Human Centred Technology Workshop 2005

Advancing the Potential for Communication, Learning and Interaction

PROCEEDINGS

8th Human Centred Technology Group Postgraduate Workshop

Department of Informatics, University of Sussex, Falmer, Brighton

In association with the British HCI Group

June 28th – 29th 2005

At The Royal Albion Hotel, Brighton

Organizers:
Paul Marshall, Diane Brewster, Sallyann Bryant, Edgar Chaparro, Beate Grawemeyer, Erika Martinez-Miron, Genaro Rebolledo-Mendez, Pablo Romero, Aybala Yuksel

www.bcs-hci.org.uk

FOREWORD

This is the eighth in an annual series of workshops held in Brighton in the summer or autumn. They bring together PhD students from around the UK and the rest of Europe with a common interest in Human Centred Computing Technology. The diverse and interdisciplinary nature of this area can restrict opportunities available to students, at their own universities, for peer review, feedback and discussion of their work or the process of completing a thesis. These workshops give such students a chance to discuss their work and also hear presentations from leading academics and commercial developers at the forefront of this field. The theme of this eighth workshop is "Advancing the Potential for Communication, Learning and Interaction".

Many people have been involved in the preparation for this workshop. I particularly thank Paul Marshall for chairing the workshop organizing committee, and the members of that committee: Diane Brewsler, Sallyann Bryant, Edgar Chaparro, Beate Grawemeyer, Erika Martinez-Miron, Genaro Rebolledo-Mendez, Pablo Romero and Aybala Yuksel

A special thank you is owed to Dr Rose Luckin whose idea it was to start this series of workshops and whose energy and vision have seen us through to now the eighth in the series.

All the above are members of the Human-Centred Computing Technology group in the School of Science and Technology (SciTech) at Sussex. This group comprises faculty, research fellows and graduate students from SciTech and other schools, interested in research on the design, implementation, and use of human-centred technologies.

The main objectives of the Human Centred Computing Technology Group are:

(i) to develop frameworks for understanding how people interact with and communicate through technology;
(ii) to apply this understanding to develop and support innovation.

This energetic and highly-regarded group currently hosts a wide portfolio of grants, including the multi-million pound EPSRC Interdisciplinary Research Collaboration (IRC) Equator and an EPSRC Platform grant.

Benedict du Boulay (Dean)
IDEAs Lab,
Human Centred Technology Group
School of Science and Technology
June 2005

Contents

Day 1

DAY 2

Designing technology for homework: Sensitivity to context

Katie Fraser
Learning Sciences Research Institute, University of Nottingham

Abstract

Technologies in homework have been positioned as an aid to both learning, and linking home and school effectively [1, 2]. This paper holds that an understanding of current homework practices, and the home context, is vital to designing technologies that can achieve these lofty goals. Data from a series of ethnography-inspired video diaries are used to illustrate how this might be achieved, outlining issues of sharing of tasks, routine and reminders, with the implications of these for design.

Introduction

While homework is at the centre of many children's lives, it is still poorly understood. Dedicated work [3] suggests that the impact of homework on education is difficult to make concrete. However, the role of technologies in supporting home study and home-school links has been the focus of much research.

Socially-driven research tends to focus on the role of the computer in the home – one technology being used for multiple tasks, rather than the single task and multiple technologies that make up the activity of homework. Sutherland et al [2] found that that children's use of home computers tends to be defined by their normal activities, of which homework is just one. Kerawalla and Crook [4] note that homework is a potentially important part of family computing – a site where children are receptive to parental involvement. While these studies, and others, comment briefly on homework, none focus exclusively on homework usage.

Technology-driven research has looked at the design and evaluation of new technologies [1, 5]. While parents are often involved in such studies, evaluation of technology's impact on home life, rather than home-school links, is rare.

Lacking in research is a focus on the place of homework within home life – the specific context in which 'homework technologies' reside. Venkatesh [6] has talked about the importance of considering the fit between the social and technological contexts in the home. Research shows how changes in the technological space can affect the social, illustrating how changing from paper technologies to computer-based ones [7, 8], or placing the computer in a certain location [4], can have important social consequences, or reflect important family issues. Homework makes demands that relate to both home and school, making it a unique social context, and what is more, a poorly understood one [3]. A starting point for studying this social context is by looking at the use and appropriation of current and traditional technologies – paper, computer, textbooks – within it.

This work attempts to follow through on this hypothesis. Ultimate goals are to assess the impact of current technologies, and guide the design of new ones. Studying current home practices should indicate how they can be supported, or altered, through technological design. As an inroad to understanding how homework technologies are used in the home, ethnography-inspired [7] video diaries were used to capture these practices. They record the practicalities of how people interact with technologies in homework contexts, capturing the use of technologies as diverse as paper and the PC, the kitchen table and the printer. By using a more structured, and family-driven form of video recording than previous studies [9], it was hoped to obtain highly concentrated records of critical incidents in homework technology use.

Method

Eight families took part in this study, split into pilot (N= 2 families), and main studies (N= 6 families). Participants were a convenience sample of families with children of school-going age known to the researcher, or recruited through personal contacts; all families in the sample contained at least one parent working in education or academia.

Participants were asked to film a wide selection of home scenarios in order to record a representative picture of homework within the context of day-to-day life. Digital video cameras were provided to each family for three weeks in the pilot, and two weeks in the main study, along with three mini DV tapes to record the diaries.

Pilot work began with an open brief to families to film video diaries surrounding their life at home. Cue questions suggested curiosity about meals, work (school and general), television, computers, and key events (arriving home and last-minute tasks). A tour and map were requested to orientate the researcher.

The main study used a more closed brief, based on feedback about the demands of recording. Participants were asked to film two examples from each cue question, plus more general examples of other technology use. Participants seemed to find providing a limited number of examples easier, but the two sets of diaries were similar in content. A third of the families at this stage did not film a tour, citing security concerns as the major reason. Each family produced around two hours of concentrated video data, showing a wide range of home work and home life.

Results

Some key issues arising from the diaries are discussed below. Examples are chosen to focus on family coordination in sharing tasks, and the place of technologies in organising work and routine. The potential implications of these are also outlined.

Example 1: Sharing

The majority of situations where parents and children work together on homework in the diaries involve co-location, with parents dipping in and out of homework tasks.

Figure 1: Neither collaborative, nor parallel

B: How do you spell cheese?
M: (walks back and looks at paper) Ch-ee-s – and then an e on the end (walks back to stove and swirls pan again)
B: (is writing and looking carefully at the paper)
M: (opens drawer and gets spoon out) And there – was there tomato or cucumber in it today?

Figure 1 shows a boy doing his homework on the kitchen table while his mother cooks her meal – visible at the top right of the picture. The mother moves first from the homework task, back to stirring her food, then to the homework task. Her movements around the room take her either towards the food preparation or towards her son, physically moving between parallel and collaborative tasks, but with conversation constantly collaborative with the son's homework task. The paper used by the child supports this co-located activity quite well. Most screen displays would face issues with the variety of angles and interactions needed to coordinate the sharing. This suggests that the tendency to design new technologies primarily to support either individual tasks or collaborative tasks is flawed. ICTs designed for education tend to support normal school classwork, which is either strictly individual or collaborative, but such technologies are out of place within the home context. Here, minimal collaboration through co-location seems far more common.

Example 2: Routine

Figure 2: Television programme finishes

L: (switches TV off as programme finishes) See if you can get on a bit faster with that, that
W: I'm done, I've only got to write one more word
L: Oh well done

In Figure 2, William is doing his homework in front of the television, with his mother to one side. The primary homework technology here is a paper one. He has been working on a piece of writing for quite some time, switching attention between the television and his work. Eventually, the television programme finishes, and his mother immediately switches off the television, and comments on the progress of his homework. The end of the programme alerts his mother to the passage of time. It is arguable whether the television is acting as a homework technology here – it does not support William's work, but certainly acts to shape it. Contrasting footage of the less time-critical computer shows another mother overlooking the passage of time while caught up in a website. Technologies can either create or subvert routine in this way – affecting everyday events, such as mealtimes, or more unusual events such as family visits. Whether technology should bow to home routine, or more actively aim to create reliable homework patterns is an important issue for designers to consider.

Example 3: Physical cues

As a complement to routine, physical cues acted as major mechanisms for reminding family members of tasks. An example can be seen in Figure 3, where items to be taken upstairs or downstairs were left on an appropriate step, or landing in one home.

Figure 3: Items left on stairs

J: And up here is some cups that maybe someone's been drinking from in the night, and they're ready to go down. And some cream that I have to use, and things that are ready to be used. And washing that's ready to be hang up, and sewing box.

The daughter here explicitly refers to the role of these items as the start of a task: 'they're ready to go down'. Similar roles were seen for homework books and bags across families. The transparency and portability of these items are potential qualities to be mimicked by new technologies; the loss of these qualities by the introduction of less transparent technologies may have consequences for family coordination.

Discussion

The three examples above outline issues that may face designers of technologies for children's homework, and illustrate the importance of these issues for design.

Involving parents in homework may require more flexibility in viewing and input than many have considered. The ability to share tasks with parents when only co-located should either be built explicitly into designs, to encourage maximum interaction, or built explicitly out, to encourage only involved help – should homework be viewed as an ideally completely collaborative task.

Implications for supporting homework routine are also clear. Physical items seem to function very effectively as memory aids – suggesting that the media on which work takes place should either be transparent in purpose, as in the case of paper, or accompanied by supplementary memory cues. Family routine could also be considered by building in time-critical events – crafting routine by demanding engagement from children at a key time – or allowing the flexibility to use technologies whenever and wherever necessary.

By highlighting current practices within the home, and their implications for design, ideas for new technologies can be guided, and it is hoped this paper illustrates both the importance and the practicality of understanding these issues.

References

1. Hughes, M., et al. *Exchanging knowledge between home and school to enhance children's learning in literacy and numeracy*. in *ERNAPE Conference*. 2003. Poland.
2. Sutherland, R., et al., *A new environment for education? The computer in the home.* Computer and Education, 2000. **34**: p. 195-212.
3. Hughes, M., *Homework and its contribution to learning: Full report of research activities and results*, in *Final Report: ESRC Research Grant, Award No. R000237857*. 2001.
4. Kerawalla, L. and C. Crook, *Children's computer use at home and at schools: Context and continuity.* British Educational Research Journal, 2002. **28**: p. 751-771.
5. Luckin, R., et al., *Coherence compilation: Applying AIED techniques to the reuse of educational TV resources*. 2004, IDEAs Laboratory, Human Centred Technology Research Group, University of Sussex.
6. Venkatesh, A., *Computers and other interactive technologies for the home.* Communications of the ACM, 1996. **39**: p. 47-54.
7. Crabtree, A., et al., *Patterns of technology usage in the home: Domestic legacy and design. Technical report*. 2001.
8. Sellen, A.J. and R.H.R. Harper, *The Myth of the Paperless Office*. 2001, USA: MIT Press.
9. Morrison, D., et al., *A virtual ethnography of the dynamics of social change in relation to new technology. ESRC End of Award Report*. 2000.

Tangibles in the balance: a comparison of physical and screen versions of the balance beam task

Paul Marshall
Department of Informatics, University of Sussex
Falmer, Brighton, BN1, 9QH
paulma@sussex.ac.uk

1 Introduction

Physical objects are increasingly being used within interaction design to give form to, access, or interact with digital information. This has lead to an explosion of prototype systems and frameworks described in this paper by the catch-all term t*angibles* [e.g. 3, 4]. What distinguishes a tangible from a more generic physical object linked to a computer, like a mouse, is that both the physical and digital components represent something [13]. Dourish [2] has argued that tangibles might better suit the embodied skills we have developed for interacting with the physical world than the more abstract representations of graphical or textual interfaces: an approach related to a more general trend within the cognitive sciences of seeking explanations for mental phenomena in terms of our bodily engagement with the world [1, 6, 14].

