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Designing for Drawing-based Modelling for tablet computers

Introduction

With the multitude of multi-touch devices and the growing tablet computer market the concept of One-Device-Per-Child (ODPC) and Bring Your Own Device (BYOD) has become relevant for educational practitioners and researchers(Chitika, 2013). The use of these large touch screen mobile devices in diverse educational environments provides new opportunities for supporting learning in formal and non-formal settings. These types of devices with larger screens compared to smartphones and increased mobility than computers can support a more natural way to interact akin to drawing and sketching. Keeping in mind that drawing, sketching, and scribbling are activities all humans do from an early age. As early as in primary school and pre-school curricula, we apply drawing as a way of supporting learning (Bollen, Gijlers, & Joolingen, 2012). Drawing-based modelling (DBM) is a term that explains the process of how drawings can be used as representations of knowledge and also how learners can utilize this to convey their perception of knowledge (WouterR Joolingen, Bollen, Leenaars, & Gijlers, 2012). Research shows that use of DBM as a key part of science education benefits learning can increase. Representations of knowledge are crucial not only to convey understanding and knowledge, but also in scientific thinking (Ainsworth, Prain, & Tytler, 2011). Educational researchers have utilized this technology and combined it with drawing, modelling and simulation to create novel educational software for students to go about creating and understanding representations of knowledge. Our research builds from the work of Bollen and colleagues (Bollen et al., 2012) and explores how to take advantage of an existing DBM computer application called *SimPaƌ* and how we developed a prototype for tablet computers. One of the key research aims of the project was to investigate what new interaction design challenges can be identified for drawing-based modelling on tablet devices to support science education?

Background

Science education provides opportunities to explore how modelling can be used for learning. The creation, modification and evaluation of models in science is key way to understand phenomena (WouterR Joolingen et al., 2012). The process of modelling can be explained as the process of construction, execution, and evaluation of external representations of systems. By constructing an external model the model becomes freely available to the world and also offers it up for scrutiny. Putting this into the context of education, much in the same way as drawing externalizes emotion and other human behaviour, an external model can also help explain a students ideas and thoughts to fellow students, teachers, and also to themselves (Leenaars, van Joolingen, & Bollen, 2012). However, creating these models, especially on computers, is challenging because of the interrelations between the model elements, their respective behaviours, and the evaluation of those behaviours. During the creation of models learners do not always apply previous knowledge and have a hard time translating knowledge when creating computer models). To create effective representations for modelling the properties of phenomenon, and the relations between them, should be made explicit and visible for the learner (WouterR Joolingen et al., 2012). One suggested way to support the activity of modelling is that of drawing.

Methods

In order to further explore the drawing as a possible activity to support modelling, a prototype for tablet computer was designed and evaluated with middle school learners. The process of designing this prototype is done using a combined iterative process of DBR and interaction design (Spikol & Otero, 2012). The prototype usability was evaluated with eight learners at a middle-school in southern Sweden. The evaluation was carried out in three ways. The first being questionnaires that participants of the evaluation were asked to fill out before testing the prototype (pre-test) and also one after the testing (post-test) that included questions about their experience with the prototype and their own perceived performance. Second, a usability test was performed where the participants performed a main task that was divided into several sub-tasks. This process was recorded with video. Lastly, the video was

analysed using a Flow Chart and Significant Events as proposed by Ash (2007).

Results

The results show that the users enjoy working with the prototype and they think that it can help them in their learning. The results also show guidelines and affordances for interaction design of interfaces for drawing-based modelling tablet applications. The reasoning behind identifying guidelines and affordances is to provide researchers, designers, and others with the means to minimize problems that may arise in the design of their own drawing-based modelling tools for education.

Discussion

In summary, the findings show both the potential of the prototype, but also the limitations of it in terms of the interaction design. The findings show that while offering users new ways to investigate phenomena, it also shows that this type of interface has certain affordances that allow for a drawing-based modelling experience on tablet devices. Interaction designers looking to either build upon this research or create similar interfaces should be aware of these affordances as they are fundamental to the tablet-based drawing-based modelling experience. In addition to this a proposed set of interaction design guidelines identified that can guide the design of these types of interface for drawing-based modelling on tablet devices.

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