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Developing Student Perception of User Interface Design using Smart Boards in Project Based Learning

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ABSTRACT

The National Curriculum of England and Wales recommends that schools adopt a variety of learning styles in order to foster the development of thinking skills. When students are involved in the design of software they are effectively involved in project-based learning. The use of smart boards, teacher instruction, or a combination of the two in the feedback and evaluation stage of the design process has proved to be an important factor in the development student perception of user interface design. The adaptive nature and flexibility of student interaction with the smart boards' user interface, and the knowledge acquisition engendered by teacher instruction, have both enhanced the development of the student's evaluation skills and ability to effectively represent their knowledge of interface design. Initial results would tend to indicate that using a smart board is of great use as an aid to student perception when the students understand the conceptual basis of the user-interface dimension being developed. The smart board seemed to be less effective than teacher instruction where students were asked to assess user-interface dimensions whose underlying concepts students regarded as difficult or abstract.

INTRODUCTION

In the Mosslands School for Boys we developed and prototyped of methodology of participatory design in collaboration with school students (Duggan et al, in press; Duggan, 2000). This methodology was called Fast Tracking. When students are involved in the design of software they are effectively involved in project-based learning (Liu & Hsiao, 2002).

The aim of this case study is to focus more closely on the feedback and evaluation side of the system life cycle and, more importantly, evaluate the development of student perception of interface design. We would argue that it was important that the students have some commonality of experience, and a conceptual framework, when discussing and evaluating interface design. We would also argue that it is important that students have some commonality of experience in representing their knowledge. Is commonality of student perception desirable, and why? We would argue that commonality of perception and its concomitant knowledge representation gives a strong indication that the students see the interface in the same way without implying a value judgement as to its design ethic.

To foster the development of this perception, we were interested to determine which method of student support best fostered this development. In particular, we were interested in determining whether the adaptive nature and flexibility of the smart boards' user interface would prove to be useful in the development of the students' perception of user interface design. In this way the smart board could be used as an aid, or scaffolding device to assist development. This case study represents an attempt to move the measurement of usability beyond the measurement of flow as documented by Duggan et al (Duggan et al, in press).

FEATURES OF THE SMART BOARD

In teaching and learning, smart boards can be used to facilitate dynamic student exploration and interaction with the curriculum content of the lesson in visually stimulating ways. Students are enabled to collaborate by sharing their ideas and perceptions with the rest of the class and responding to constructive feedback.

Our smart board offered the following facilities:

- Board and pen, which enabled direct writing onto the board and full on-screen editing.
- Studio software, which enabled storage, retrieval and integration of multimedia resources;
- The use of 'flipcharts'.
- The use of pre-installed content.
- Handwriting recognition.
- Web browsing; annotation and the saving of changes.
- The import and export of files to the school intranet and other destinations.

CONCEPTUAL FRAMEWORK FOR USABILITY

An existing qualitative theoretical construct used to define user interface dimensions was adapted to provide a conceptual framework suitable for quantitatively assessing student perception of the design of the user interface. Reeves and Harmon (Reeves & Harmon, 1994) have created two dimensions to be used for the evaluation of interactive multimedia (IMM) in education. These two dimensions are the pedagogical dimension and the user-interface dimension.

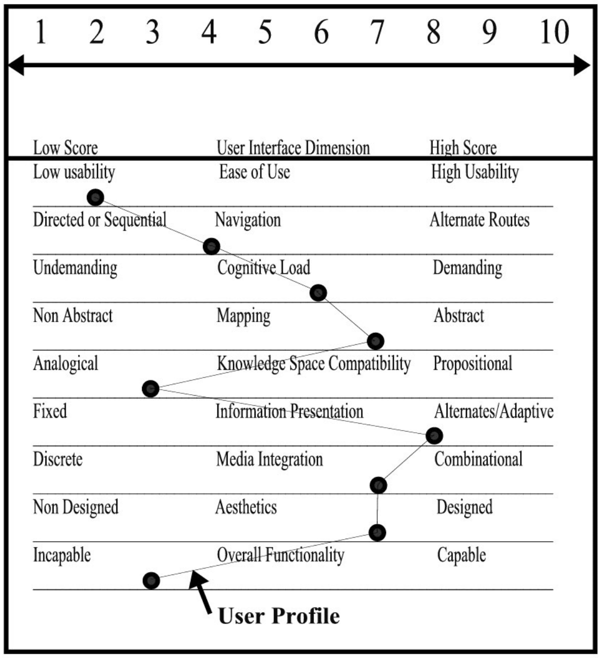
The pedagogical dimensions are those aspects of the design of the IMM that directly affect learning. They are defined as; *epistemology*, *pedagogical philosophy*, *underlying psychology*, *goal orientation*, *instructional sequencing*, *experiential validity*, *role of instructor*, *value of errors*, *motivation*, *structure* and *accommodation of individual differences*.