In a previous paper [7] we suggested that tangibles might be well suited to a form of constructivist learning characterised by a cycle between engaged physical activity and reflective abstraction supported by digital representations. However, although there is some evidence that using tangibles might facilitate learning (see [10] for a review), it remains unclear what kinds of learning tasks interaction with a physical object might be beneficial for, and in what ways the physicality of the interface might influence how the learners interact with it. Triona and Klahr [12], for example, found that using physical materials had little affect on children's ability to design unconfounded experiments when compared to children using virtual materials presented on a screen.

This paper describes a study, currently in progress, designed to compare the effects of using physical or virtual materials on collaborative discovery learning. It differs from the Triona and Klahr study in focusing on a task where the physicality of the materials is an aspect of the space of the problem to be solved: the balance beam task.

2 The balance beam task

The balance beam task was introduced by Inhelder and Piaget [5] as a measure of children's proportional reasoning. The task in its standard form asks the child to predict and explain the direction of movement (either left down, right down, or remaining in balance) of a balance scale with different weights placed at either one or multiple positions on each side of the fulcrum. Siegler [11] developed a more standardised task to categorise children's knowledge about balance, as expressed by their performance on different types of problems. From Inhelder and Piaget's formative work and from the results of pilot studies, he derived three rules (Rules I-III) that he hypothesised might characterise children's impartial understanding of the behaviour of balance beams. He derived a fourth rule (Rule IV), to describe mature performance, from a rational task analysis of the problem. More recently, a number of additional rules have been proposed, including the *addition* rule and the *qualitative proportionality* (QP) rule [8].

Subjects can be categorised according to which rule they are using through their performance on six types of balance beam question. There are simple problems requiring no arithmetic to solve: *balance* problems with equal weights equidistant from the fulcrum; *weight* problems with unequal weights equidistant from the fulcrum; and *distance* problems with equal weights at different distances from the fulcrum. The other three types of problems had more weight on one side of the fulcrum, but with weights placed at a greater distance on the other: *conflict-weight* problems where the side with the greater amount of weight should tip down; *conflict-distance* problems where the side with the weights at the greatest distance should tip down; and *conflict-balance* problems where the greater weight on one side is compensated for exactly by the greater distance on the other and the beam should remain in balance. The balance rules are described in table 1.

Rule	Description
I	Compare only the weight on each side of the fulcrum. Answer that the beam tips towards the side with the greatest weight
II	When the weights are different, answer as Rule I. When weights are the same, answer that the beam tips toward the side with the weights at the greatest distance
III	Attend to both weight and distance in all circumstances, but do not know how to combine them quantitatively. When presented with problems where the largest weight and greatest distance are on different sides of the fulcrum "muddle through", guessing the direction of movement
IV	Multiply each weight by its distance from the fulcrum and find the sum of these cross products for each side. Answer that the beam tips towards the side with the largest sum
Addition	Compare the sum of the weight plus the distance for each side for balance problems for conflict items
QP	Predict that all conflict items will balance due to the greater distance compensating for the greater weight

Table 1: Description of balance beam rules.

3 Design

A study was designed to determine whether the use of physical materials might influence how students learned to solve balance beam problems. There were three stages to the study. Participants initially completed an individual pre-test, comprising twenty-seven balance beam questions of different types. Then in pairs, they were given thirty minutes to determine the rule that determined whether the beam would balance, tip left, or tip right. The pairs worked with either physical or virtual versions of the same apparatus (shown in figure 1). They were assigned to one of three conditions:

1. *Force condition.* Participants experimented with a physical balance beam. When placing or taking weights off the beam, subjects were instructed to hold onto it at either end, thus allowing them to feel the force exerted by weights.
2. *Torque condition.* Participants experimented with a physical balance beam. When placing or taking weights off the beam, subjects were instructed to hold onto it at the middle, thus allowing them to feel the turning effect of the force exerted by the weights.
3. *Screen condition.* The subjects experimented with a virtual balance beam on a large screen. The weights would be dragged and dropped using a mouse.

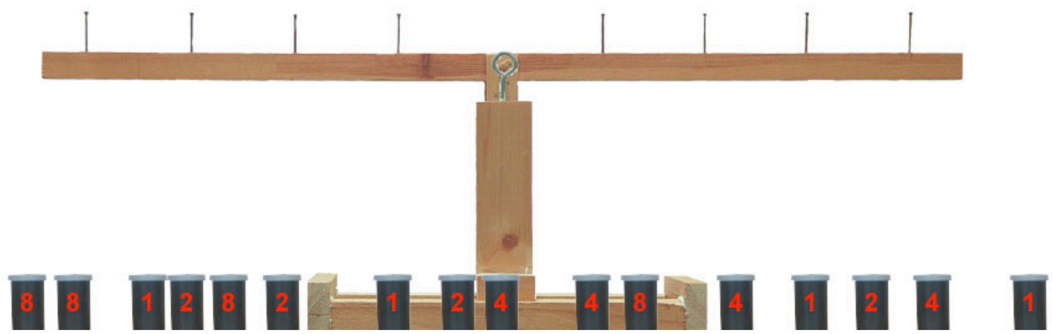


Figure 1. The physical balance beam was constructed out of wood and weights were constructed from plastic film canisters filled with lead. The weights could be placed onto nails positioned at regular distances from the centre of the beam. The virtual beam was constructed in Macromedia Director using photographs of the physical apparatus.

Two physical conditions were included to determine if different kinds of physical activity might influence how participants learned to solve balance problems. The participants were video recorded throughout the thirty-minute experimental phase of the session. Finally, subjects individually completed an individual post-test comprising twenty-seven new balance beam questions of different types.

4 Analysis

Participants' pre- and post-tests will be assigned to a balance rule using probability estimates. Changes in participants' rule use will be compared across the different conditions to determine whether there are learning differences related to use of physical or virtual materials.

Participants' verbal protocols and interaction will be analysed using a coding scheme adapted from Okada and Simons' [9] study of collaborative discovery learning. This analysis will focus on the relationship between hypothesis generation and evaluation and search of the space of possible experiments. It is designed to uncover more subtle differences in participants' problem solving strategies.

5 References

1. Clark, A. *Being there: putting brain, body and world together again*. MIT Press, Cambridge, Massachusetts, 1997.
2. Dourish, P. *Where the Action Is: The Foundations of Embodied Interaction*. MIT Press, Cambridge, 2001.
3. Fishkin, K.P. A taxonomy for and analysis of tangible interfaces. *Personal and Ubiquitous Computing*, *8* (5). 347-358.
4. Holmquist, L.E., Redström, J. and Ljungstrand, P. *Token-Based Acces to Digital Information*. Springer-Verlag, Karlsruhe, Germany, 1999.
5. Inhelder, B. and Piaget, J. *The growth of logical thinking from childhood to adolescence: an essay on the construction of formal operational structures*. Routledge and Kegan Paul Ltd., London, 1958.
6. Lakoff, G. and Johnson, M. *Philosophy in the flesh: the embodied mind and its challenge to western thought*. Basic Books, New York, 1999.
7. Marshall, P., Price, S. and Rogers, Y., Conceptualising tangibles to support learning. in *Proceeding of the 2003 conference on Interaction design and children*, (Preston, Engalnd, 2003), ACM Press, 101-109.
8. Normandeau, A.L., Larivee, S., Roulin, J.L. and Longeot, F. The balance-scale dilemma: either the subject or the experimenter muddles through. *Journal of Genetic Psychology*, *150* (3). 237-250.
9. Okada, T. and Simon, H.A. Collaborative discovery in a scientific domain. *Cognitive Science*, *21* (2). 109-146.
10. O'Malley, C. and Stanton Fraser, D. Literature Review in Learning with Tangible Technologies *Nesta Futurelab Series*, Nesta Futurelab, 2005.
11. Siegler, R.S. 3 Aspects of Cognitive-Development. *Cognitive Psychology*, *8* (4). 481-520.
12. Triona, L.M. and Klahr, D. Point and click or grab and heft: Comparing the influence of physical and virtual instructional materials on elementary school students' ability to design experiments. *Cognition and Instruction*, *21* (2). 149-173.
13. Ullmer, B. and Ishii, H. Emerging frameworks for tangible user interfaces. *IBM Systems Journal*, *39* (3-4). 915-931.
14. Wilson, M. Six views of embodied cognition. *Psychonomic Bulletin and Review*, *9* (4). 625-636.

How can we advance the potential for learning via technology? It's all in the CREATIVE design

Sylvia M. Truman & Paul Mulholland,
Knowledge Media Institute, The Open University, Milton Keynes, MK7 6AA
E-mail: s.m.truman@open.ac.uk; p.mulholland@open.ac.uk

Abstract: A question gaining wide spread interest in the design of educational technologies, is 'how' can learning tasks be structured so that creativity can be facilitated in educational settings? In the domain of music education, contemporary research focuses upon how technology can be utilised to assist students with *learning to create* music. However, this raises the question 'how can we encourage students to think creatively when interacting with learning technologies?' We suggest that theories advocating learning as a socially constructive process may shed light upon creative phenomena. Extending upon this, an integrative framework of learning and creativity is presented. This framework exists as a design support tool to aid the design of educational systems. This paper also provides an example of a music composition program (SoundScape) designed in accordance with this framework.

1. Introduction

Traditional pedagogy isolates the learner from social interaction and concerns pre-packaged lesson materials being delivered from the teacher and/or learning program to the student. Such an approach concerns itself with the passive absorption of knowledge, which is later tested via exam based scenarios. Although this may equip students to pass exams, they may face difficulty when applying concepts into authentic practice (Brown *et al,* 1989). We therefore emphasise the importance of designing educational technologies in a way to facilitate the natural learning process.

2. Theoretical background: learning and creativity

With growing advancements in technology, learning programs are an ever present element of education today. However, technology is often misconstrued as a medium for disseminating knowledge to students as opposed to providing a virtual space in which the student is an active participant, exploring a domain for themselves. It is therefore emphasised that the focus of educational media should not reside with what technology will improve education, rather the way in which such technology is designed should be considered. This emphasises the importance of design considerations of e-learning systems. In this paper we extend upon constructivist and constructionist perspectives on learning. These perspectives suggest learning is not solely an individual process as people naturally interact with others and their surroundings, and learning is the outcome of these interactions (Vosniadou, 1996). Furthermore, from a constructionist point of view, it is important for students to be actively engaged in personally creating a product meaningful to themselves and others (Papert, 1993; Harel, 1991).

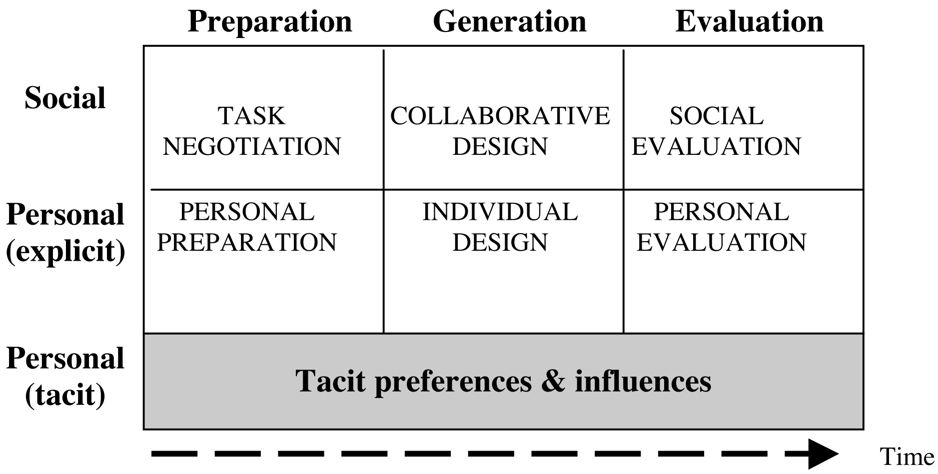
2.1 The creative process

Wallas (1926) formalised the four stage model, representing the creative process. This model consists of four stages; preparation, incubation, illumination and verification. Preparation concerns immersing one's self within a domain and developing a curiosity about a particular problem (Getzels, 1964). At this stage, an individual will also consciously accumulate knowledge and draw upon influences from previous experience. During the incubation stage, conscious thought pertaining to the problem is rested and left to the unconscious mind (Claxton, 1998). Illumination occurs when one experiences a sudden flash of insight (Poincare, 1913). Finally, verification concerns forming judgements pertaining to the creative artefact produced. A number of scholars have continued to apply the four stage model as a basis for understanding creativity (Osche, 1990; Goswami, 1996), while others have extended upon it (Amabile, 1996; Runco & Dow, 1999) offering models consisting of several stages. Others have proposed different approaches which show no correlation with the traditional model (Eindhovern & Vinake, 1952).

