HOW DOES COMPUTER BASED SIMULATOR-TRAINING IMPACT ON GROUP INTERACTION AND PROFICIENCY DEVELOPMENT?

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Abstract

The aim of this article is to investigate how training in a real time radiology simulator impact group interaction and proficiency development in comparison with conventional group training. Thirty-six students — 20 women and 16 men participated. One group trained with a radiology simulator (simulation group), and the other group analysed pre-produced image pairs (control group). The results show that the main expressed verbal activity in the control group is interpretation, distinguished by a continuous pattern as well as a more academic terminology. In the simulation group the main activity is action proposals/-commenting, distinguished by a fragmented pattern as well as non-academic terminology. The simulation group improved their test results significantly while the control group did not. The differences between the groups in terms of group interaction and proficiency development may be related to the manipulation and the immediate responses of the students´ actions the simulator training offer.

Introduction

In photographs it is easy to perceive spatial relationships due to what is called pictorial depth cues. In a radiograph, however, it is almost impossible to understand the spatial relations. One important difference between a photograph and a radiograph is that radiographs are transparent two-dimensional representations of three-dimensional objects where no information about depth relations between object details is available. Although pictorial depth cues can be perceived in radiographs they are irrelevant and misleading. There are, however, ways to overcome these shortcomings. When radiographs exposed from different angles are analysed the spatial relations can be deduced if the observer has the appropriate knowledge and skill. Contrary to the more or less automatic perception of spatial relations in photographs, the analysis of spatial relations in radiographs is an intellectual process that needs training. Computer-based simulation can be a part of that special training and help the students to learn and reflect on the radiographic practice, its tools, methods, theories and possibilities, for making good decisions in their future work.

Ong and Mannan in a similar way claim:

> In virtual worlds, learners can be simultaneously provided with three dimensional representations, multiple perspectives and frames-of-reference as well as simultaneous visual and auditory feedbacks. With careful design and implementation, these capabilities can be synthesized to create a profound sense of motivation and concentration conducive to mastering complex materials. (2004, p. 363)

According to popular discourses about knowledge and learning, knowledge making is seen as a process of human beings working together (collaboratively) challenging each other, a process of intellectual negotiation and collective decision making (Bruffe, 1984). Collaboration in educational settings is considered to contribute to the sharing of arguments and opinions within a group, encouraging the kind of reflection that leads to a deeper learning of the subject. Individuals frame the same situation in different ways and are thereby able to contribute in unique ways to learning and knowledge building (e.g., Jonassen et al 1999, 2003; Mörch & Dolonen, 2004). Research on computer-based simulations also notifies that the group is positive for learning both when using high fidelity simulators as well as computer-based simulators. Yeager et al. (2004) claim that high-fidelity simulation-based training has the potential to improve human performance and enhance professional confidence but that perspectives from peers reinforce positive aspects of performance. Similarly Davies (2002) claims that for successful engagement with computer simulations, students should work on group projects where they can share their understanding. However, the outcome of collaborative learning may depend on what is supposed to be learned. Gokhale (1995) found, for instance, that students who participated in collaborative learning performed better on critical thinking tests than students who studied individually. However, no significant differences were found in drill and practice tests.

In this study we will focus on how training in a real time radiology simulator impact on group interaction and proficiency development in comparison with conventional group training. If learning is achieved through active participation and primarily mediated by verbal language, and if proficient participation involves extensive verbal, subject-relevant communication, then it is interesting to explore how a learning environment encourages and supports interaction and dialogue, and whether interaction and dialogue actually occur in this environment. By interaction and dialogue we refer to such that arguably contribute to a common development of subject-relevant knowledge as well as to the individuals' development towards competent actors within the frames of their practice.

