Citation for published version:
Girard, S & Johnson, H 2006, DividingQuest: Using emotive interface personas in educational Software. Computer Science Technical Reports, no. CSBU-2006-20, University of Bath, Department of Computer Science.

Publication date:
2006

Link to publication

Department of Computer Science

Technical Report

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Technical Report 2006-20 December 2006

ISSN 1740-9497

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ISSN 1740-9497

DividingQuest:
Using emotive interface personas in educational software

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ABSTRACT

Research in educational technology has developed an interest in the capacity of software to be adaptable to children's needs in terms of content, therefore enabling children to acquire learning at their own rate. This paper considers research on open-learner modelling, helping characters and emotions, and describes how this has been applied to the design of the "DividingQuest", a mathematical teaching-aid tutoring system for English year 6 children (10-11 years old). Designed using a participatory-design approach with year 6 children and teachers, the DividingQuest provides the foundation and necessary infrastructure for undertaking studies investigating the impacts of using emotive interface personas as helpers in Open-Learner Modelling tutors, on the appropriation and understanding of the user-model component by children.

Keywords
Participatory Design, Interface Persona, Educational software, Emotions, Open Learner Modelling

Categories and Subject Descriptors
H.1.2 [**User/Machine Systems**]: Human Factor; H.5.2 [**User interfaces**]: User-Centred Design;

General Terms: Design, Human factors.

1. INTRODUCTION

Today's technologies are transforming people's interaction in their everyday activities, including the way our children live, learn, and play. It is therefore important to understand the impact the use of those new technological devices has on children to better support them in everything they do. Mathematics, along with English and Science, is a core curriculum subject. However, for a significant majority of primary school children, mathematics is not an appealing subject, considered as difficult to learn and teach due to its abstract nature. In order to overcome this problem research has been looking for a solution to render the learning and teaching of mathematics more enjoyable and motivating, enabling the most able children to be stretched academically, whilst providing extra support at the basics for those who require it.

The research on intelligent tutoring systems (ITS) is currently focusing on the improvements to the learner model to make the understanding and potentially, interaction between the user and the tutor more effective. The use of pedagogical agents in education software has proven to have real potential to motivate and engage the user in the learning experience [7]. Studies in Open-Learner Modelling (OLM) for children [3] using smiling faces as representation of knowledge seemed to help the motivation of the children to use the software. The construction of a teaching help system enabling investigation on whether the inclusion of affect into the design of ITS might therefore be beneficial to the child, could hold the key for a more valuable and enjoyable learning experience.

In this context, the DividingQuest will provide the foundation and necessary infrastructure for undertaking studies investigating the use of interface personas with strong emotive representations. These personas will act as helpers in OLM tutors, allowing the assessment of the impacts on learning achievement, child motivation and the appropriation and understanding of the user-model component by children.

After reviewing the related research work, we will describe the iterative participatory-design process adopted for the realisation of the DividingQuest. We will then detail some of the software characteristics. We will conclude on the research achievements and some future work considerations.

2. RATIONALE

User models representing the user as a learner can be used in the design of educational software and ITS. The learner model is the foundation of a system with the potential to treat learners as individuals. Research in user-modelling for computer-assisted instruction systems gives an increasing interest in open learner models (OLM): models of the user that are available for viewing by and potentially interacting with the learner and sometimes others. OLM systems offer the potential to help learners and teachers to reflect on models of their own knowledge, misconceptions and learning processes. It can help motivate students who aspire to perform at the highest standard as well as giving them ideas of their own performances against average results. A research issue is to incorporate OLM into conventional learning systems. By working closely with classroom teachers there is a need for defining interfaces where teachers and learners could own the learner models and make the best use of its content about the learner development.

Research in ITS is currently focusing on the improvements of the learner model to make the understanding between the user and the tutor more effective. Bull et al [2] demonstrated that children from the ‘concrete operational stage’ can understand and use an OLM in their learning and that this may be beneficial for their performances. The inclusion of pedagogical agents into the ITS have been shown to change the way children use the ITS and some findings indicate that this could increase the motivation of the child to use the application and its performance while using the system. Whereas a conventional intelligent tutoring system may be invisible and fairly abstract, the addition of an animated pedagogical agent to the interface provides elements of embodiment, visibility and personality; in addition to the ability to communicate in an intelligent manner, a pedagogical agent should, according to Lester et al. [8], have socio-emotive abilities and be lifelike. Consequently, the addition of animated agents to ITS opens up the possibility for learners to have a personal relationship and an emotional connection with the agent, which in turn may promote interest in the learning task [10].