3. An Integrative framework of learning and creativity

Drawing on the above, we have developed a framework which represents a distillation of creativity theory focusing upon education. This framework is presented the form of an integrative framework, which exists as a design support tool to assist the design of creative educational experiences for the classroom (see figure 1). Wallas's four-stage model has been adapted as the fundamental basis for this framework, with the processes of preparation, generation and evaluation represented laterally across the framework. The vertical dimensions reflect individual (denoted here as personal) and social components of creativity. The 'social' level refers to others, peers and society. Whereas, 'personal' levels reflect explicit and tacit levels of thinking.

Figure 1 – An integrative framework of learning and creativity



The processes of preparation, generation and evaluation are three integral concepts of the creative process. Every creative act involves the preparation of ideas. At a personal level, an individual will develop a curiosity or a desire to create. Once this desire has been established, information is consciously accumulated from the external environment and thoughts may be discussed with others on a 'social' level which the individual can reflect upon. If working in a collaborative setting, group-wide negotiations of the task will also take place. Inevitably, the way in which an individual prepares for the task will be influenced by their past experiences (Schank, 1995).

The generation process of the framework encompasses social and personal design. Within this process ideas are generated which can involve negotiation between the individual and peers in their environment. Additionally, idea generation is assisted partly by a continuous dialogue which occurs between conscious thought at the personal explicit level and sub-conscious processing at the tacit level. The evaluation process concerns reviewing early creative ideas through to evaluating the final artefact. Evaluation may occur at a personal level, or at a wider (community) level. We emphasise that the framework does not commit to a strict linear route, rather the creative process is cyclic in nature. Therefore, the review of creative ideas may result in a need to revise ideas which may result in further preparation, or evaluation or further generation and so on. The processes of the framework are not mutually exclusive, as in some instances processes within the framework may overlap. The framework can be used as a design support tool to facilitate creative thinking in the classroom by ensuring that preparatory materials are scaffolded to the six component boxes of the framework.

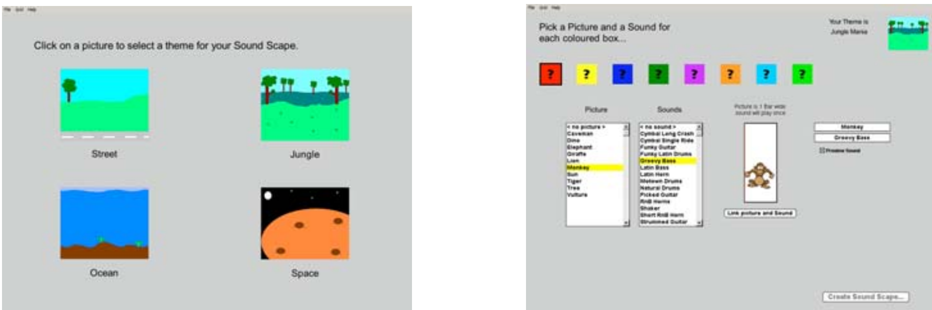
4. SoundScape: A creative-collaborative learning environment

SoundScape is a music composition program which has been constructed as a vehicle to demonstrate how the framework can be applied in practice. It has been specifically designed for school aged children, allowing them to work collaboratively and creatively to construct a piece of music. SoundScape replaces traditional stave notation with ‘themes’ and ‘objects’. Thus, constraints of musicality are removed. Previous studies have indicated that traditional music notation acts as a barrier to creativity, limiting independent exploration of music in a composition task (Pugh, 1980). The utilisation of alternative graphic notations as opposed to stave notation has also been associated with an increase in diverse compositional strategies (Auh & Walker, 1999).

4.1 SoundScape design: considering processes involved in the creative process

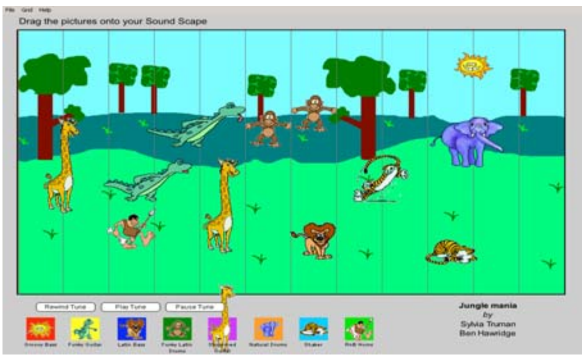
Students begin their interaction with SoundScape within the preparation process of the framework. Initially, students are set the task of selecting one of four themes including; a street, a jungle, an ocean and a space theme. Following their selection they are then presented with ten cartoon objects associated with the theme, which they must then match to music samples (see figure 2).

Figure 2 – Themes and picture / sound associations in SoundScape



Within this section of the ‘preparation process’, students can be expected to discuss the task to be completed within the paired-groupings. The program seeks to provide reflexivity in learning, by encouraging the students to think on a deeper level to justify their learning choices made. Therefore, when a picture and sound association has been made, the system will ask the students to explain why they have made that association. The composition interface is the point at which students enter the ‘generation processes’ of the framework.

Figure 3 – The composition environment in SoundScape



The interface relays to the student the selected theme which is set as the background and the selected objects are presented in coloured boxes at the bottom of the screen. The lines running from top to the bottom of the composition screen represent bar lines, so it is easy to depict images which are associated with a longer sound duration than others (see figure 3). With regard to figure 3, students simply drag the objects from the coloured boxes onto the theme and structure them on the composition background as they wish. In terms of the framework, it is expected that students will collaboratively discuss and personally construct ideas. It is also expected that pair wise discussions may also trigger further realisation of ideas._In terms of evaluation, it is expected that on an individual level, a student will form their own judgements concerning the composed work. On a collaborative level, it is expected that pair-wise reflection and judgements concerning the composition will take place. Arising from this, students may move between generation and evaluation phases as refinements are made to the composition. Students might then seek wider evaluation of their composition from their peers and /or teacher. For example, students can listen to each others compositions or can print out the pictorial representations which can be exhibited in the classroom to encourage peer-wide evaluation.

5. Conclusions

This paper has discussed an approach towards advancing learning through technology by considering the creative process. In particular, this paper has focused upon an integrative framework of learning and creativity, which exists as a design support tool to facilitate creative learning in the classroom. The music composition program 'SoundScape' has also been presented as a vehicle to demonstrate how this framework can be applied in practice. This is part of a wide programme of research for which studies are currently being conducted.

6. References

Amabile, T.M (1996) *Creativity in Context.* Boulder, CO; Westview.

Auh, M & Walker, R (1999) Compositional strategies and musical creativity when composing with staff notation versus graphic notations among Korean students. *Bulleting of the Council for Research in Music Education.* 141. p 2 – 9.

Brown, Collins & Duguid (1989) Situated Cognition and the Culture of Learning. E*ducational Researcher.* January – February. 32-43

Claxton (1998) *Hare Brain Tortoise Mind: Why Intelligence Increases When you Think Less*. London. Fourth Estate Limited.

Eindhoven, J.E & Vinacke, W.E (1952) Creative processes in painting. *Journal of General Psychology.* 47. p 165 – 179.

Getzels, J.W (1964) Creative Thinking, Problem-Solving, and Instruction. In E.R. Hilgard (Ed), *Theories of Learning and Instruction*. Chicago; University of Chicago Press.

Goswami, A (1996) Creativity and the quantum: A unified theory of creativity. *Creativity Research Journal.* 9. p 47 – 61.

Harel, I (1991) Children Designer's: Interdisciplinary Constructions for Learning and Knowing mathematics in a Computer Rich School. Norwood, NJ; Ablex Publishing.

Osche, R (1990) *Before the Gates of Excellence: The Determinants of Creative Genius.* New York; Cambridge University Press.

Papert, S (1993) The Children's Machine: Rethinking School in the Age of the Computer. Basic Books. New York.

Poincare (1913) in Leytham, G (1990*) Managing Creativity.* Norfolk. Peter Francis Publishers.

Pugh, A (1980) In defense of musical literacy. *Cambridge Journal of Education.* 10, 1. 29 – 3.

Runco, M.A & Dow, G (1999) Problem Finding. In Runco, M.A & Pritzker, S.R (Eds) *Encyclopedia of Creativity.* (Vol. 2). P 433 – 435. San Diego, CA; Academic Press.

Schank, R (1995) *What we Learn when we Learn by Doing.* Northwestern University, Institute for Learning sciences.

Vosniadou, S (1996) Towards a Revised Cognitive Psychology for New Advances in Learning and Instruction. *Learning and Instruction.* Vol. 6. No. 2. 95 – 109

Wallas (1926) *The Art of Thought.* London; Jonathan Cape [republished in 1931].

The Sensed and Stated Self

Manuela Jungmann mj43@sussex.ac.uk
Geraldine Fitzpatrick, Katerina Mania--Interact Lab, University of Sussex

Abstract
This paper describes how wearables and body sensing technologies promote the transcribing of the physiological "self," a collection of body states into virtual space, and how this aspect becomes increasingly relevant to new context-aware applications. Tackling such an investigation would entail a holistic embodiment, which would go beyond the current state of user representation and beyond data visualization. It would draw from various cultural sources that are focusing on understanding this notion of the "self." By constructing a theoretical framework and experience models derived from user studies, such a research effort could be brought conceptually into the arena of a prototype. However, its complexity lies in mapping out a highly interdisciplinary subject matter.

Introduction
With the event of personal computing technology computers are moving closer entering an individual's sphere of intimacy; this trend has been continued with wearables and body sensing technologies. In a literal way computers are becoming a second skin in the place they physically occupy, and at the same time, go under our skin when they collect data pertaining to our body states. Although they gather increasingly personal data, displaying these datasets in virtual space, in respect to representing the user has not evolved along side these new technologies.
Early investigations into user representation date back to the 90's and were usually tied to navigating, task performing and chatting in virtual space, they were not conceived to adapt to more than one application or more than one platform. Investigating the basic representation of the "self" was passed by in this process. But with the sensor revolution moving forward, the transcribing of the physiological "self," a collection of body states, into virtual space becomes more relevant to numerous applications.

