draw a simple bed (context); subsequently, others started to contribute until it was 'finished'.

The group solution drawing comprised of five main elements: a bed, a person, bedside unit, alarm clock and bucket, with all members contributing to the drawing. Most parts were two-dimensional representations, but the bed and the figure in the bed were three-dimensional. The drawings (using a mouse) were not accurate, but reasonable for the age range: they showed a basic solution when together. In addition, the students drew grass, flowers, a cat's head, a mill, and a cloud with a text message inside. Finally, the students coloured and decorated the drawing and made it more detailed.

The main parts (Figure 4 and the description below) were drawn in sequence. However, each part was visited more than one time by different students during the process, and, each time it was revisited, it got more detailed and sometimes coloured. Mostly, a single student was drawing each part, although more than one student sometimes drew different parts at the same time. On a few occasions, more than one student was drawing each part together.

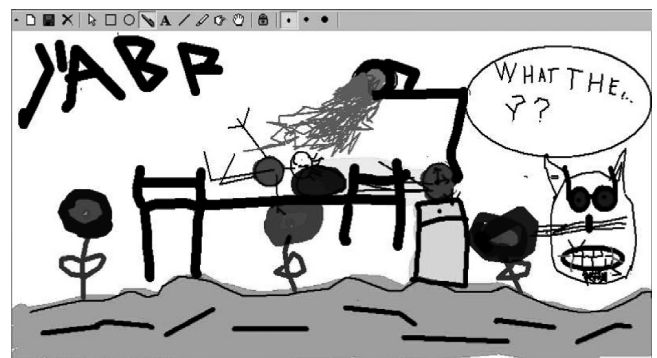


Figure 4: Shows the Students' Final Solution

There were four members (MS1, male student one; MS2, male student two; FS1, female student one and FS2, female student two). The process was:

1. MS1 began to draw the bed
2. MS2 began to draw the figure in the bed
3. FS3 began to draw the bedside unit
4. MS1 started to draw the bucket above the bed
5. MS1 started to draw the alarm clock
6. FS3 drew the alarm clock hands
7. MS1 connected the alarm clock to the bucket
8. FS4 drew a face and hair on the figure in the bed
9. FS3 drew the cat's face with MS2

10. FS3 coloured the figure and the bed set
11. MS1 and FS3 continued with the cat face
12. FS3 drew glasses on the cat and MS1 connected the bucket further to the alarm clock and coloured the pillow
13. FS3 began and finished drawing the field and the grass
14. MS2 drew the cloud and the text inside
15. MS1 began to draw another cloud but later erased it. FS3 tried to write text inside
16. MS2 started to draw a game with MS1.
17. FS3 drew the flowers; FS4 drew the black lines on the grass
18. MS1 drew the word Yeah (Jabb) as he won the game

Table 2 shows who started to draw different parts of the drawing (initiative): MS1 and FS3 were most active and clearly reacted with each other the most.

Student	Initiatives
Male one	8
Male two	3
Female three	7
Female four	1

Table 2: Students' Initiatives

The students collaborated silently through their drawing and also wrote text to each other inside the VRE during the work. This appeared on each screen, so all were aware. Usually, a single student was drawing, but sometimes they worked in pairs or threes; only once was the whole group drawing together. The virtual whiteboard indicated who was drawing at any one time, enabling names and times to be related to activity

During their work, the students responded to each other and commented on the work with text messages within the VRE. These demonstrated a light hearted, collaborative spirit, including comments and emotional expressions such as "he he he he", "lol", "how interesting", "beautiful" or "very pretty". Table 3 shows how often the students wrote these messages:

Student	Frequency
Male one	7
Male two	10
Female three	15
Female four	24

Table 3: Student Text Communication Rate

Table 3 shows how MS1 only used text messaging seven times. MS1 communicated positively; for example, passing comment about of the colours of the water and the flowers. MS2 also used text positively, expressing his opinion about the presentation of the drawings. He also mentioned how the size space used for specific parts of the drawings was an important issue. FS3's comments were more concerned with the design and presentation of the drawing, and MS1 had ideas and the initiative to start drawing; she, for example, started with the grass, flowers, and vivid light. She was clearly motivated and concerned about the presentation and the aesthetics of the drawing. FS4 was not communicating much about the design: her emphasis appeared to be for personal contacts in a humorous way, without focusing on the drawing. On some occasions she 'flirted' with MS1, although she mostly communicated with MS1 and FS3.

Table 5 shows the collaborative activity when the students were drawing on the virtual whiteboard inside the VRE; It also shows co-operation frequency during the work and the time spent drawing, measured in seconds and minutes. The duration was found by creating time quotes with Transana (<http://www.transana.org/download/index.htm>) (taken from when each student started to draw and subsequently stopped). This illustrated the activities inside the VRE, and was used by the author to highlight the co-operation.

