A Qualitative Assessment of Communicating Spatial Concepts in Virtual and Physical Environments via a Text-Based Medium

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Abstract

The pedagogical exercise described here was used to investigate how spatial communication about the manipulation of objects in a virtual and physical space is communicated between remote partners. It continues work done by others. Where it differs from previous research in this area is in its use of a qualitative methodology to study how these types of interactions are structured, communicated and interpreted via text-based media. What emerged from the qualitative analysis are new insights over the previous quantitative investigations. This paper reports on completed research.

1. Introduction

There are many examples of quantitative studies of collaboration involving computer-mediated communication in three-dimensional virtual environments (3DVEs)[1][2][3][4]. On the other hand, the qualitative aspects of 3DVEs are largely unexplored.

Quantitative evaluations include: hardware and software implementation; user-to-user and user-to-machine interactions; and cognitive evaluations relying on timed task completion, user performance and accuracy. Qualitative evaluations, on the other hand, help us to understand the participant’s personal experience when interacting with 3DVEs. It involves evaluation of the participants’ comments derived from the researcher’s observations and interviews. It seeks to comprehend the users’ actions.

In order to investigate the qualitative aspects of interaction in 3DVEs, a pedagogical exercise was conducted which involved 10 participants communicating spatial concepts using physical and virtual blocks via only text-based communication. Participants were located remotely from each other with a set of either physical or virtual construction blocks. The interaction between participants and the elements involved - codes of communication and process and physical and virtual object manipulation - were recorded and analysed in an attempt to understand the experiential nature of their interactions.

2. Background

The evaluation of construction tasks using building blocks can be seen in many fields of research: cognitive assessment [5]; architectural development and presentation [2]; tangible interfaces [6]; collaborative learning [7]; and virtual environments [3]. In all these, the building-block activities provided data for spatial task quantitative analyses.

In all these experiments, the participants were observed either interacting with physical or virtual blocks or presented with the task of reconstructing a spatial pattern by assembling physical or virtual objects. Their quantitative analysis measured the accuracy, completion time and efficiency of either type of object manipulation.

What these studies do not tell us is what influence the background of the participants and the peculiar settings might have had on the experiment outcomes.

A qualitative study on the other hand, involves a more detailed appraisal of participants’ backgrounds and the test environment thus exposing any interference this might have on the results reported.

3. The Project

Participants were asked to develop a kit of physical and virtual parts based on a simple rule:

"Given three types of blocks – 1x1x1, 1x2x1, and 1x3x1 – how many aesthetic permutations of a 3x3x3 volume, suitable as a model for a modern art gallery, can be constructed?"
Each pair of students was given a set of wooden blocks (see figure 1). Virtual blocks were constructed with the same ratio of sizes in VRML and viewed using Cosmo Player in Internet Explorer (see figure 2). The team members communicated with each other using MSN Messenger. Participants were physically located in separate PC labs.

![Figure 1. Kit of wooden blocks.](image1)

A qualitative methodology [8] was adopted for this study. It allowed for judgments and conclusions to be arrived at via a triangulation process of iterating renegotiated meanings until consensus was achieved.

![Figure 2. Virtual blocks showing chat application.](image2)

Ten final-year Bachelor of Information Environment students in a Virtual Environments course were divided into five groups of two. The students came from diverse backgrounds – international students, interstate students, and ages ranged between 20 and 35, with one female and nine males. For some, English was a second language. Their acculturation to digital media was equally diverse – from extensive self-taught students, some already working in the multi-media industry coming back to ‘upgrade’ their qualifications, to those with little exposure to digital technology.

Each group conducted the virtual versus physical block test once. Following this, they changed roles. A completed exercise required a participant to work on two tasks - using the physical/virtual blocks to ‘build’, and physical/virtual blocks to ‘follow’, or vice versa. Each group member was positioned with their blocks in a room remotely located from the other with their blocks. Participants could only communicate via the text-based chat application. Their constructing was observed, and questions were asked during and after the exercise, and their chats analysed.

The exercise began with both the participants taking their place in different rooms. They logged into the chat application. The participant with the virtual blocks launched a browser window to view the virtual blocks. The participant with the wooden blocks arranged their blocks ready to begin. While building with the blocks, one participant conveyed the block positions and orientations layer by layer via the chat communication application. The other participant followed. They tried to interpret the other’s instructions and arrange their blocks in a similar manner. After each block placement instruction was passed they confirmed it with feedback messages. A sequence of requests and confirming remarks was passed throughout the iterative process.

Finally, after both parties were satisfied with their constructions and reconstructions, they compared both sets of block permutations for similarity. The chat log was saved. The exercise was then repeated by participants swapping places and block types.

4. Results

After the participants had completed their tasks with the wooden and virtual blocks, they reported that the natural characteristics of the wooden blocks allowed for a better building process. They claimed it was “easier, faster and logical”; the wooden blocks provided tangible contact and tactile interaction from the individual, allowing for more natural construction; they could touch and turn the blocks, smell, taste and feel their physical attributes; they could stack the different sized wooden slabs one on top of the other; they could “build the art gallery one-room, then one-storey at a time”.

Those that moved from the physical blocks to the virtual blocks in the first round reported: they felt restricted by having to use mouse, keyboard and Cosmo Player control buttons; could click on any of the blocks but only drag them in the x-z plane; they had to choose blocks from one of the levels for construction rather than being able to stack them.

For those participants who went from the virtual to the physical they did not report the same degree of initial frustration with the virtual system. However, neither did they report any frustration with the physical after working with the virtual. Nevertheless, on
reflection, the overwhelming majority of virtual to physical transition participants reported negative feelings towards the virtual compared to the physical.

What emerged from the exercise was the dominance of the wooden blocks over their virtual counterparts as the preferred medium for constructing aesthetic permutations given the rules. Despite being given the option to start with the physical or the virtual blocks, all groups started the exercise by constructing the physical blocks first. Their virtual counterpart followed. This may be a mitigating factor in the reported greater efficacy of using the wooden blocks to complete the task.

Two elements of importance in conveying the blocks' arrangements were; which block to use; and, its position and orientation. Communicating spatial concepts using natural language can be challenging; especially via the textual means conducted in this study. Problems in communication in relation to social interaction lie in participants' uncertainties in seeing the same thing and/or misunderstandings in relation to spatial references [1].

In practice, the default view of the virtual blocks was adopted. In the physical world, participants used the top-tilted view. By contrast, the virtual blocks were usually viewed (and customized by default view) from a corner. This was perceived as a natural viewing stance for both blocks construction process. This was described by the participants as enabling the user to see 'more' sides of the blocks. Hence, what was more important in the process was how the default view in the virtual blocks application was set.

5. Conclusion

The exercise described here compared the relative efficiency of communicating spatial concepts using text alone. In pairs, participants developed the virtual and physical blocks together. This gave them a general idea of what the characteristics of both media, their potential drawbacks and how they might be overcome. The sequential nature of the communication and building process made the task seem quite straightforward. It would be interesting to see how the participants communicate a more complex spatial cue by using more complex objects. Spatial communication using natural language can be difficult due to its vague and underdetermined nature. However, with enough referential cues, this seems to have been largely overcome.

What was gained from the analysis of chat logs and general questioning by the researchers during and after the exercise, not normally present in traditional quantitative analysis, was why participants prefer the physical blocks (they were more natural, conformed to gravity, etc.). Most quantitative analyses report a preference for the physical version without contextualizing this result in terms of the participants’ reasoning behind it. This may reflect the specific tasks performed and response to questionnaires given. In this task students gained a better understanding of their interaction with 3DVEs and online chat to communicate spatial concepts.

References