A Classroom Investigation of Software Design Requirements for Special Needs Learners

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Our study investigates the establishment of a design framework for multimedia software design for young learners with autism. The researcher, in partnership with local special needs and autism schools, has developed a social skills multimedia-based lesson.   The Discrete Trial Instruction (DTI) teaching approach has been adopted within the framework of the prototype. DTI is a teaching method used to teach children with learning difficulties. DTI aims to positively improve a social behaviour or teach a task to a child within the classroom environment. The researcher has completed an in-depth study in the field in order to build a specific user model for these young learners. A series of interviews, classroom observations, parent/tutor reviews and sequential prototype design evaluations have been performed. Non-obtrusive observation techniques have been followed throughout the user profile building stage, as suggested by Druin, a children's technology and interaction design expert. This approach enables learners to feel at ease in their own environment.

Findings from these early investigations and user profiling have shown that ease of access to technology and software is a key criterion for these young users. A variety of multimodal technologies such as touchscreens and switches must also be integrated into the design of software. These technologies alleviate the motor and input difficulties which many young learners find when using the more common hardware devices such as a keyboard or mouse.

Further recommendations have also indicated the importance of audio to be included within the prototype construction. From the perspective of this project, voiceovers have been recorded to assist children with reading and understanding of lesson content. Results from initial evaluations state that current software on the market is strongly targeted at an American audience. Our project consists of an Irish tone in order to make the lesson more comprehensible for the young learner. In accordance with the DTI approach an animated social scenario lesson has been created using web animation tools. Accompanying the animation is a sample quiz and short animated rewards to assist with motivation and the transfer of knowledge of the lesson content.

A nationwide survey is currently in progress to further consolidate the design structure of the prototype. A random sample of Irish national special needs schools has been chosen to participate in the survey. An online questionnaire documenting both interface design and software usability questions has been developed to evaluate the software design framework. It is anticipated that results from this survey should further help the progression of educational computer-based programmes for young learners with autism, and contribute to a clearer understanding of multimedia and software development approaches that have good learning and teaching potential.

Keywords Learners with Autism; Social Skills; Usability; Storyboarding; Multimedia; Animation

1. Introduction

This paper documents the development of a software design framework for primary school children with autistic spectrum disorders (ASD).

A user centred design approach is taken during each phase of software development. Teachers in a local special needs and Applied Behaviour Analysis (ABA) (Lovaas, 1987) school have been recruited, in order to provide feedback during each design phase. A series of questionnaires and interviews were conducted with teachers as a means of understanding user requirements (Jarrett *et al*., 2005). From these early investigation techniques a user profile was constructed which was used as a basis for onscreen designs. The phases within Mayhew's (1999) Usability Engineering Lifecycle are also followed during the design and

development of the computer-based prototype. As Mayhew's (1999) model is strongly focused on usability tasks, this close involvement with users and their feedback at each stage is appropriate for development of special needs software.

A social skills lesson was created as a computer-based prototype (Walsh and Barry, 2008a; Walsh and Barry, 2009). Prototype analysis with tutors provided us with a method of creating the software design framework for special needs learners.

2. Requirements Analysis

Requirements Analysis involves the gathering of information from users during the early phases of design. It provides the researcher with an understanding of the user and how they conduct their everyday tasks. The main aim of this enquiry is to find effortless and unproblematic methods for the user while working with computer-based systems. Due to the sensitive nature of this research area, extra care and special methods are used during user profiling.

Young primary school learners with autism, in the four to nine year age range, are the primary users of this system. The children in the class have limited verbal skills and only possess a small range of vocabulary. The Picture Exchange Communication System (PECS) is used within the classroom as a method of communication (Bondy and Frost, 2001). All objects in the classroom are labelled with a velcro patch, and children can then attach their card to the object if they wish to refer to it.

2.1 Task Analysis

Task Analysis is the process of understanding how the learner currently uses software and interacts with the computer. The findings from task analysis enable the creation of a fully functional software package that will support the child in completing lessons aimed at enhancing social skills development

User observation was the central approach used during this phase. Particular attention was paid towards the day-to-day routine of the child. The teacher also demonstrated the different software available in the school and discussed the current problems and benefits of the technology.

It is important for the researcher to gain an understanding of how the children currently interact with the technology available in the school. A number of children in the classroom were observed using the classroom vocabulary software.

As suggested by Hanna *et al.* (1997), instead of requesting young children to complete a series of direct tasks it is more appropriate to allow the children to explore the software at their own pace. As they still are at a very early school level they will find drill type tasks difficult to follow and tiresome.

The researcher visited the children in their designated classroom and sat with the children at their own level when observing their classroom activities. The researcher took all notes discretely in a small notebook and asked permission from tutors before displaying the laptop (Druin *et al.*, 1999). Further discussions with tutors and demonstration sessions took place in the tutor's office.