1. The current state of user representation

1.1. How we understand user representation

Representing the user in virtual space can have more than one purpose. In most cases though, the representation is functional in the context of the virtual environment. In well-known games such as Doom and Quake, user representation is used to follow the design of the game (Andersen, 1998) since the main attraction here lies in the mastery of the virtual space (Johnson, 1997). In the case of such games a stationary hand operates in 3D virtual space displayed on a 2D monitor. Equally navigational in 3D are online virtual worlds, e.g. activeworlds.com and there.com, were user representation is used towards acting out experiences. Users navigate humanoid characters as avatars, which allow them to project a 'chosen,' 3D body into the virtual environment. Avatars have also been called virtual actors or interface agents, because the user acts out a role in that space, expressing a set of desires, likes and dislikes when interacting with others. In virtual reality research, collaborative virtual environments (CVE) such as MASSIVE[1] and DIVE[2], have lend themselves to research embodiments, avatars, clones and agents for multi-user by using very basic block-shaped forms. Here researchers have noted that users are still viewed as people on the outside looking in and that those environments make no provisions for visualizing them inside the system (Steve Benford et al., 1997). In looking at the key issues of user embodiment in CVE's researchers concluded that virtual body-building will involve identifying the important issues in each case and supporting them within the available computing resource (Steve Benford et al., 1997). Besides a 3D exploration of user representation for virtual worlds and CVE's, StarCursor (P. R. Rankin et al., 1998) used an anthropomorphic cursor symbolically displaying the body with a heart, limbs, eye, and aura. In the virtual context the cursor represented multimedia channels for personal disclosures, communicative signals and actions (Spence, 2001). On a more rudimentary level, instant messaging e.g. ICQ.com and Window's messenger, utilize 2D generic, iconic user representations to communicated online availability with various qualifiers and customization possibilities.

1.2. What has been done to go beyond

Affective computing and Presencia[3] are branches in research that are looking at how the user can be interpreted in virtual space. Affective computing focuses on exploring new ways to sense and interpret the affective state of users (Barbara Hayes-Roth et al., 1998) by giving computers the ability to help communicate emotion, that is, receiving and sending emotional cues (Picard, 2000). Rather than representing the user in virtual space, affective computing establishes an empathetic relationship by introducing an affective agent to the user (Winslow Burleson et al.). Presencia or Presence research is concerned with the sensation of "being there" in a mediated environment (Wijnand Ijsselsteijn et al.), as a matter of suspended disbelief or "out of body" experience when we react in virtual space as if in physical space. Mel Slater, one of the presence pioneers, was able to measure a sense of presence by observing users in immersive virtual environments. But both, affective computing and Presence-research are confined to specific platforms and specific applications. Having the need to capture multiple bodily cues, for example from facial muscles (affective computing) or creating believable virtual environments by displaying them on head-mounted displays (Presence-research) does not make for large user participation.

1.3. Why is there a need to go beyond the current state of representation

With increasingly personal data collected by societal, cultural, and enterprising establishments, the idea of ubiquitous computing has proven problematic. Ubiquitous computing in its purest form advocates that all computation is contained in the environment rather than on the person (Bradley Rhodes, 1999). Privacy issues and difficulty with maintaining personalization of ubiquitous computing systems have given good reason to move sensors from the environment to the person. Wearables offer a

[1] MASSIVE [Model, Architecture and System for Spatial Interaction in Virtual Environments]
[2] DIVE [Distributed Interactive Virtual Environment]
[3] Presencia stands for Research Encompassing Sensory Enhancement, Neuroscience and Cognition with Interactive Applications. More at presence-research.org

solution to these problems (Bradley Rhodes, 1999). Of course they are not without problems and by now a combination of wearable and ubiquitous computing seems to deliver the best results. But as Bradley Rhodes wrote, wearable computers have the potential to "see" as the user sees, "hear" as the user hears, and experience the life of the user in a "first-person" sense; this makes them excellent platforms for applications where the computer is working even when we aren't giving explicit commands. However, the information that is being collected by wearables in so-called context-aware applications needs to be rendered visible, and when it comes to sensing the body, that information has to be displayed in some shape or form. One of the advantages that wearables give to the user is the freedom to do something else while the role of the wearable computer is in support. Along these lines, the displayed interface needs to follow the support role of the wearable by allowing for minimal cognitive demands but a maximum of information displayed. That "first person" sense described earlier moves us away from user representation as it was understood in desktop computing, allowing for more authentic, individualized, and concrete "in the moment" information. By sensing the body, thereby obtaining physiological, psychophysical and emotional states of the body, we are also moving closer to what could be termed the self. We are no longer representing ourselves but rather transcribing ourselves remotely. That there is a gap for remote transcribing of the self can be pointed out in two very different applications. In last years' UBICOMP paper "The CareNet Display" (Sunny Consolvo et al., 2004) under section 5.2 "Providing Sufficient Information without Complicating the Display" the ambient display interface of iconic nature did not communicate effectively the body state of the elderly person to the distant participants. In contrast, Thecla Schiphorst and Kristina Andersen pursuing a more artistic deployment of wearables while focusing on remote transcribing, note that the next step in (their) future work means exploring mapping and "meaning" in data patterns across participants' body state (Thecla Schiphorst et al., 2004). And from the point of developing hardware as it is the case in "LiveNet: Health and Lifestyle Networking through Distributed Mobile Devices" (Michael Sung et al., 2004) an appropriate interface that could be displayed on the LifeNet PDA would make the application complete.

2. How representation of the self could be approached

2.1. What does it mean remote transcribing of the "self"?

If it was said earlier that we are not only moving closer to what could be termed a sense of self and that that can be no longer called representing ourselves in virtual space, then we need to look at the consequences of this observation. Transcribing here would mean that we transfer "ourselves" from the physical state to a virtual state using a transformational process, such as sensing and digitizing the data. But what should come out on the other end, in digital form, should be as close as possible to the original input that constitutes this "self," and is not just a singular aspect in physical manifestation. Meaning it should embody holistically what was captured from the original source when recomposing it in digital form. Holistic embodiment would go beyond mere visualizing data; it would draw from various cultural sources that are focusing on understanding this notion of "self." Although it has become clear that the approach to this research would be interdisciplinary, it should be said that these sources have to be chosen selectively to keep within the scope of the research project. It would be a viable aim to build up the remote transcribing of the self so that it could evolve, eventually having full-fledged interactions with others in virtual space. An open-ended research approach would also allow for subsequent adaptations that are application specific. Further, focusing on the body state in daily life as a stage for the self, then the idea of daily life with all its unpredictability should figure into the design of the user studies.

2.2. Mind-body integration

So sensing the body would mean capturing a collection of emotional body states which in turn are the result of thoughts (mental images) that have activated a specific brain system. Given that the essential condition for a mind is the ability to display images internally and to order those images in a process called thought (Damasio, 1995). These images are not solely visual; there are also “sound images,” “olfactory images,” and so on (Damasio, 1995). More over, factual knowledge required for reasoning and decision making comes to the mind in forms of images through varied sensory modalities. And the essence of a feeling here is the process of continuous monitoring that experience of what the body is doing while thoughts about specific content roll by (Damasio, 1995).This illustrates just how intertwined, mutually and reciprocally connected and influenced the mind-body connection is. But it further shows how important these elements are for perception and cognition. For this research it will be imperative to investigate the most direct and complete correlation of the brain, mind, body and feeling plane in order to create a perceptive and cognitive system for the digital plane. This would not only comprise the internal mechanisms but also the external ones such as facial expressions, gestures, and voice.

2.3. Research approach

In order to integrate all previously mentioned points, a theoretical framework will be the foundation against which I conduct user studies. The final outcome should be a prototype of a system reflecting the idea of remote transcribing the self using body sensing technologies, respectively wearables. To bring the theoretical framework into a practical arena, a conceptual approach will be inevitable to establish a design rationale. Initial user studies should feed into establishing an experience model from which I draw for the creation of the final prototype. These user studies need to be conceived with a variety of parameters such as types of environments and types of users to identify the most basic needs and establish requirements informing the design space.

3. Conclusion

I have shown that there are plausible reasons to investigate what used to be termed user representation in virtual space. I have argued that with new technologies such as wearables, a new way of representing the user in virtual space is necessary. What I have termed remote transcribing of the “self” should be tested in a prototype, which could create a conceptual model for a variety of platforms and context-aware applications. I have shown that the complexity of this research is vastly interdisciplinary and that the real skill will be in mapping it out in a tight and compact manner.

References:

Andersen, Kristina Gregers [1998] The Avatar as Instrument for Navigation [Ms Thesis].

Barbara Hayes-Roth, Gene Ball, Christine Lisetti, Rosalind W. Picard, Andrew Stern [1998] Panel on Affect and Emotion in the User Interface. *IUI.* San Francisco, ACM.

Bradley Rhodes, Nelson Minar, Josh Weaver [1999] Wearable Computing Meets Ubiquitous Computing. *The Proceedings of the 3rd International Symposium on Wearable Computers.* San Francisco.

Damasio, Antonio [1995] *Descartes' Error: Emotion, Reason, and the Human Brain*, Papermac Macmillian Publishers LTD.

Johnson, Steven [1997] *Interface Culture: How new technology transforms the way we create and communicate,* San Francisco, Harper Collins.

Michael Sung, Alex Pentland [2004] LiveNet: Health and Lifestyle Networking Through Distributed Mobile Devices. Human Dynamics Group MIT Media Laboratory.

P. R. Rankin, C. van Heerden, J. Mama, L. Nikolovska, R. Otter, J. Rutgers [1998] Starcursors in ContentSpace. *Siggraph.* ACM.

Picard, Rosalind W. [2000] Affective Computing. *Communications of the ACM,* 43**,** 50-51.

Spence, Robert [2001] *Information Visualization*, Addison-Wesley/Pearson Education.

Steve Benford, John Bowers, Lennart E. Fahlén, Chris Greenhalgh, Dave Snowdon [1997] Embodiments, Avatars, Clones and Agents for Multi-user, Multi-Sensory Virtual Worlds. *Multimedia Systems,* 5**,** 93-104.

Sunny Consolvo, Peter Roessler, Brett Shelton [2004] The CareNet Display: Lessons Learned from an In Home Evaluation of an Ambient Display. *Ubicomp.* Nottingham, UK.

Thecla Schiphorst, Kristina Andersen [2004] Between Bodies: using Experience Modeling to Create Gestural Protocols for Physiological Data Transfer. *CHI2004.* Vienna, Austria.

Wijnand Ijsselsteijn, Huib de Ridder, Jonathan Freeman, S.E. Avons Presence: Concept, Determinants and Measurement.

Winslow Burleson, Rosalind Picard, Ken Perlin, Jon Lippincott A Platform for Affective Agent Research. MIT Media Lab, New York University Media Research Laboratory.

Communication and Interaction using Touch - Examine the User Before You Reproduce his Hand!

Simone Gumtau
University of Portsmouth, UK
E-mail: simone.gumtau@port.ac.uk
http://www.moohnaland.de

Abstract

My research interest is haptic and tactile channels in communication - interacting via our sense of touch. This includes interacting with digital information on the computer and interacting with each other via remote communication.

While continually innovating technology, the main research focuses of the Haptics community concerning the user are his psychophysical and neurological processes. My contribution is to introduce an investigation of the cultural context of touch. I am interested in the meanings we ascribe to different types of touch. I explore this field with the help of low-tech prototypes and social sciences and art and design methodologies.

The human being is not merely a subject made up of dissectible layers of information processing. He should be appreciated as a whole being and in context. This may help to avoid creating technology that sometimes becomes awkward and seems inhuman - quite the opposite, it could help to create poetic and metaphoric devices and services that intrigue and stimulate the user. With more available and more accessible technology, a multidisciplinary approach can be encouraged and a broadened range of ideas can be tested early on with simple prototypes. This should ultimately create a more engaging experience for the user.

Communication via Touch: Technological Developments

Establishing contact in a physical sense also means creating and confirming a mental and emotional connection. Touch, as well as having a physical-sensory modality, has a psychological dimension in which we can literally reach out and communicate. In nonverbal language, body contact and gestures are an important part of the information exchange. It has also been established that human beings can learn new languages based on touch. *Tadoma*, a language used by people with dual sensory impairments (deaf-blind), works by placing the hand on lips, neck and cheek to feel vibrations, airflow and facial movements made during verbal expression. Alphanumeric languages like *Braille*, for people with visual impairments, consist of decoding raised dots on paper.