Student active	Seconds	Minutes	Frequency
None	391.3	6.5	45
MS1 alone	204.4	3.4	22
MS2 alone	258.4	4.3	23
FS3 alone	206.5	3.4	18
FS4 alone	24.4	0.4	5
MS1+ MS2	239.3	3.98	24
MS1+ FS3	102.9	1.7	13
MS1+ FS4	72.1	1.2	7
MS2 + FS3	103.7	1.72	27
MS2 + FS4	66.4	1.1	6
FS3 + FS4	66.9	1.1	6
MS1 + MS2 + FS3	44.1	0.7	17
MS1 + MS2 + FS4	2.9	0.048	3
MS2 + FS3 + FS4	19.7	0.328	5
MS1 + FS 3+ FS4	3.0	0.05	2
MS1 + MS2 + FS3 + FS4	6.2	0.103	2
MS1 alone + w. one student	546.7	9.1	79
MS2 alone + w. one student	428.5	7.14	80
FS3 alone + w. one student	480.0	8	69
FS4 alone + w. one student	229.8	3.83	37
MS1 total time	552.7	9.2	46
MS2 total time	495.2	8.25	49
FS3 total time	546.8	9.11	45
FS4 total time	255.4	4.25	17
MS1 alone + w. two students	540.1	9.0	44
MS2 alone + w. two students	422.2	7.036	47
FS3 alone + w. two students	483.8	0.83	42
FS4 alone + w. two students	223.6	3.726	15
MS1with two students	50.0	0.83	22
MS2 with two students	47.0	0.78	25
FS3 with two students	66.8	1.1	24
FM4 with two students	25.6	0.42	10
MS1 with one student	414.3	6.88	44
MS2i with one student	409.4	6.8	40
FS3 with one student	273.5	4.52	57
FM4 with one student	205.4	3.4	19
One student drawing	693.7	11.56	69
Two students drawing	651.3	10.855	67
Three students drawing	69.7	1.16	26
Four students drawing	6.2	0.103	2

Table 5: Shows Student Activity when Collaborating inside the VRE. MS1 (1) is male one, MS2 (2) is male two, FS3 (3) is female three and FS4 (4) is female four.

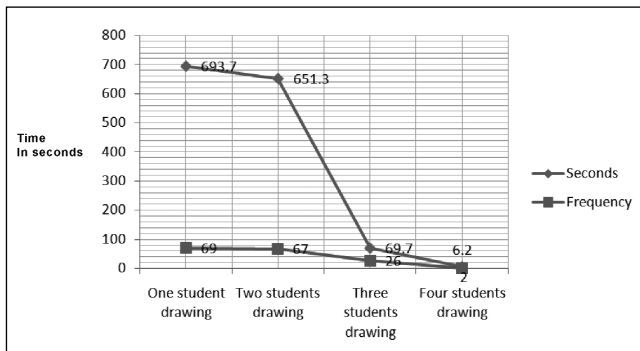


Figure 5: Shows how active the students were, whether they worked in ones, twos, threes or altogether. The top line is the time they spent in total, whilst the bottom line shows how often they were active.

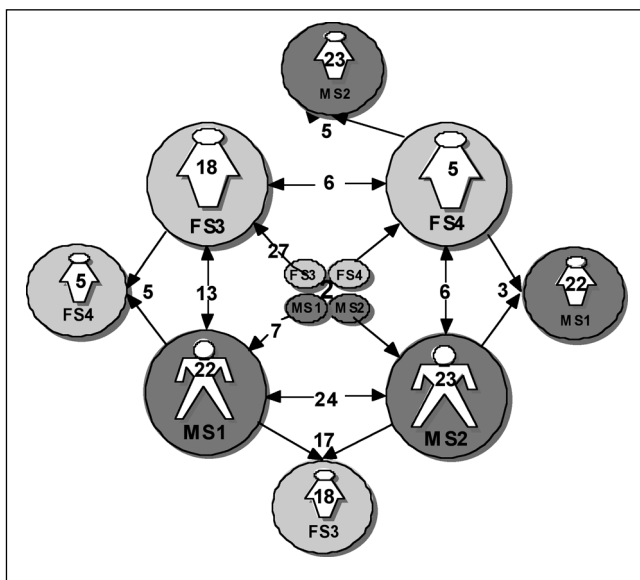


Figure 6: Shows how often the students worked alone and together, as groups of two, three or four; the dark colour indicates the males and the light colour the females. On each figure is written the frequency when that individual worked alone. The arrows between the figures indicate co-operation with frequency, and the small central cluster indicates when all four collaborated, with 2 as the frequency.