In this study we are primarily concerned with the user interface dimensions, which concern those aspects of IMM that ensure meaningful interactions with software. These are defined as; *ease of use*, *navigation*, *cognitive load*, *mapping*, *screen design*, *knowledge space compatibility*, *information presentation*, *media integration*, *aesthetics* and *overall functionality*.

Cooper and Maor (Cooper & Maor, 1998) developed an evaluation grid for the assessment of the pedagogical dimensions of IMM software. To evaluate the user interface dimensions we can adapt the pedagogical evaluation grid of Cooper and Maor (Cooper & Maor, 1998) to produce a user-interface grid (UIG). See Figure 1.

We regard and define usability as a range of possible responses across a spectrum. Given that definition, Figure 1 illustrates how the UIG can be used to record the students' perceptions (evaluation and knowledge representation) and create an overall *user profile* of the software

Figure 1: Example User Interface Grid (UIG) for knowledge representation. Adapted from Cooper & Maor (Cooper & Maor, 1998).



under development in the case study. Students marked on the grid a score for each of the dimensions to create an overall profile. Intermediate values were not allowed.

EXPERIMENTAL DESIGN

The null hypothesis (H_0) to be tested states that, in the population of subjects, there is *no difference* student perception of user interface design pre-scaffolding, and student perception of interface design post-scaffolding.

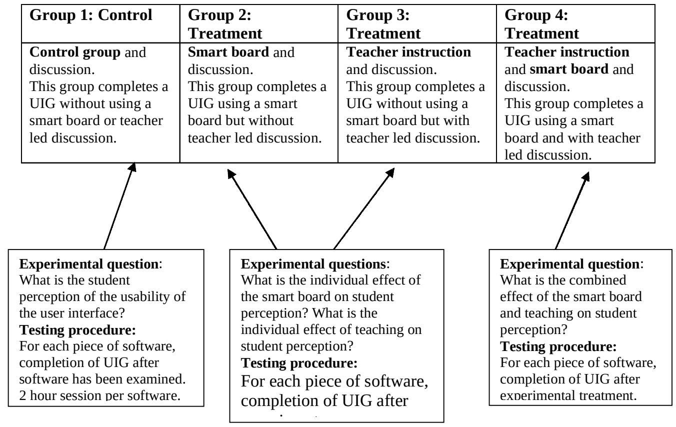
To control extraneous effects on experimental results (internal validity) it was important that the experimental design took account of the possible effect of instruction from staff on the development of student perception. Measurable changes in the development of thinking skills may take considerable time. Tutorial software alone is not effective for developing thinking skills, but can be used as a basis for discussion between learners and prove effective in infusing thinking skills within the curriculum (Wegerif, 2002). Therefore, strictly speaking the students should use several different pieces of software over a considerable period of time and be able to discuss and explore ideas with each other. For the purposes of this study, only one piece of software was examined.

We also needed to consider the effect that possible variation in the usability of the software had on the experimental results. To this end, four groups of 57 year 9 students were recruited to participate in this phase of the study. The sample size was regarded as small, but acceptable, for this category of experiment (Salkind, 2000). However, recruiting greater numbers of equivalent students was difficult within the school. The students were randomly selected as independent samples by average SAT score in a double blind test to each of the four groups. We would argue that there are two factors which could contribute to a change in student perception. These are; use of a smart board and teacher led discussion. Therefore the null hypothesis could be broken down into three sub-hypothesis*:*

Hypothesis H_1. Student perception of interface design is not significantly affected by the use of a smart board.

Hypothesis H_2. Student perception of interface design is not significantly affected by teacher instruction.