Design of the Study

Participants were drawn from undergraduate students at the Dentistry programme at Umeå University attending a course in Oral and Maxillofacial Radiology. Thirty-six students — 20 women and 16 men attending the 4th semester — voluntarily participated in a randomised experimental study. It comprised three parts: (i) Proficiency test before training: Based on these test results, the students were randomised into two main groups. (ii) Training to determine the third dimension using parallax: One group trained in a radiography simulator, and the other group performed conventional training by analysing pre-produced image pairs (control group). The training lasted 60 minutes and was performed in small collaboration groups with three students in each group. All groups, 6 + 6 groups, were adjusted to include at least one person of each sex. The training was video-recorded. (iii) Proficiency test and questionnaire after training: The proficiency tests before and after training had identical design. It comprised three separate subtests that were considered to be of importance in interpreting spatial relations in radiographs utilising parallax (e.g., Nilsson, 2007; Nilsson et al, 2006, unpublished manuscript). The Principle subtest aims at assessing the participants' *understanding of the principles* of motion parallax. The Projection subtest aims at assessing the participants' *ability to apply the principles* of motion parallax. The Radiography subtest aims at assessing the participants' *ability to locate object details* in authentic radiographic images utilizing motion parallax. The questionnaire after training dealt with learning environment, training tasks and training modality.

An outline of the design is presented in Table 1 below.

Table 1: Design of the study

Evaluation of collaborative learning			
Variables	Input	Process	Output
	Pre-training proficiency	Exercise A1 – Simulation group Exercise A2 – Control group	Student appreciation, Post-training proficiency
Evaluation	Proficiency test	Video-recording	Questionnaire, Proficiency test

The Simulator

A prototype simulator for training radiology has been developed. In the simulator, real time radiographic examinations of patients can be performed. The simulator utilizes the powerful Virtual Reality (VR) technique to allow the user to position models of the patient, x-ray machine and the film in any desired position. X-ray images are then "exposed" and the simulator presents immediately geometrically correct radiographs rendered from the individual positions of the models (Nilsson et al., 2004). Training is thus performed in a safe environment without the use of ionizing radiation.

Simulation and Control Group

The physical settings for the two groups are comparable in the sense that both include three students working on a computer-supported radiology task with the support of a passive teacher. The 3D-group worked with a simulation and performed different exercises aiming at developing understanding of and ability to apply the principles of motion parallax and to locate object details in radiographic images. The training program had four structured exercises. The 3D-simulation software has been implemented in a standard PC equipped with two monitors. One of the screens represents a three-dimensional model while the other represents two-dimensional x-ray snapshots that the students can make from the model. The Simulation-PC control peripherals include a standard keyboard as well as a 3D-mouse and a pen-like controlling device (tracker).

Figure 1: View of the scene in the simulator used in the collaboration study. The high resolution skull model from Stanford is partly visualized (teeth).

The control group worked with x-ray image pairs presented with MS PowerPoint. The students discussed radiographic projection theory to develop understanding of and ability to apply the principles of motion parallax and to locate object details in the images. The computer used in the control group was a standard PC, equipped with keyboard, mouse and one monitor

The Video Recordings

The analysis was performed through two phases. In phase one three questions were posed to a number of randomly chosen videotapes, producing thematic answers. These questions were:

- What are the participants talking about?
- How are they talking about it?
- How do they relate to each other and to the learning environment as a whole?

The questions generated themes and when no more themes could be found phase one ended. In phase two all video data was split into one-minute time segments and coded with the themes generated in phase one. This allowed us to conduct a highly structured analysis based on an understanding that was influenced by the current set of data. (schemata used for coding as well as definitions of the applied themes are to extensive to be included in this paper)

The Questionnaires

Questionnaires were used to complement the analysis of the process/video recordings and focused on the task, the participants and the working model in relation to interaction and dialogue. It also inquired into students' ideals and prior experiences of education and learning. Answers were given either by grading statements on a five-point scale or choosing one 'best fit' alternative, in most cases with the possibility of open ended commenting. Since it was rather extensive it has not been translated and enclosed in this document.