Designers of children’s technology must concentrate not only on the mechanics of their interfaces but also on features that will keep children engaged [4]. Work by Hanna et al, [6] suggests that the difficulties that children have with reading can be reduced by the use of ‘visually meaningful icons’, ‘thoughtful cursor design’, and the addition of features such as rollover, audio, animation, and highlighting.

Many researchers have explored the relationship between fun, play and learning, reasoning that fun contributes to being motivated to pursue an activity, and as such can also contribute to learning effectively [9]. Draper [5] suggests that fun is associated with playing for pleasure, and that the sense of fun may be achieved by presenting tests in a different medium incorporating multimedia stimuli. Developing educational software incorporating a gaming genre is seen as a motivational factor for children enticing them to use the software [1]. The intervention of pedagogical agents at appropriate moments in the software might motivate the children and helping them relate more to the software storyline, therefore considering using not only as a teaching tool but also as a game.

3. USER-CENTRED DESIGN

The main objective of the design is to develop a highly usable, interactive learning environment for children to practice effectively mathematics on a computer. From the point of view of the child, the user interface is the main interaction, as it provides a domain for them to interpret and execute system tasks. Consequently, the design stage involves making the interface intuitive and exciting so that children can easily relate to it. The end system should be supportive of the tasks that the children and teachers perform and designed to be attractive for children. We therefore worked closely in the design process with a year 6 child and a year 6 teacher following a Participatory-Design approach to incorporate into the design their views and opinions about the user-interface and mathematical content, including the system functionalities defined during the Stakeholder-Centred requirement analysis.

The organization of the child Participatory-Design sessions had an iterative nature, for the granularity of the design being refined at each stage of the design. This enabled the iterative sessions to have a different focus each time, providing more motivation to the child as each session produced a result closer to the final product. Some suggestions however were contradictory to several design solutions generated from studying the HCI literature, as well as violating HCI practices. In these cases, the child’s inexperience within the field of HCI was noted and existing professional theory was preferred.

The inclusion of teacher Participatory-Design sessions within the evolution of the design realized from the child’s inputs were revealed particularly salient Some compromise were needed between design ideas from the children on the mathematical content, or their access to peers results, and the teaching strategy of the teacher and its pedagogical groundings concerning the openness of the child user model. It was therefore possible to modify the design from the teacher’s input, explaining to the child the reasons for the modifications and enabling another iterative refinement of the design from the teacher’s inputs.

As the Participatory-Design was realized with only one user at a time, we decided on an adaptation of the PICTIVE and CARD methods (*Muller, 1991, 1992; Tudor, Muller and Dayton, 1992*) to create a low-fidelity prototype. The prototype was chosen to be low-fidelity in terms of interaction and high-fidelity graphically, with the use of Microsoft PowerPoint™, also chosen as our Participatory-Design child already had a good knowledge of its functionalities in creating animated cartoons. The use of PowerPoint™ to create the prototype enabled the child to express the exact representation of the concepts and images he wanted to be included in the software, whereas the use of oral description might have produced a final design different from the child’s expectations. It also enabled the child to positively transfer knowledge from actual applications he had experience and to have a better idea of the final result of the prototype solution according to his expectations.

4. THE DIVIDING QUEST

4.1 Storyline and reward scheme

The DividingQuest is an adventure and fantasy game, which aims to “change the world by succeeding mathematical challenges”. Inspired by the Lord of the Ring™ storyline, it includes various mathematical challenges to succeed in different areas of the game, in order to finally reach the most challenging area and accomplish the quest. The game includes 5 areas of dividing challenges with 3 levels of difficulty in each area. Winning a level 1 quiz gives the child the access to one particular piece of the warrior’s armour made of bronze. Winning a level 2 quiz transforms this piece of armour into silver whereas winning a level 3 quiz transforms the silver piece into gold. To access the final part of the game (the Challenging the Dragon Area), the warrior should have some knowledge in each of the mathematical area (5 pieces of armour), being more familiar with at least 2 areas (at least 2 silver pieces) and a specialist in at least one of the areas (at least 1 gold piece). For the user to have some visibility on their performance, they are constantly presented with the number of rewards they won in this quest in the form of a reward board on a permanent menu frame.

4.2 Help system representation

The DividingQuest has been implemented as a website application with a SQL database back-end for registering data about the user. It includes three different user-interfaces: child, teacher and administrator.

4.2.1 *Three child user-interface*

The architecture of the software will enable investigations on the impacts of using emotive interface personas as helpers. The DividingQuest includes 3 representations of the child user-interface, to be differentiated in their representation of help system (by buttons, by an interface persona giving verbal praise and rewards, or by an interface persona with the characteristics of the second interface but also displaying some emotions).