Figure 2: Factors to be tested in each experiment.



Hypothesis H_3. Student perception of interface design is not significantly affected by a combination of the use of a smart board and teacher instruction.

The main outcome of the experimental design was to isolate the individual contributions of the smart board and teacher led discussion elements to the overall change in student perception. Each of the four groups was assigned to one of the experimental treatments outlined in Figure 2. Individual students contribution to the discursive element of the experiment were recorded as they discussed the design.

Post experimentation, students were individually asked to talk through their responses to produce qualitative confirmation of the results. Students were given printouts of the UIG on which to record their responses.

The smart board was located at the front of the classroom and linked to the schools curriculum intranet. The students were able to display their own ideas and designs and discuss them with the group. There were five 'one hour' sessions over a period of three weeks, each session dedicated to the examination of two user interface dimensions. During each session students worked in groups of three.

In the lead up to the experiment it was explained to the students that there were *no correct responses*, that we were mainly concerned with how their evaluation and knowledge representation of their perceptions' changed in the light of using the smart board for scaffold-

Figure 3: Kruskal-Wallis analysis of variance results.

Groups	Kruskal-Wallis test statistic	Comment
1, 2 (D)	**Ease of use**: $\chi^2(1)=40.316$; $p<0.01$	Significant beyond the 1 per cent level.
1, 3 (D)	**Ease of use**: $\chi^2(1)=1.095$; $p>0.05$	The result is not significant.
1, 4 (D)	**Ease of use**: $\chi^2(1)=14.447$; $p<0.01$	Significant beyond the 1 per cent level.
1, 2 (O)	**Navigation**: $\chi^2(1)=14.409$; $p<0.01$	Significant beyond the 1 per cent level.
1, 3 (O)	**Navigation**: $\chi^2(1)=9.044$; $p<0.01$	Significant beyond the 1 per cent level.
1, 4 (O)	**Navigation**: $\chi^2(1)=0.329$; $p>0.05$	The result is not significant.
1, 2 (A)	**Cognitive load**: $\chi^2(1)=2.611$; $p>0.05$	The result is not significant.
1, 3 (A)	**Cognitive load**: $\chi^2(1)=3.274$; $p>0.05$	The result is not significant.
1, 4 (A)	**Cognitive load**: $\chi^2(1)=3.190$; $p>0.05$	The result is not significant.
1. 2 (A)	**Mapping**: $\chi^2(1)=0.049$; $p>0.05$	The result is not significant.
1, 3 (A)	**Mapping**: $\chi^2(1)=7.703$; $p<0.01$	Significant beyond the 1 per cent level.
1, 4 (A)	**Mapping**: $\chi^2(1)=6.475$; $p<0.05$	Significant beyond the 5 per cent level.
1, 2 (D)	**Screen design**: $\chi^2(1)=69.690$; $p<0.01$	Significant beyond the 1 per cent level.
1, 3 (D)	**Screen design**: $\chi^2(1)=72.400$; $p<0.01$	Significant beyond the 1 per cent level.
1, 4 (D)	**Screen design**: $\chi^2(1)=87.434$; $p<0.01$	Significant beyond the 1 per cent level.
1, 2 (A)	**Knowledge space compatibility**: $\chi^2(1)=2.398$; $p>0.05$	The result is not significant.
1, 3 (A)	**Knowledge space compatibility**: $\chi^2(1)=4.690$; $p<0.05$	Significant beyond the 5 per cent level.
1, 4 (A)	**Knowledge space compatibility**: $\chi^2(1)=6.399$; $p<0.05$	Significant beyond the 5 per cent level.
1, 2 (D)	**Information presentation**: $\chi^2(1)=6.129$; $p<0.05$	Significant beyond the 5 per cent level.
1, 3 (D)	**Information presentation**: $\chi^2(1)=97.679$; $p<0.01$	Significant beyond the 1 per cent level.
1, 4 (D)	**Information presentation**: $\chi^2(1)=0.178$; $p>0.05$	The result is not significant.
1, 2 (O)	**Media integration**: $\chi^2(1)=2.999$; $p>0.05$	The result is not significant.
1, 3 (O)	**Media integration**: $\chi^2(1)=13.170$; $p<0.01$	Significant beyond the 1 per cent level.
1, 4 (O)	**Media integration**: $\chi^2(1)=0.232$; $p>0.05$	The result is not significant.
1, 2 (D)	**Aesthetics**: $\chi^2(1)=5.185$; $p<0.05$	Significant beyond the 5 per cent level.
1, 3 (D)	**Aesthetics**: $\chi^2(1)=2.584$; $p>0.05$	The result is not significant.
1, 4 (D)	**Aesthetics**: $\chi^2(1)=0.290$; $p>0.05$	The result is not significant.
1, 2 (D)	**Overall functionality**: $\chi^2(1)=4.635$; $p<0.05$	Significant beyond the 5 per cent level.
1, 3 (D)	**Overall functionality**: $\chi^2(1)=11.289$; $p<0.01$	Significant beyond the 1 per cent level.
1, 4 (D)	**Overall functionality**: $\chi^2(1)=19.856$; $p<0.01$	Significant beyond the 1 per cent level.