Moving on from these, researchers have tried to create technological devices to facilitate touch communication. At first, the aim was to assist users with sensory impairments, later to add another layer of information in computer-mediated communication. The *Tactaid* is a vibrotactile feedback device, which is used by people with hearing problems to acquire speech and listening skills. The *Optacon* was developed for users with visual impairments - it translates a printed letter captured by a tracking lens into a tactile image via vibrotactile pins.
Geldard developed the language *Vibratese* [5]. It uses 5 vibrotactile signals placed on the chest to make letters, digits and words - and proved subjects could learn artificial tactile languages.

ComTouch [2] is moving away from the concept of alphanumerical coding and employs an approach based on non-verbal gestures. Using the metaphor of the handshake, it allows people to create their own coding system with vibratory signals delivered to the hand. All participating subjects managed to establish communication successfully, even with the audio channel restricted. MacLean is developing *Haptic Icons* [8] - an attempt to design computer-generated force or tactile feedback signals to convey meaning, as the foundation of developing a haptic expressive language. Similar explorations are led by Brewster's group, who call their designs *Tactons* [1].

With the *Vibrobod* and *What's Shaking*, researchers Dobson et al [3] created a vibrotactile interpersonal communication device and a newsgroup navigation device for complementing interpersonal interaction in a digital space. They found that vibration and temperature successfully facilitated the exchange of emotional and social content. For example, people interpreted a high frequency, intense vibration buzz as a very active newsgroup. The researchers claimed that touch as a communication medium is well suited to elusive concepts of personal information like ambience, affect and urgency, but less so for the transmission of precise, complex information. They conclude that their mappings were so successful that no prior training was needed and does not require any special literacy.

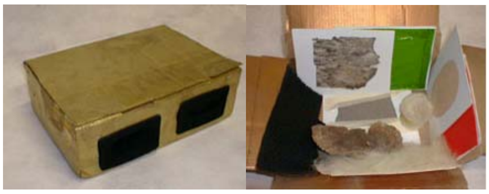
It is appropriate and desirable that no specific training was needed to use and understand the devices, but I feel Dobson et al have tapped into an area of research potential which offers great benefits for extending the communicative capacity of haptic interfaces.

Researchers of haptic communication devices are calling for a set of general rules in haptic communication that could inform a system of design parameters. Too little is known about the exact communication possibilities of touch - although many people have a pretty good "feeling" about it. It does make sense firstly to look to psychophysics as an informant. For example, it has to be established what differences in stimuli we can actually detect, before we design stimuli. However, to gain insight into tactility as both experience and meaning, I am proposing it may also be beneficial to look at the cultural and social context of touch. And, as well as designing haptic expressions and testing their validity, it may also be interesting to design devices to allow free expression and observe what users actually do with them – to gain intimate insight of real users' needs.

Tactile Semiotics: Haptic Box Experiment

What I am suggesting is that there may be an underlying, learned system of signs and symbols, a cultural and social system of codes we can build on: Semiotics. This is, in my view, what has made the *Vibrobod* and *What's Shaking* successful - they have utilized this system to map meaning to touch. Semiotics is the science of signs. Every language is a system of signs, and therefore, to study the generation of meaning and communication effectively, it is important to be aware of semiotics. In Graphic Design - or visual communication - the study of semiotics is one of the foundations in order to be able to use visual language effectively to express and communicate the message we want to get across. According to semiotic theory, a coding system is existent in every media 'channel' [9] - although researchers have concentrated mostly on linguistics and aesthetics. If we can familiarize ourselves with the codes of tactile semiotics, can we utilize them in haptic communication?

With the Haptic Box I am investigating whether we associate certain emotional values with tactile experiences. It is a box containing ten different textures, presented in a random sequence. They can be felt (not seen) with one hand while the other hand fills out a semantic differential scale - a set of 12 polarized word pairs rated from one to seven - to show the semantic link between the tested object and the subject's mental imagery. A questionnaire about touch memories



***Left**: Haptic Box - providing touch sensation without visual stimuli*
***Right:** Ten different textures*

and associations was filled out afterwards, to gain insight into the subject's touch awareness.

Association to Physical Nature: A lot of overlap on the collated scales was probably often due to the physical nature of the object, and the fact that some of the word pairs can be taken very literally - e.g., almost everyone associated *rugged* rather than *delicate* with the Tree Fungus. Whereas no one could agree whether the Fungus was *pleasant* or *unpleasant* to touch.

Cross-modal Association: The Silk texture - most found it to be *delicate* and *light* (physical feature), but also almost all subjects associated it to be *fragrant* rather than *foul*. It is possible that we are entering the world of cross-modal associations here: to associate Silk with a feminine element, maybe with perfume. People also agreed on it feeling *sweet*, *young*, *relaxed*, *valuable*, but interestingly, *weak* and *cowardly*: terms traditionally associated with femininity - the "weak" gender.

Common Association with Natural Materials: Noticeably, it seems that the most correlation between subjects is over the materials that are the most organic, natural. It appears the more artificial the material, the more associations diverge. This could be because the settings in which we meet organic materials (Tree Fungus, Bark) are usually similar, so we share the same experiences and associations. The experience of synthetic materials on the other hand is manifold and it is more difficult to describe a common denominating experience or association.

25 subjects have undertaken the Haptic Box. There seems to be a reasonably high correlation between test subjects' choices - meaning there could be a cultural system of semiotics at work.

Spontaneous Haptic Expressions: PinKom Experiment

Left: *Touch sensor* ***Right:*** *Tactile shape display*

Touch communication offers several mappings to design with: parameters like vibration signals, temperature, shape and force feedback can all convey information. At the moment, building prototypes in a feasible way to study the effectiveness of these mappings is very difficult and takes up most of the research time. User studies often have to be reduced to pilot studies.

To counteract this, I built a low-tech solution that could be useful in predicting how people will use personal haptic devices and how they will react to these new forms of expression and whether they will develop idiosyncratic languages. PinKom is a mock-up of an imaginary haptic communication device that will allow the spontaneous forming of communication codes via that haptic channel, similar to *ComTouch*. It utilizes the potential of shape display and real time force feedback by a remote human being for personal, intimate expression and sense of presence. Touch is assumed to be very useful in communicating presence and affect to loved ones in remote locations or increase a sense of presence while interacting with digital environments [6].

Couples in a love relationship will use the PinKom for at least a week. Qualitative data will be generated and spontaneous forming of communication codes shall be monitored, providing a glimpse of the real uses people would put their new touch based communication devices to. Even though the prototype is not fully functional at present, it is allowing some results and pointers for future designs. For example, it seems that the dimension of the real time force will be more powerful than the shape display on its own. The PinKom is not to my knowledge feasible with current technology, but as a user-centred design study of new ways of communicating via remote touch, it is my approach to ascertain useful future specification. Tollmar [10] suggests combining blue-sky research with down-to-earth design methods in designing new interfaces. He argues that only one method without the other will result, in the first case, in failure due to lack of realistic outcomes or, in the latter case, in inhibition of innovative ideas by limiting the design only to what seems feasible. This way we might also guarantee user-friendly designs, as the ideas can be tested very early on in the process (user-centred / user-involved approach). Mock-ups can be used to help users envision the kind of systems they need - and in turn inform the designers of exactly what will be required [4].

Conclusion

Tangible interfaces are part of the new design space, which promises the user rich, holistic, multi-sensory and intuitive interactive experiences. We are exploring a new dimension of HCI and telecommunication that could give room for information of affect, atmosphere and presence – something which is often considered redundant and therefore neglected in interface design.

I proposed the novel approach of using semiotic theory to research cultural aspects of touch communication. With the Haptic Box I have demonstrated how we can investigate cultural systems and integrate this knowledge. Following a recent presentation of this work to the Haptic community, there was positive feedback and interest by engineers and computer scientists. This work will be further developed with a special focus on vibration signals.

. With PinKom, I am investigating what kind of expressions are intuitively and spontaneously performed when confronted with the new medium of a tangible interface. This focus on the user will tell us which design parameters might be successful ones to choose.

Finally, to promote cross-fertilization as has been described here, I hope that with more accessible technology and the use of mock-ups, a multidisciplinary approach, a meeting of art and science, will be realised. This will help to build evocative interfaces that use metaphor, semiotics and suggestion. So far, as shown in the reviewed case studies, this has been most successful in creating a meaningful experience for the user.

References

[1] *Brown, L., Brewster, S., Purchase, H.: "A First Investigation into the Effectiveness of Tactons", Proceedings of Worldhaptics 05, 2005*

[2] *Chang, A., O'Modhrain, S., Jacob, R., Gunther, E., Ishii, H.: "ComTouch: Design of a Vibrotactile Communication Device", Proceedings of DIS 02, 2002.*

[3] *Dobson, K., Boyd, D., Ju, W., Donath, J., Ishii, H.: "Creating Visceral Personal and Social Interactions in Mediate Spaces", Proceedings of CHI 01, 2001.*

[4] *Ehn, P., Kyng, M.: "Cardboard Computers: Mocking-it-up or Hands-on the Future" in Greenbaum, J., Kyng, M.: Design at Work: Cooperative Design of Computer Systems, Lawrence Erlbaum Associates, 1991.*

[5] *Geldard, F.A.: "Some Neglected Possibilities of Communication", Science, 131, pp. 1583-1588, 1960.*

[6] *Ho, C., Basdogan, C., Slater, M., Durlach, N., Srinivasan, M.: "An Experiment on the Influence of Haptic communication on the sense of being together", presented at the BT Workshop on Presence in Shared Virtual Environments, 1998.*

[7] *Lee, J.C., Avrahami, D., Hudson, S. E., Forlizzi, J., Dietz, P.H., Leigh, D.: "The Calder Toolkit: Wired and Wireless Components for Rapidly Prototyping Interactive Devices", Proceedings of DIS 04, 2004.*

[8] *MacLean, K., Enriquez, M.: "Perceptual Design of Haptic Icons", Proceedings of EuroHaptics, 2003.*

[9] *Nöth, W.: "Handbook of Semiotics", Bloomington, Indiana University Press, 1990.*

[10] *Tollmar, K., Junestrand, S., Torgny, O.: "Virtually Living Together - Using Multiple-Method Designing in the Search for Telematic Emotion", Proceedings of DIS 00, 2000.*

Exploring SenseCam to inform the design of image capture and replay devices for supporting reflection

Rowanne Fleck
Interact Lab, University of Sussex
rmmf20@sussex.ac.uk

Introduction

A user-centered approach to design has been described as involving four basic activities; identifying needs and establishing requirements, developing alternative designs, building interactive version of the designs and evaluating those designs (Preece, Rogers and Sharp, 2002). However, technology is developing rapidly and constantly opening up possibilities for novel forms of interaction. Therefore research in HCT must sometimes start from a more 'technology-led' or 'technology-inspired' (Rogers, Scaife et. al., 2002) position whilst still maintaining a human focus. Instead of starting with the problem situation, we start with the technology in order that we might explore and build up an understanding of the nature of the interactions they create, and the situations in which they may be used. In this paper I will outline how I plan to investigate the possibilities for a piece of technology called the SenseCam, presently being developed by Microsoft Research in Cambridge, to support reflection. I hope that a deeper understanding of this can lead to guidelines that will feed back and inform the design of future similar devices.

Research Ideas

The SenseCam is a small wearable device that combines a digital camera with a number of sensors which are used to trigger pictures at 'good' times (presently when other people are around or when there are changes in the environment such as in light levels or sound levels). The SenseCam was envisaged as a device that might add to a lifetime store of data, providing a kind of visual diary of your life and act as a memory aid. However the question of what all these images can really be used for and other issues such as privacy remain largely unanswered. I am investigating the possibility that it might support reflection.