Figure 1: 3 help system representations

4.2.2 *Helping system*

Three types of mathematical help are given to the user: a general method to answer the question, some hints (such as the access to division tables) and the access to a detailed correction of an incorrectly answered question. When a child accesses some help, we look at the effect of using help on the result of the next question. The use of help and the result of the next question are then registered in the database for further analysis during empirical studies.

4.3 Learning metaphors

In English schools, teachers use the traffic-light system to represent a child's performance (ie. green for success, orange for partially understood and red for a lack of success). This has been applied as a learning metaphor for the progress bar indicator of the game as well as the interface personas animations giving visual feedback of the correctness of the result.

The graphics however for the progress bar indicator differ from one area to another to match the environment of the area they belong to and help the children remember in which area of the game they are. A white icon with an animal has been added to represent the current question being answered and differentiate it with the questions still to answer. Figure 2 illustrates the progress indicator for the *Bewitched Woods Area*:

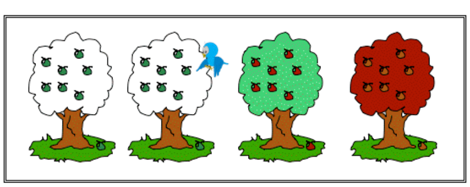

Figure 2: Progress Indicator Icons

The traffic-lights system has also been used in the representation of the interface personas to magnify the verbal praise given after one question or one quiz: the clothes are progressively transformed from bottom to top to green if the child answered correctly. On the contrary, in the case of incorrect answers, the clothes turn progressively to red from the top to the bottom.

4.4 Children Open-learner model

The child learner-model is open to the child (with control restrictions) and to the teacher (for visualization and modifications).

When the user first uses the software, he is asked to select a helper in the case of representation of help system by an (emotive) interface persona. The software registers the choice of helper in the database. In future, when the user connects to the website, the system gets the chosen helper for a display of the interface persona throughout the child's quest. Once the child chooses a helper, there is no possibility by change.

The child can interact with his user model through the choice of things they like the most. It has been decided that the questions on problem solving would be given to the child using the things he or she likes the most, instead of a random choice of themed pictures and concepts. For this reason, the user is asked to choose a number of things they like in different categories at their first use of the software.

Currently in the design, the user-model, at the end of a won quiz, updates the number of questions to succeed the quiz to the number of questions the child won incremented by 1 if they did better than before. The children can notice the modification when they try this level again in the progress indicator with the number of questions to succeed.

The teacher can visualize and interact with the child learner model in his own interface. He has access to the performance of the children of his class and can modify the number of questions to be answered correctly to access a reward for a specific child of his class.

5. CONCLUSION

This article constitutes a first step on the inclusion of affect in the design of helping characters in open learner modelling tutoring systems. The DividingQuest presents researchers with three possible user-interfaces for children with different help systems, a management system for teachers and a visualization and customization interface for researchers on the variables to register for empirical studies. Designed using a Participatory-Design approach, it has been evaluated by children as fun and exciting to use. The mathematical content is adapted to the year 6 class teaching practices, and therefore is more likely to produce an enjoyable and valuable learning experience during the software deployment in classes. The next step is now to deploy it into schools in order to investigate the impacts of using emotive interface personas in Open-Learner Modelling tutors on the learning achievement, and child's motivation and appropriation and understanding of the user-model component by children.

6. FUTURE WORK

Our future research program includes the deployment of the DividingQuest into schools for empirical study as well as some modifications of the software. The first empirical study to be realized will investigate whether there is a difference in learning achievement and motivation between a help system represented by buttons, an interface persona, or an interface persona expressing emotions. The DividingQuest will then be used to answer research questions such as: Does the use of emotive interface persona enable a better identification of the child with the characters? Are teachers willing to give advice to the children through the use of the software and are children more likely to follow advice in the emotive condition? Do certain activities of the software contribute to a better child understanding of mathematical concepts than others? How do children from different cognitive development stages respond to the help given? We would also be interested in realizing some modifications on the instruction model of the tutor to increase the difficulty of the problems it gives depending on the student's progress. The children could then have the opportunity to interact with their learner model and ask for easier or more difficult questions in the test. The results and learning benefits of this openness of the child learner model could be then analyzed in further research studies.

Finally, we are interested in sharing information on class performance to other schools registered with the system, for a class challenge to be organized. The children would therefore view the challenge as an opportunity to succeed better in the quest than other schools, increasing their motivation in the learning session.

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