ing. This discussion facilitated a common understanding of the meanings of each dimension. It is important to note that any possible source of training by the teacher was avoided during the discussion so that internal validity could be preserved.

ANALYSIS

For each of the treatment groups (groups 2, 3 and 4), the data for each user interface dimension was compared against the equivalent user interface dimension in the control group.

To ensure that the correct statistical test was implemented the base data for each dimension of the user interface was analysed using a *one sample Kolmogorov-Smirnov* test. In each case the results indicated that the data was non parametric in nature. This indicated that a *one way Kruskal-Wallis analysis of variance* would be the most appropriate method for determining the significance of the results (Kinnear & Gray, 2000). The results are indicated in Figure 3.

DISCUSSION

As yet, we do not have sufficient results to conclusively prove, or disprove, the sub hypothesis, and we are careful that the conclusions drawn should not be overstated. Nevertheless, the results proved to be interesting.

As part of the analytical process, we wished to examine the preconceptions that representative students would have regarding the success of the scaffolding process in altering student perception. It was envisaged that these preconceptions would prove to be a useful backdrop against which to compare the eventual results. To avoid possible contamination of the experimental results by student expectation (Tuckman, 1999) feedback was sought from a sample of students not involved in any of the experimental groups.

Oral feedback from these students at the beginning of the experiment indicated that student perceptions of the user-interface design could be broadly categorised as *obvious*, *developmental* or *abstract* (our terms) as shown in the *groups* column of Figure 3. Students largely regarded the assessment of *navigational structure* and *media integration* as *obvious*. Generally speaking, the students believed that they fully understood the conceptual basis and quantification of those user interface dimensions they regarded as obvious. They indicated that they did not envisage that the process of scaffolding by a variety of different methods would not change their responses in any way. The students indicated that those dimensions, which the students regarded as *developmental*, could possibly show significant changes as a result of scaffolding. Student responses indicated that they believed that they understood the concepts they were attempting to represent, but were unsure how to quantify them. Student response to those dimensions, which the students regarded as abstract, was generally ambivalent. The responses indicated that the students believed that they did not really understand the concepts involved. Therefore, they believed that any form of scaffolding would generate significant difference and aid their understanding.

The nature of the student feedback led us to project that we could expect no significant difference to be displayed by any treatment method for the *obvious* user interface dimensions: *navigation* and *media integration*. We could expect significant difference to be displayed for the *developmental* user interface dimensions: *ease of use*, *screen design*, *information presentation*, *aesthetics* and *overall functionality*. We could also expect significant difference to be displayed for the *abstract* user interface dimensions of *cognitive load*, *mapping* and *knowledge space compatibility*. However, the results proved to be somewhat contradictory and not what we were expecting. Use of the smart board effected significant difference in the *obvious* user interface dimension of *navigation* but not *media integration*. It also effected significant difference in the *developmental* user interface dimensions: *ease of use*, *screen design*, *information presentation*, *aesthetics* and *overall functionality*. Use of the smart board effected no significant difference in any of the *abstract* user interface dimensions. Teacher instruction effected significant difference in the all *obvious* user interface dimensions. However, teacher instruction effected significant difference in the user interface dimensions of *screen design*, *information presentation* and *overall functionality* but not *ease of use* or *aesthetics*. The use of teacher instruction effected significant difference in the *abstract* user interface dimensions of *mapping* and *knowledge space compatibility* but not *cognitive load*. Perhaps the most contradictory results of all occur where the use of use of a smart board and teacher instruction were combined. No significant difference was effected in any of the obvious user interface dimensions. Significant difference was effected in the developmental user interface dimensions of *ease of use*, *screen design* and *overall functionality*. Significant difference was not effected in *information presentation* or *aesthetics*. The use of a smart board and teacher instruction effected significant difference in the abstract user interface dimensions of *mapping* and *knowledge space compatibility* but not *cognitive load*. Perhaps the most perplexing results from the analysis can be gleaned from examination of the user interface dimensions *navigation* and *information presentation*. In both cases examination of the results indicates that the combination of treatments actually negates the effect that each would have had individually. One possible explanation could be that the results of the students own discussion while using the smart board and the instruction given by the teacher are somehow giving a contradictory impression of how the interface should be perceived.