Definitions of reflection are wide and varied but there are a number of situations in which it is thought beneficial, for example when learning from experience and developing professional practice. Dewey, one of the earliest people to consider the nature of reflection, describes reflective thought as "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends" (1933, p118). I am taking reflection to be something very similar to this general definition, to mean taking time to think more deeply about things that have been come across or occurred and considering how they relate to what is already known. The literature advocates numerous techniques for supporting reflection (e.g. Moon, 1999) and various uses of technology (e.g. Seale 1998). One way in which technology can support reflection is by recording. This can work in two ways; firstly technology can support the collection and recording of data to draw conclusions from later in an experimental type setting. Secondly it can record the process of an event, for example an email conversation, screen shots taken at various points in the life of a document, video recording of a trainee teacher in front of a class. These allow people to go back and see what they have done and reflect on why, and how effective the approach was.

The SenseCam is a device that will support the recording of process. My approach will be to explore its use in various situations and compare and contrast the reflection supported in order to map out the space of possibilities for how a wearable passive capture camera (the SenseCam) can invoke or support reflection. I then hope to make some design suggestions. The situations that I am intending to explore are: learning from experience, professional practice, and some everyday situations. I am also interested in exploring how it might augment other methods of diary keeping for things such as time management or healthy eating.

Situations of Use

Learning from Experience: Kolb (1984) understands reflection as the process of developing concepts from experience. Boud, Keogh & Walker (1985) expand on this and describe how by returning to an experience and re-evaluating it, learners are able to associate and integrate this new experience into their existing cognitive structure which may lead to a changes in their understandings and future actions. Images captured by SenseCam may help students to recall more accurately what really went on in learning experiences such as field trips and see things that they perhaps didn't notice at the time. Also, the visual images may provide a good way for students to share their experiences with other students or instructors and form the basis of discussion. I am presently analysing the results of a pilot study where students were asked to take part in a learning experience wearing the camera. I then asked some of the students to answer questions based on their experience with the aid of the images to support their memory and some without the images.

Professional practice: The role of reflection in the development of professional practice is similar to that of learning from experience as professionals are encouraged to learn from their experiences in practice. Schön (1983) talks about the need for professionals to both reflect-in-action, which he describes as thinking and guiding an action without interrupting it, and reflect-on-action, which is looking back at or stopping an action in order to think about it. When reflecting on action, professionals can consider the actions they took, the reasons why they took these actions and evaluate the success of the outcome. Schön believes that it is through this process practitioners develop the repertoire of skills and techniques which in an expert are tacit. Reflective practice is actively utilised in a number of professions both to train professionals, for example in teaching (Reinman, 1999), and in continuous professional development for example in health care professions (Clouder, 2000; Williams, 2002). I have been in discussion with physiotherapists, podiatrists and teachers about the potential of the SenseCam to be a tool for reflection-on-action.

Everyday situations: I have also given the SenseCam to a number of people to wear at the weekend. These studies have highlighted a number of usability issues with the camera. I am however also very interested in how people choose to use the cameras, when they wear them, when they don't, what they enjoy about the captured images and what they would like to use them for. I am also interested to see if there is any evidence that the images are supporting reflection, and to compare this to reflection provoked in the other situations. Are there aspects of our daily life that passive image capture may add value to? I asked people to try to wear the camera for a whole day initially (for a number of reasons this was not always possible). After that, they were free to wear it when they wanted. I then asked people to talk me through the images they collected, then answer a few questions about their experience of using the camera. These sessions were videoed. I am planning initially to look at the collected data using an approach similar to grounded theory (Strauss & Corbin, 1998).

Augmented Diaries: An initial brief look at some of the data collected in the everyday situations suggests that the images collected may be good for raising awareness of habits that people have and are not fully aware of. There are a number of situations in which people are asked to keep a diary in order to become more aware of what they are doing. Two such examples are to improve time management skills and to help weight loss. I am presently considering how to investigate the use of the SenseCam to support this diary keeping process. A record in images might improve on retrospective written accounts in various ways.

Conclusion

The SenseCam is an initial prototype of a device that can capture images passively. By trialing this camera in a number of situations in which it might support or provoke reflection and analyzing these, I hope to be able to experiment with different dimensions of both the capture device and the image replay in order to provide guidelines for the use of passive image capture to support reflection. This understanding will hopefully allow others who come from a more requirements based position to see how such devices and techniques could be incorporated into potential designs for evaluation.

References

Boud, D., R. Keogh, et al. (1985). Promoting reflection in learning. Reflection: Turning experience into learning. D. Boud, R. Keogh and D. Walker. London, Kogan Page: 18-40.

Clouder, L. (2000). "Reflective practice in physiotherapy education: a critical conversation." Studies in higher education **25**(2).

Dewey, J. (1933). How we think. Boston, MA, D. C. Heath.

Kolb, D. (1984). Experiential learning as the science of learning and development. Englewood Cliffs, New Jersey, Prentice Hall.

Moon, J. A. (1999). Reflection in learning and professional development. London, Kogan Page Limited.

Preece, J., Y. Rogers, et al. (2002). Interaction design: beyond human-computer interaction. Chichester, New York, John Wiley.

Reinman, A. J. (1999). "The evolution of social roletaking and guided reflection framework in teacher education: recent theory and quantitative synthesis of research." Teaching and Teacher Education: 597-612.

Rogers, Y., Scaife, M., Harris, E., Phelps, T., Price, S., Smith, H., Muller, H., Randell, C., Moss, A., Taylor, I., Stanton, D., O'Malley, C., Corke, G. & Gabrielli, S. (2002) "Things aren't what they seem to be: innovation through technology inspiration." Proceedings of DIS2002 London, 25-28 June, 373-377.

Seale, J. K. (1998). Using learning technologies in psychology education to encourage reflection. http://www.sohp.soton.ac.uk/jks1/CPI98paper.htm. Accessed: 30/10/02

Schön, D. A. (1983). The reflective practitioner: How professionals think in action. London, Temple Smith.

Strauss, A. and J. Corbin (1998). Basics of qualitative research: Techniques and procedures for developing grounded theory. California, Sage Publications.

Williams, R. M., J. Wessel, et al. (2002). "Journal writing to promote reflection by physical therapy students during clinical placements." Physiotherapy Theory and Practice **18**: 5-15.

A user-centred mobile television consumption paradigm

Hendrik Knoche
University College London, Computer Science Department, London, UK.
e-mail: h.knoche@cs.ucl.ac.uk

Abstract : **This paper describes the design considerations for a mobile television service from a user-centred perspective. Results from previous research on interface design, traditional TV consumption, and focus groups on user expectations and needs in a mobile context are taken into account.**

1. Introduction

This paper explains the design considerations for a demonstrator for a mobile TV service, which will be part of and accessed through mobile phone devices. More specifically, this demonstrator emulates the service of the Satellite Digital Multimedia Broadcast (SDMB) system. The cost-efficient country-wide distribution of the multimedia content will be achieved by integrating satellite broadcast capacities with existing terrestrial 3G and beyond 3G infrastructures [1]. The SDMB service assumes the use of mobile phones with extensive storage that allows the consumption of previously cached content at opportune times as well as the watching of live streams and receipt of alerts.

The interface design of this service must consider the following factors:

- how people use their mobile phones
- how and why they watch regular television and whether this holds in a mobile context
- the technical requirements of the different content types
- the technical restrictions of the mobile phones and the SDMB system
- users and their needs when in places where they obey different social norms

To address these questions concerning the overall quality of experience of a mobile TV service I have conducted focus groups [2] and conducted lab-based experiments on the acceptability of audio and video encoding bit rates [3]. This resulted in the interaction design of the mobile TV service demonstrator which represents the scope of this paper.

2. Traditional TV Consumption

Television consumption generally takes place at home. Watching television is a rather passive or “lean back” activity in which an audience passively consumes broadcast content. Remote controls facilitate hopping through parallel channels of sequential content - an opportunistic search for content to satisfy a viewer’s moods and mindsets. When in a group, however, the decision of what to watch can be a contentious one.

People watch television for social and psychological reasons. On the social side people value the time they spend with friends and/or family and enjoy the communal experience. Mood management is one of the major psychological drivers for watching television. People who are bored may choose excitatory or arousing content, while those who are stressed are likely to prefer relaxing content [4].

We can see higher commitment viewing with favourite shows, programs for which people plan ahead of time, and shows for which viewers have to pay for on a per-use basis. During high commitment viewing people change channels infrequently and are less accepting of outside interruptions. When viewing on a low commitment basis, on the other hand, people make more channel changes and may allow other demands and activities within the home to distract them relegating TV viewing to a background activity.

For the context of this work I consider the following to be the defining characteristics of standard television: Instant on – once a person turns on the TV he/she continuously receives content of a sequential channel. Easy switch - the cost of switching to a different channel is low, especially with a remote control. Seamless switch - the switch to a parallel channel is more or less instantaneous. Graceful transitions - due to the way TV is programmed, the transitions from a program that has just ended to the next program are smooth in an attempt by broadcast companies to keep their viewers. No spatial overlap - channel navigation does not spatially overlap with the content. No functional overlap - TV sets are dedicated to their purpose and can be used simultaneously with many other appliances.

In a study on digital television, Eronen and Vuorimaa found that users who were interested in watching television were not interested in interacting with an EPG or interactive television. The authors emphasized that digital television should maintain the familiar living room TV experience [5].

3. Mobile Phones and Mobile TV

Being mobile consists of spurts of activity that interwoven with periods of dead or unstructured time. The usage of mobile phones evolves around the three general user areas of home, work, and public [6]. People use them mainly is to stay in touch with friends and family and synchronize with them in and across space and time. The perceived main threats to this need are high cost, imperfect coverage, and short battery life [2].

How does the use of a mobile phone - the centre of communication representing activity and control - go together with the passive or "lean back" consumption of television content?

In terms of mobile consumption, people are worried about absorbing themselves in multimedia content, which requires their visual attention and progresses at its own pace. They fear increased risks of accidents or lapses (e.g. missing train stops) [2]. Many people are wary of the effect their mobile phone usage, i.e. talking aloud, has on others in public spaces. For these and other considerate users multimedia consumption requires the use of headphones, which might further immerse them. It is currently unclear if and how mood management of ordinary TV usage will translate to the mobile context.

Previous research has shown that peoples' average [7] usage of mobile TV is less than ten minutes long. This has ramifications both on the type of content as well as the way that people will consume it. Longer programs will be more appealing to people that experience extensive dead times; for example, long commuters [2].

How does the small screen size affect the content and its consumption? In general fidelity is traded off for mobility and availability. Mobiles have modest screen sizes. Large visual stimuli result in orienting responses (involuntary attention) and increases in arousal [8]. We do not know how attention and arousal decreases when viewing on smaller screens or whether headphone usage will partly compensate for this. A less attentive audience engages in more channel changing [9]. Less absorbing mobile television could be associated with more channel-changing and less attention to embedded commercials. Smaller screens might also affect the different content types viewed on the handset.

With reduced screen sizes screen clutter could become an issue much earlier than at traditional TV resolutions where screen clutter has been shown to impede attention and comprehension [10]. Text clearly suffers from small screen size, as a small screen renders text nearly illegible. If text were sent through a separate channel and presented separately people could easily adjust the viewing distance to the handheld device.

On current mobile phones videos are usually accessed through galleries that include a thumbnail and a title describing the content. The typical question that arises after a clip has finished playing is: What next? Whereas traditional impromptu television choices are based on the content and the point of entry to the content, the consumption of downloaded or video on demand requires more user interaction and decision-making which is partly due to the payment model. The naming of items in an EPG exerts a strong influence on user choice. In the following section we will present an alternative to this approach.

4. Proposed Design

In short, the proposed design is based on the assumption that mobile users have short windows of opportunity, engage in low commitment viewing with channel changes, and need to control the content easily while in public spaces where they have unsteady visual fields. These are all challenges to the idea that mobile TV viewing should be an effortless, enjoyable experience.

I believe that the cost of choosing the next clip in current mobile interfaces, in terms of cognitive overhead, is a major inhibitor to a flow experience [11] of multimedia content, which already suffers from small screen sizes.