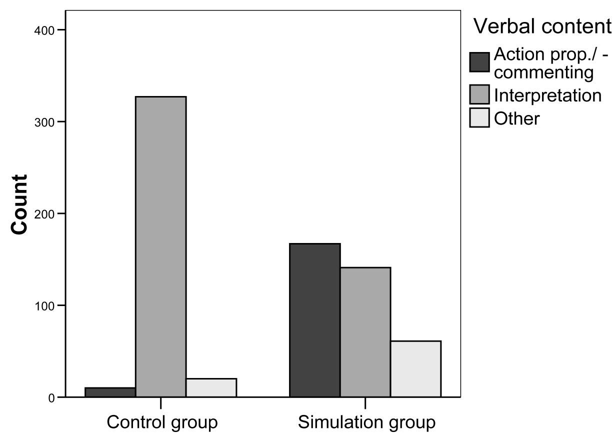
Results

The results from the questionnaire show that all students have some experience of working with a personal computer, but half (44 %) of the participants' have never worked collaboratively around computers. Many (40 %) claim that they rather work alone, but only a few (9 %) say they feel uncomfortable with group work. A majority (78 %) claims that they are active and engaged when working in a group. In respect to their own personal learning, nearly everyone (95 %) states that comprehension is important while considerably less (72 %) agree that learning new facts is important. Eight out of ten (84 %) say that prior courses were aimed at learning new facts. The only question that yielded a significant difference between the main groups concerned the students' motivation to participate. 89 % of the students in the Simulation group stated a positive response, to be compared with the 44 percent of the students in the control group

The Impact on Group Interaction

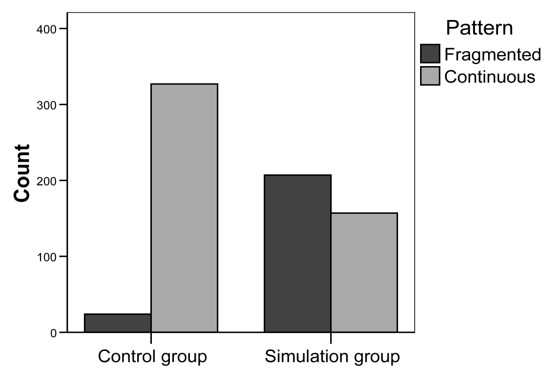
There is a significant difference between the two exercises regarding *what the participants talk about*. The verbal content in the control group fall almost exclusively (to 92%) under one analytic category: Interpretation. What the participants seem to be doing is trying to reach coherent analyses of the images by means of verbal reasoning. The verbal activity in the simulation group on the other hand is more complex as it is distributed over two main analytic categories: interpretation (38%) and action proposals/commenting (45%). Figure 2 presents the distribution of content in the expressed verbal activities in the two exercises.

Figure 2: Comparison of exercises by distribution of verbal content over interpretation, action proposals/commenting and other. (In the other category are social comments, comments on the technology, meta reflections on learning and ambiguous activity. Accounts for 50% of the category in both exercises).



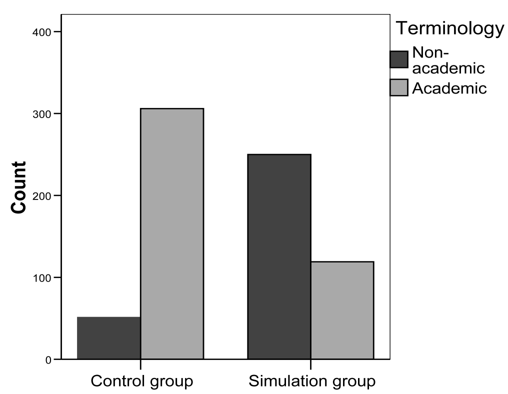
The results show that the verbal activity in *how the participants talk* in the control group were distinguished by a continuous pattern in the contributions (93% of all cases), which was often lacking in the simulation group (43% of all cases). This means that verbal contributions in the control group more often made evident references to and clearly extended on prior verbal contributions. Figure 3 shows the pattern of the contributions as continuous and fragmented for the two exercises.

Figure 3: Comparison of exercises by distribution of expressed reasoning over continuous and fragmented in the control group (image examination) and the simulator group (Simulation) respectively.



Relating to *how the participants talk* is their terminology used. The control group more often used an academic terminology in their contributions (86% of all cases), while groups in the simulation group mainly used a more context dependent, non-academic, terminology (68% of all cases). Figure 4 below presents the distribution of terminology over academic and non-academic in the two exercises.