Of course, it should be realised that a determination of significance only indicates a difference in student perception between the treatment groups. It does not indicate whether the treatment inculcates any commonality of student perception of user interface design. For that we could examine the standard deviation of each user interface dimension for each of the four groups as an indicative measure of dispersal. In all cases a comparison of the standard deviation of each user interface dimension in the control group, against its equivalent in each of the three treatment groups, indicated that the standard deviation in the treated group was substantially lower in all but three cases. The standard deviation of the control group was virtually identical to the standard deviation of group 3 (teacher instruction) for the user interface dimension screen design. For the user interface dimension aesthetics the standard deviation of the control group was substantially smaller than the standard deviations in group 3 (teacher instruction) and group 4 (smart board and teacher instruction). This would tend to indicate that while a determination of significant difference often yielded contradictory results, in the majority of cases the reduction in the standard deviation in the treated groups indicated that the students were coming to share a commonality of perception about user interface design.

CONCLUSION

We regard the results to be interesting, but not conclusive as yet. The results indicate a probable connection between the use of a smart board, teacher instruction or a combination of the two as a scaffolding device, and change in student perception of user interface dimensions. They also indicate that these scaffolding devices help to inculcate a commonality of student perception of interface design. However, these results were generated from only one test, so they need to be confirmed by repeated experimentation. It is too early to be able to predict trends or experimental outcomes. We need to find out how variations in software interface design effect the development of student perception. It may prove to be the case that the smart board as a scaffolding device will be of use in only a limited subset of possible user interface configurations. Of equal importance, we need to investigate the possible effect that variations in the pedagogical dimensions of the software may exert on student perception. It may prove to be the case that students react in a similar way only to software with a similar pedagogical profile. We plan to extend, and adapt, our experimentation to attempt to answer these questions.

REFERENCES

Cooper, M. & Maor, D. (1998). Mathematics, Multimedia and Higher Level Thinking Skills. In Proceedings of the Western Australian Institute for Educational Research Forum. August. Freemantle.

Duggan, P. (2000). Masters of the universe-data-logging with an online telescope. In Good Practice in the Use of ICT in Schools. Paper presented at the annual meeting of Teachers Helping Each Other conference, London, March.

Duggan, P., Ghaoui., & Simco, M. Fast Track: School Based Student Software Design. 'E-Education Applications: Human factors and innovative approaches', Claude Ghaoui (ed), IRM Publishing, USA, (in press).

Kinnear, P. R. and Gray, C. D. (2000). SPSS for Windows Made Simple Release 10. Psychology Press Ltd., Hove.

Liu, M., & Hsiao, Y. P. (2002). Middle School Students as Multimedia Designers: A Project Based Learning Approach. Journal of Interactive Learning Research. Vol. 13, Issue. 4, pp. 311-337.

Reeves, T. C., & Harmon, S. W. (1994). Systematic evaluation procedures for interactive multimedia education and training, Systematic evaluation.

Salkind, N. J., (2000), Statistics for people who (think they) hate statistics. Thousand Oaks: Sage Publications, Inc.

Tuckman, P. W. (1999). Conducting educational research "5th ed." Fort Worth : Harcourt Brace.

Wegerif, R, Sams, C and Barrett, G (2002). The role of computers in learning conversations. Paper at IFIP 2002 conference. Manchester. (http://fels-staff.open.ac.uk/).

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