An electronic program guide (EPG) can be a valuable instrument in content navigation [7] and could be a tab/channel in the proposed design; however, it is not a fast entry point to mobile TV service. In order to maximise the amount of time spent watching content during the relatively short idle periods, mobile TV should behave like ordinary TV. When turned on, it should start playing that content that was last played. It should continuously show content until it has run out of new content and then loop back again to the first program. The only exception to this should be if a lower battery threshold is reached beyond which the user’s usual communication pattern in relation to the charging pattern cannot be guaranteed. In this case the application would halt with an appropriate message.

The support of program changes is twofold. If the user is not interested in a channel he can change to a different channel by selecting the channel’s tab on the screen depicted on top in Figure 1. Programs are serially aligned in the channels. It is not clear yet how the television brands, i.e. channels like CNN and BBC, will carry over to mobile television but current research suggests that a channel- centric consumption will prevail for some time over genre or category-centric channels (e.g. the channel of all news programs) [7]. However, for practical reasons, i.e., the feasibility of emulating full channels in our studies, we will follow a category-centric approach.

Figure 1: Demonstrator for mobile TV with channel tabs on top, play/pause, skip buttons, and audio control on the bottom

In previous studies users voiced their desire for indexed programs that would allow them to skip to interesting parts or scenes [7]. This functionality is based on content items as originally conceived by [12], which make up part of a program. If the user is not interested in a content item but wants to continue watching the same program he can navigate to the next content item with the buttons “>>” and “<< “. A ‘double-skip’, meaning two fast successive button presses, will be interpreted as a skip of the program and the service will continue with the next program on the same channel. With channel changes and program skipping the user can navigate a two-dimensional content grid with little cognitive effort. This interface allows for more habit formation [13] in contrast to lists displaying video clips, which differ every day or possibly every time a user browses them.

If for any reason, e.g., to get on a bus, the user needs to halt his/her viewing, he/she could use the pause button (||) and pause the program at its current position. The label of the button then toggles to a play (>) symbol. For incoming calls the presentation of the content should be automatically paused and the user confronted with the question of whether to accept or reject the call.

5. Summary

I have presented a design for a mobile phone based television interface, which draws from previous research on television watching behaviour and its psychology, mobile phone usage, focus groups on mobile multimedia consumption expectations and needs, and lab experiments. I believe that this user-centred approach leads to a design of a mobile TV service that will leave operators with services that offer quality of experience and which users find enjoyable and for which they are willing to pay.

I suggest a mobile television interface that aims at porting many of the standard television characteristics to the mobile phone as long as peoples' communication needs are not compromised, especially in terms of battery life and in receiving and making calls. I believe that a television service that presents content immediately on start up, that allows users to change channels, that skips boring parts and that pauses the content if necessary is a good way to approach the challenges of watching audiovisual content while on the move.

The only drawback from this approach is that the people might get too immersed in the television program because the device does not stop playing.

References

[1] K.Narenthiran, M.Karaliopoulos, R.Tafazolli, B.G.Evans, P.Vincent, C.Selier, C.Nussli, N.Chuberre, M.Mazzella, A.Jacobs, L.Zaccheo, M.Dieudonne, F.Rible, K.Petit, A.Nazif, K.Aldinger, L.Roullet, A.Pouliakis, I.Andrikopoulos, I.Mertzanis. S-DMB System Architecture and the MODIS DEMO. IST Mobile and Wireless Comm. Summit 2003 .

[2] H.Knoche, J.McCarthy. Mobile Users' Needs and Expectations of Future Multimedia Services. WWRF12. 2004.

[3] J.McCarthy, D.Miras, H.Knoche. TN01.1.03_UCL_MAESTRO. 2004.

[4] D.Zillman. Mood Management: Using Entertainment to Full Advantage, in: L.Donohew, H.E.Sypher, E.T.Higgins (Eds.), Communication, Social Cognition, and Affect, Erlbaum, Hillsdale, 1988, pp. 147-172.

[5] L.Eronen, P.Vuorimaa. User preferences and designers' views on what would suit the user. Conference on Advanced Visual Interfaces. Proceedings of the Working Conference on Advanced Visual Interfaces . 2000.

[6] J.Edelmann, J.Koivuniemi. Future development of mobile services and applications examined through the real options approach, Telektronikk, 2, (2004) 48-57.

[7] C.Södergård. Mobile television - technology and user experiences Report on the Mobile-TV project. 2003. VTT Information Technology. ESPOO 2003.

[8] B.H.Detenber, B.Reeves. A bio-informational theory of emotion: Motion and image size effects on viewers, Journal of Communication, 46(3), (1996) 66-84.

[9] E.M.Perse. Implications of cognitive and affective involvement for channel changing, Journal of Communication, 48(3), (1998) 49-68.

[10] M.Edwardson, K.Kent, M.McConnell. Television news information gain: Videotext versus a talking head, Journal of Broadcasting & Electronic Media, 29, (1985) 367-378.

[11] M.Csikszentmihalyi. Flow: The psychology of optimal experience, HarperCollins, New York, 1990.

[12] N.Negroponte. Being Digital, Vintage, New York, 1996.

[13] J.Raskin. The Humane Interface, Addison-Wesley, 2000.

A Comperative Research in Blended Learning: State University vs Private University

Sevinç Gülseçen, PhD
Department of Informatics, Istanbul University, Turkiye
gulsecen@istanbul.edu.tr

I_ıl U_urlu
Research & Graduate Policy, Sabancı University, Turkiye
isilugurlu@sabanciuniv.edu

M. Erhan Ersoy
Ferhat Nutku
Department of Informatics, Istanbul University, Turkiye

Abstract
The aim of this paper is to examine how blended learning affects learning motivation of students from state and private universities. Our hypothesis in this research is that, blended learning enables the students, who have less interest in the courses – in this case students from private university - to become more enthusiastic. We prepared a series of surveys that will be conducted to two different groups of students from two different universities. The students will be presented with surveys at the beginning and end of the course and then the results will be compared accordingly.

Introduction
As Gary Becker, Professor from the University of Chicago and winner of the 1992 Nobel Prize in Economics explains "We've had, until the growth of the Internet, teachers standing up in front of a bunch of students and lecturing to them with some give and take. The Internet has the potential to be the first major change in this process since Socrates" (Uskov, 2003).

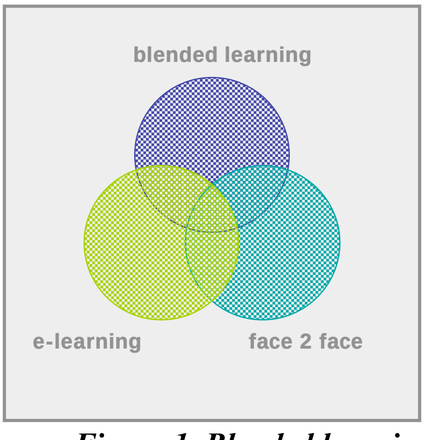


Figure 1. Blended learning

Academics have recognized for years the shortcomings of the faculty-centered classroom, but it has been difficult to break away from the paradigm. In an online environment, the instructor soon takes a back seat. Students are empowered to learn on their own and even to teach one another. Particularly in the discussion group mode, students have the opportunity to explain, share, comment upon, critique, and develop course materials among themselves in a manner rarely seen in the F2F classroom (Kassop and Mark, 2003).
The term blended learning refers to courses that combine F2F classroom instruction with online learning and reduced classroom contact hours (reduced seat time). The combining F2F and fully online components optimizes both environments in ways impossible in other formats (Dziuban and Hartman, 2004).
This kind of instruction is becoming more commonplace in higher education. Students not only attend classes, meet face-to-face with each other and their instructors, but also can

communicate electronically outside class meetings using course management tools such as WebCT, BlackBoard, Angel, and the like (Firck & An, 2003).

A blend is an integrated strategy that involves a planned combination of approaches, such as coaching by a supervisor; participation in an online class; reference to a manual and participation in seminars, workshops, and online communities, forums, chat etc.

The table below presents the possibilities of what can constitute a blended learning approach:

Table 1. Possibilities of a blended learning approach (Rossett, Douglis and Frazee, 2003).

Live face-to-face (formal) • Instructor-led classroom • Workshops • Coaching/mentoring	**Live face-to-face (informal)** • Collegial connections • Work teams • Role modeling
Virtual collaboration/synchronous • Live e-learning classes • E-mentoring	**Virtual collaboration/asynchronous** • Email • Online bulletin boards • Online communities
Self-paced learning • Web learning modules • Online resource links • Simulations • Scenarios • Video and audio CD/DVDs • Online self-assessments • Workbooks	**Performance support** • Help systems • Print job aids • Knowledge databases • Documentation

There has been a considerable amount of research on human interaction and communication in online distance learning. Web-based training, as a kind of distance learning, does not merely provide a different medium for traditional classroom interactions, but creates an environment for students to take part in much richer and relevant educational activities. By incorporating a Web-mediated cross-cultural learning activity into the course curriculum, students may be presented with new and greater challenges that extend beyond their traditional, and often passive, learning of theories and content (Singh and Dron,2002). In this study we will explore these effects such as changes in students' manners against courses, their motivation for studying, increases or decreases in attendance rate to the classroom, their responsiveness for the courses and the like.

Research Method

We created a measurement and reviewing process to analyse the results of blended learning. Firstly we determined three elements of our research which are: participants, milestones and questionnaires.

Participants

Group Private (P): We recruited 40 undergraduate students from a private university for this group. The main characteristics of those students are less interest in courses, low attendance rate and low grades. Currently, courses are being delivered in face-to-face mode, but with web enhancements.

Group State (S): The students in this group are undergraduates at a state university. As compared to the other group, these students are more responsive and hardworking. There are 40 students in this group. Courses are being delivered also in face-to-face mode, but with web enhancements.

Instructors: A course with the subject "Algorithms and Introduction to Programming" will be given to the both groups by two instructors. Both of the instructors are experienced in either e-learning or F2F and they will carry out the program from the beginning and analyze the groups by this point of view.

Milestones

Spring term lasts 15 weeks at both universities.

Weeks

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
GS	*HW*		*HW*		*HW*	*MT*		*HW*		*HW*		*HW*	*F* *FSE* *ISAS*	*BLS* *SIA*

Figure2. Milestones

- GS: General Survey
- MT: Mid-Term quiz
- F: Final examination
- FSE: Final Student Evaluation
- BLS: Blended Learning Survey
- SIA: Survey for Instructors' Assessments
- HW : Homework
- ISAS: Instructor Self Assessment Survey

Instrument

We developed a semi-structured questionnaire series that included six short surveys:

1.General Survey (GS): Our purpose is to determine the groups' computer literacy level.

2.Final Student Evaluation (FSE): The both instructors will answer FSE to evaluate the students' level of participations in the course.

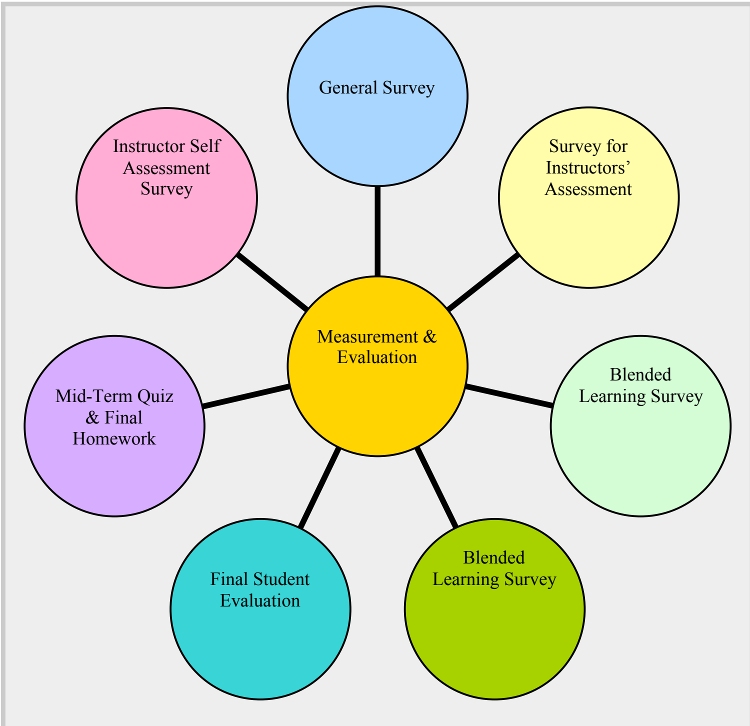


Figure 3. Series of Surveys

3.Current exams and homework for measuring the students' quantitative success.