2. Storyboard Design

The initial design phase, storyboarding, lays the foundations for commencing the design process, based on findings from Requirements Analysis. The final paper-based mock-ups were evaluated with the teacher to discuss if they met the criteria previously specified. A diagrammatical representation of the initial design phase is shown in Figure 1. As these mock-ups are only paper and pen sketches they provide a quick and cheap method for creating designs while talking to users.
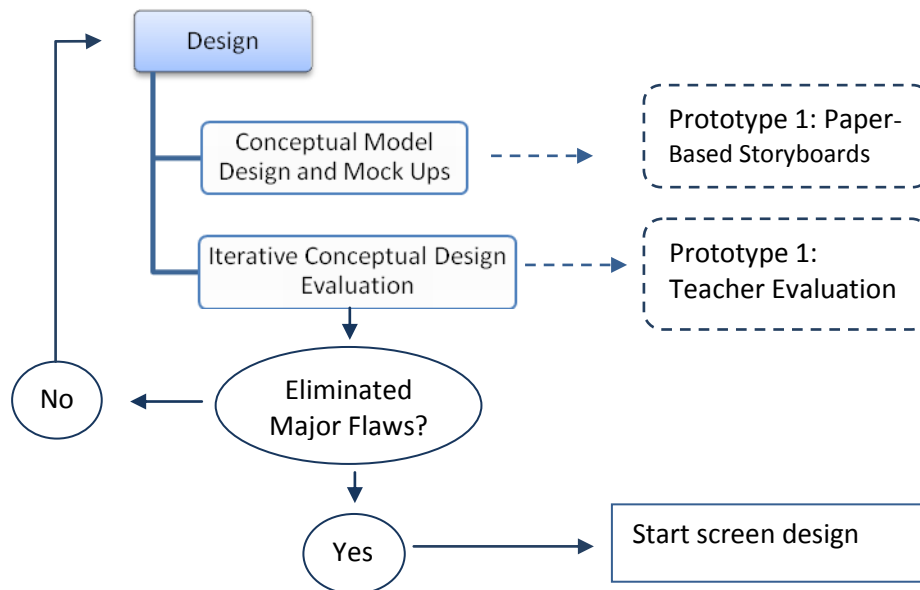

Figure 1 Design approach for storyboards (adapted from Mayhew, 1999)

A selection of paper-based storyboards representing the prototype's interface design, were created and evaluated with autism tutors (Walsh and Barry, 2008b).

3. Technologies used during Analysis and Design

The overall findings from task analysis and storyboarding concluded that accessibility and ease of use were key components to be included within the software design. The users in this investigation are dependent on hardware technologies such as touch screens and switches. The main interface components, i.e. buttons and menus, had to be developed to allow for these devices.

Additional recommendations from tutors indicated that the use of audio should be introduced into the prototype design. Following an autism software benchmarking study, results summarised that much of the educational software available in Irish schools, were targeted towards American users. The learners often found the American accents and terminology confusing. A voice-over was recorded and integrated into a section of the prototype lesson. The learner was provided with buttons in order to control the sound and the relevant onscreen text changed colour in order to correspond with the voice-over. Through inclusion of these additional components, it is intended to actively engage the learner within

the learning environment (Hardy *et al.*, 2002).

A combination of technologies was used during analysis and design to provide an accessible user interface for the learner with autism:

- *Cascading Style Sheets (CSS):* The Cascading Style Sheets provide a uniform and predictable format across all web pages. This responds to the learner's need for 'sameness' or 'strict routine'. If each page layout is in the same format the learner can anticipate the next page of the prototype (Peeters, 2000).
- *Web Accessibility Software:* This software was used to ensure that the prototype web pages approved to the accessibility standards set by the Web Accessibility Initiative (WAI) (WAI, 2006).
- *Text-to-Speech Software:* Even though a voice-over had been created for a section of the prototype, it was not possible to create audio for the complete prototype. A test was performed on all text areas of the prototype, using *Read & Write Gold* text-to-speech software (Texthelp, 2009).

4. Conclusions

A nationwide survey was conducted with a random sample of tutors in Irish special needs schools.

The online questionnaire contained a set of interface design and usability questions. Overall, the teachers provided a positive response towards the prototype. The interface design was regarded positively in most cases. Its clutter-free and minimalistic design provided easy navigation for the young learner. The theme of the prototype, *washing my hands*, was also commented upon as being a constructive approach for teaching social skills to young learners as well as advancing their reading skills. A comment a received from a tutor stated,

"…The voiceover functionality is very useful and clear. A wide variety of social skills could be taught with this application…"

The results from this survey are currently being analysed, in order to establish a set software design guidelines of multimedia learning technologies for young learners with autism.

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