The students mostly worked alone or in pairs on the virtual whiteboard (Figure 5); MS1 spent more time than the others drawing. He started the work and was leader, along with FS3 (Table 5). They started to draw the most important parts of the solution, such as the bed, the bedside cabinet, and the alarm clock. Also, MS1 and MS2 spent the most time together as a pair and were drawing the same parts together a few times. However, MS2 seldom began drawing new elements and collaborated mostly with MS1. MS2 was the most active alone.

MS1, MS2, and FS3 spent 3-4 minutes drawing, but FS4 spent just 0.4 minutes. The male students were more active in the technical part of the drawing, whereas the female students were more interested and active in the aesthetics part. MS2 had little initiative in drawing new parts (2), but did contribute to others' ideas; FS3 had the biggest initiative for decorating the drawing, and FS4 was passive when working alone but worked better in pairs and with three students. She spent most of her time together with FS3, and, subsequently, MS1, MS2 and FS3 spent the most time together.

Discussion and Conclusion

The teacher reported how the students were not discussing the work together face-to-face or online, during work inside the VRE; therefore, he concluded that the students were not collaborating together, but working as four individuals. However, by analysing the video and the interviews with the students, it was possible to see that the work *was* based on co-operation.

The drawing produced underlines the need for pre-training in the use of digital input devices for drawing: the students used the mouse, but lacked skill in using the cad software. They may have been better if they had accepted the teacher's offer on training. However, the teacher gave informal training, included in the drawing test at the beginning of the lesson. The skill levels for individuals in using the VRE CAD were identified as significantly different. However they were all, with the exception of FS4, able to individually design inside the VRE and contribute to the solution. Student FS4 *could* contribute to other's designs.

During the exercise the students did not communicate face-to-face, but did use the VRE graphics and text facility. FS4 wrote most of the text messages that show, partly, her interest. However, most of the content of her messages were personal rather than relating to the work. Just two of the students were able to draw three-dimensionally, and, as before, the drawings differed in accuracy, clarity, and detail. Nevertheless, the students worked together and were able to submit a basic and understandable solution.

It was identified the students played different roles in their design work: their solution was drawn in 10 parts and in a logical order. It was MS1 who had the initiative to begin the drawing and he also designed most of the technical parts of the work; he used fewer text messages than the other students and was not asking for the others' opinions. FS3 showed initiative relating to colour and decorating the drawing, while MS1 and FS3 were the primary drivers for adding detail to the different parts as made by the other two.

Messages showed that the female students were primarily interested in the aesthetics of their drawing; this probably means that aesthetics are important for motivating female students and should therefore be included in the task (based on the two females within the group). This could also indicate different values between the sexes, as the female students were more interested in the visual aspects: this needs following up with far larger groups.

The students worked as avatars during the lesson, but never mentioned this fact: they were probably familiar with using avatars from playing inside of the VRE and also from playing other computer games at home. The students used the avatars to open the virtual whiteboard in the entire screen mode, and when they were not active they became avatars. They could use the VRE, with its avatars, as easily as other computer software. However, to enter the virtual whiteboard, the student had to move the avatar and this might have affected their performance and response speed.

To draw together as avatars was a relatively new experience for the students and therefore probably difficult for them. The students co-operated silently, but supported each other with text messages. Most often, students worked alone; the entire group rarely worked together or in threes. However, they did collaborate in pairs and spent a similar amount of time alone. They most often drew as individuals on different parts of the drawing, and drawing was also identified as a method for communicating during the design. FS4 was not very interested in the drawing, possibly because her skill was limited. The students seemed happy during the lesson: their text messages demonstrated a light-hearted collaborative spirit, including personal comments and emotional expressions.

Wrapping up by Revisiting the Research Questions

The aim of this pilot study was to gain experience and an understanding of the pedagogy of using VRE for co-operative idea generation within the school context. Cooperative idea generation activities within the VRE were observed. Students silently communicated with each other with their drawings initiative and by writing text to each other. Pre-training students in drawing is important before they start using the VRE, as is allowing them to play together inside the VRE. An interesting teaching method used was to train students was through gaming, before the lesson began; this made them familiar with the environment and the cad. The students' skill levels were different, but everyone was able to contribute to the collaborative drawing activity. Students adopted different roles during their cooperation and they also showed different initiative, with one of the students leading the activity and two

leading the idea generation. Students were interested in the aesthetic part of their drawing, and this affected their design in the end and generated a light spirit in the classroom that may well have enhanced idea generation. The avatars did not play a noticeable role in the pilot study; however, they may be useful in a game-based co-operative collaborative activity: this may represent an interesting continuity of this pilot study.

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