Figure 4: Comparison of exercises by distribution of terminology over academic and non-academic.



The verbal activity in both exercises reveal that interpretive content most often is combined with a continuous pattern (89%) and academic terminology (83%), which can be contrasted with action proposals/commenting which most often is expressed in a more fragmented way (84%) and with a non-academic terminology (89%). This tendency is true for both exercises.

We have seen that the main expressed verbal activity in the control group is interpretation, which is distinguished by a continuous pattern as well as a more academic terminology. In the simulation group the main verbal activity is action proposals/commenting, which is distinguished by a fragmented Pattern as well as a context dependent terminology. The described differences are summarized in Table 2.

Table 2: Summary of the main characteristics of the two exercises

	Control group	**Simulation group**
Verbal content	Interpretive	Action oriented
Pattern	Continuous	Fragmented
Terminology	Academic	Non-academic

Impact on Proficiency Development

The question is *if exercise is correlated with post-training proficiency or proficiency development.* T-tests were used to compare the group means on post training proficiency test as well as on mean proficiency development and the results show that there is no significant difference between the groups, the simulation group and the control group. There is however a significant difference in how the group mean score develop from pre- to post test (see Nilsson et al., unpublished manuscript). The simulation group improved their proficiency test results significantly ($p = 0.008$). The control group did not increase their test results significantly ($p = 0.930$). We conclude that the students in the simulation group seem to develop more in terms of overall test results.

However the proficiency-test consists of three subtests and there are differences between the two groups in mean post test score. The principal test is showing a 1.6 points difference and the Radiography test 0.3 points between the groups. The groups are equal in the projection test. We conclude that the subtests' contribution to the overall difference are not equal and the principal test contributes the most.

Discussion

When it comes to how both learning environments encourage and support interaction and dialogue, and whether it occurs in the environments, we can conclude that in the control groups participants are included in a discussive climate, which theoretically is assumed to impact positively on learning (e.g., Sfard, 1998; Wenger, 1998). The results indicate that the control group, are the group that in highest extent express that they analyse, synthesize and evaluate ideas cooperatively but also are the groups that have the lowest proficiency development. We found a significant proficiency development in the simulation group that did not exist in control group. We can conclude that training in a real time radiology simulator have higher impact on proficiency development than conventional group training. This study demonstrates the same results as Nilssons study regarding how individual simulator training supports proficiency development (e.g., Nilsson, 2007).

However, we have not, in this study, considered how individual factors such as gender, age, motivation and how student activity during the exercises are related to the concluded differences. More elaborated and deepened analysis will give more insight to whether, for instance, the simulator training in a more explicit way give information about the gap between actual performance and the expected learning outcome as well as how to alter the gap. (e.g., Sadler, 1989). Sadler (1989) points out that a key premise is that for students to be able to improve, they must be able to monitor the quality of their own work during actual production. In the simulation group the goal is a correct positioning of an object or model, which demands manipulation and observation to ensure that the group are on the right track. In the control group the goal is a verbal statement, expressed in academic terms, about relations between objects in a static image pair. The peer support in the conventional training but also the image training itself might not have given the necessary information for monitoring the quality of their own work during actual production. Consequently there is a better transfer between the simulation training and the post-test. The collaboration in the control group could primarly have been an training in argumentation and communication and not given the students information about how the gap between actual and expected learning outcome should be altered. For instance, Gokhale (1995) suggests that collaborative learning is more meaningful in developing critical thinking than for knowledge of facts. It is possible that if the test had measured how individuals argue about how to interpret radiographic images the control group may had performed better. However, more research is needed before any certain conclusion can be done. For instance, what can we learn from students working with simulators but also from students working conventionally — how should teachers and peers act?

At the moment the most reasonable understanding is that the differences between the groups both in terms of group interaction and proficiency development are related to the manipulation and immediate responses of the students´ actions that the simulator offers. The immediate responses of their thinking in action seem to contribute to knowledge about interpretation of radiographic images.

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