4. Blended Learning Survey, which try to measure students' time for study, their interactivity and participation in courses and also find out whether all the learning objects have been reached.

5. Survey for Instructors' Assessments, whixh is also a multiple choice survey, which aims to enable students to assess their instructors.

6. Instructor Self Assessment Survey, this unique survey will be answered by the instructors for self assessment.

Data Collection and Analysis

Most of the surveys used in this research will be conducted online through our web-based e-learning environment. The other questionnaires will be distributed to the students who are willing to participate in the study by the instructors and an assistant.

E-learning environment

We have launched a new web-based online learning site for both groups. In this new environment the groups will find;

Guidance; Because learners don't always know when they need additional instruction or when they're ready to test their course skills, effective blends need to include guidance. Direction can appear as sample paths and recommendations in terms of roles, tasks, priorities and progress.

Focus on flexible options; Blended learning enables students to get an answer, regardless of the location, time, and learning preferences. This has positive ramifications for increasing the retention.
Embrace redundancy; Redundancy is part of any good blend because it allows students to receive the same and elaborated messages from several sources in various formats over time. For instance, a topic is discussed in a traditional classroom; it's elaborated on in the online community. In addition, instructors are able to host online chats a day in a week to practice key concepts, deliver online homework, develop a support network to facilitate ongoing information sharing.

Expected Results

- Blended learning enhances the curiosity of the students in the class.
- Thoughtful and logical integration of the inherent strengths of F2F and online learning. Therefore students' motivation, attendance rate, and interest in courses will be increased.
- Group S's grades will be much higher than Group P.
- Generally, students who are familiar with technology literacy will adopt better learning approaches than the rest of the students.
- Unique knowledge ecology will be created among the both groups, with the help of the online learning environment.
- Increased student satisfaction with the mode of instruction compared to traditional formats.
- Students will be more actively involved in their learning. Therefore the instructors will be more chllanged.

Discussion

Blended learning provides students with equal opportunities, regardless of the fact that they either study at a private or state university. Success and motivation depend on the intellectual capacity of the learner, his/her personality, his/her emotions and attitudes towards learning, his/her learning styles, his/her special needs.

Acknowledgements

Special thanks to MSc. Informatics Students M. Erhan Ersoy and Ferhat Nutku for their enormous effort in developing web-based learning environment of this research.

References

- An, Y.; Frick, T. (2001) Blended Instruction: Student Perceptions of Communications Technology in Face-to-Face Courses, Department of Instructional Systems Technology,2001
- Dziuban, C; Hartman, J. (2004) Blended Learning, Educause Center for Applied Research, Research Bulletin, Volume 2004, Issue 7.
- Kassop, M. (2003), Ten Ways Online Education Matches, or Surpasses, Face-to-Face Learning. http://ts.mivu.org/default.asp?show=article&id=1059&action=print
- Rossett, A; Douglis, F. And Frazee, R. (2003), Strategies for Building Blended Learning, 2003 http://www.learningcircuits.org/2003/jul2003/rossett.htm
- Singh, S.; Dron, J. (2002), Networking: a study in planning developing cross-cultural collaboration, ALT-J, Volume 10(2), 29-38.
- Uskov, V. (2003) Students Centered Learning in Online and Blended Education on Computer Information Systems. fie.engrng.pitt.edu/fie2003/papers/1513.pdf
- The 2004 National Survey of Information Technology in US Higher Education, http://www.campuscomputing.net

Learning Patterns

Elana Copperman
Computer Science Department *Michlalah – Jerusalem College*

1. INTRODUCTION

The process of designing software systems is, in essence, a learning process. Before the software engineer can construct a system, he or she must develop a broad understanding of the underlying process, construct a conceptual model of the desired system, and only then may proceed with the step by step design of the final system.

Many similar stages are involved in the learning process. A software engineer constructs a software system, whereas the learner constructs knowledge. Similarly to the software engineer, the learner proceeds from an initial understanding of the relevant background knowledge involved. He or she then constructs a conceptual model of the new topic, and then assimilates the particular details.

In addition, software engineers attempt to construct models of complex and abstract real-life systems. By their very nature, learning systems may also be complex abstract systems, since the potential for human learning is virtually unlimited.

Software design patterns are used to describe successful solutions to common problems and transfer these solutions to practitioners in an effective format. Based on this analogy between software systems and learning processes, we attempt to define models of learning using commonly accepted software engineering models.

We propose the concept of a learning pattern, as a concise description of a basic building block of a learning process. The patterns describe solutions to recurring problems which arise in various learning situations. The solutions themselves present successful techniques, derived from research in psychology, education, and science education. The patterns described are well-known to experts in those fields. The use of learning patterns presents a format suitable to Computer Scientists and Software Engineers to facilitate teaching and learning, in academic or industrial settings.

We present a methodological framework for describing new patterns. The goal of this proposal is to allow researchers and practitioners to access pertinent well-proven and researched learning theories and models. This work serves as an invitation to the research community to expand the list of learning patterns, and demonstrate their applicability in practical applications. Learning patterns may also serve as a convenient vehicle for guiding Computer Science and Software Engineering instructors who have little or no formal background in theories and methodologies of education.

1.1. Learning Patterns

In this work, we propose the methodology of**learning patterns** as fundamental building blocks upon which common models and theories of learning are built. They are based on well-established and commonly accepted elements of learning theories.

Learning patterns describe key steps and structures involved in the process of learning itself. They do not define a formula, how to teach or how to develop learning materials. However, the definition of a specific learning pattern helps clarify some elements involved in successful learning of a common type, and includes guidance in which situations this type of learning is most relevant.

Learning situations are varied, as are the humans who learn. As an example, learning algebra in a high school classroom involves learning of a very different type than the situation where a medical intern studies with licensed physicians who serve as mentors in a hospital setting. Each learning situation involves any of a variety of learning patterns, and no single pattern is applicable in every setting. The primary characteristic of a learning pattern is its ability to crystallize our understanding of important components involved in a learning process.

One of the long-term goals of our work is to provide tools and methodologies to guide and train teachers, and to assist in the development of appropriate learning materials. However, our emphasis is on the initial development of learning patterns, which is in itself a significant and non-trivial task.

The Pedagogical Patterns Project [2,4,5] has published a series of teaching patterns, which may be viewed as complementary to our work. The patterns developed are also based on Alexander's architectural design patterns. As described by the project members, these patterns "offer a way for experienced teachers to pass on their experiences" [4]. The project has been publicized within the community of object-oriented software pattern language researchers, and a pattern language for teaching Computer Science is evolving. Further research may expand learning patterns and teaching patterns, to provide both the theoretical background and the practical guidance for efficient learning and teaching.

2. LEARNING PATTERNS: TEMPLATE

In order to define learning patterns, a common format is proposed below. This template is based on [3,6,1], and adapted for describing learning elements. An established format for defining learning patterns will provide a common language for their definition, and facilitate their applicability. The basic template adopted here for the definition of learning patterns is similar to the template commonly used for defining software patterns. It may include the following elements:

1) **Pattern Name** – Our initial goal is to establish a common vocabulary (which is often only recognized in limited research circles) for describing key aspects of learning. The pattern name adopted is the most commonly accepted terminology, as established in scientific research. However, since terminology comes from a varied background, often different parties define the same basic terms in varying or even contradictory ways. A conscious effort has been made to establish a common vocabulary with a clear definition for each learning pattern.
2) **Classification** – Each learning pattern will be classified into one of three possible categories, based on its role in the learning process. These categories are as follows:

a. **Structural** – Relate to basic element involved in human cognition.
b. **Personal** – Relate to the dynamic process of learning, on an individual level.
c. **Communal** – Relate to the dynamic process of learning, as a social process.

3) **Initial Context** – A clear description of the learning situation in which the pattern is relevant, including desired learning goals and behavioral objectives, and whether the pattern is a static element or a dynamic learning process (or some combination). It will also include a description of the **context**, or the broader background in which the learning situation is contained. In addition, we may relate to **constraints** or forces whose interaction may influence the learning process.
4) **Resolution** – The resolution defines the pattern itself, which serves as a guide in understanding the steps involved in learning, or the change occurring within a structure as a result of learning. It helps us to understand how learning may resolve those forces, which triggered the initial state posed by the learning situation. It is not intended to be an algorithm or an itemized list for teachers or curriculum developers. In describing the resolution, we note how the pattern describes an important component of learning or a common learning process.
5) **Resulting Context** – After describing the resolution involved in applying the learning pattern, we describe the ensuing context, and how the learner has come to achieve the desired initial goals and objectives. This resulting context may describe the changes to the initial context as a result of a dynamic learning process, or the refined state of a cognitive structural component, or some combination. At times the descriptions of the resolution and the resulting context may overlap.

In cases where the learner has failed to achieve the desired initial goals and objectives, an attempt is made to analyze the possible causes. This may be due to an inappropriate assessment of the initial context and its relevance to the particular learning pattern, or due to additional constraints or forces which were not taken into consideration.

6) **Examples** – Primary emphasis is placed on examples in the analysis of learning, so that it becomes clear how the pattern is expressed in practical learning situations.

7) **Scientific Background** – An attempt is made to describe and cite these results in simple terminology, which may be understood by laymen (rather than academic researchers). This summary attempts to facilitate the understanding of the sources for the discovery of the learning pattern, and the background leading up to the learning pattern definition. In case we have found a variety of inconsistent or slightly different uses of the terminology in the literature, we relate to these citations in the literature and make note how they differ from our definition of the pattern name and its components.

8) **Related Patterns** – This may assist practitioners to gain a broader spectrum of learning patterns available, and how they may relate to each other. Related patterns often present common forces, and thus their application may complement each other in a learning process.

In addition, often the resulting context will describe a potential initial context for further learning, using related patterns. Thus practitioners may more easily utilize learning patterns one after another, and describe learning as a step-by-step process or as a series of learning units which begin in one situation and proceeds to some final eventual goal.

9) **Known Applications** – This is an essential element in our dictionary of learning patterns. The aim is to provide practitioners with well-documented, successful applications of learning patterns pertaining to teaching and development of learning materials. However, since our work is only a preliminary research work, we presently cannot compile a list of known uses. Our hope is that eventually these may be appended to an established dictionary of learning patterns, and expanded to construct a dictionary of teaching patterns.

Sections 1 – 6 are mandatory; the remaining sections may be included as appropriate.

3. SUMMARY

Learning patterns do not provide formal mechanical rules for effective learning. They serve as guides for learners and researchers, and define the basic building blocks of well-proven genres of the past. They also provide a framework for communication between those involved in a particular learning process, or in the construction of quality learning materials. This may help facilitate efficient learning and guide in the assessment of the level of learning achieved.

Several learning patterns have been defined and utilized; they include the following:

1. Structural patterns – misconception, subsumer, schema.
2. Personal patterns – cognitive conflict, conceptual change, assimilation and accommodation, advanced organizer, internalization and externalization, induction, deduction.
3. Communal patterns – tool mediation, zone of proximal development.

Learning patterns have been introduced informally to Computer Science teachers with little or no academic training in educational theories and methodologies, who teach on the undergraduate college level. Initial attempts have been made to utilize learning patterns in designing courses in Java programming on the college level, and object-oriented programming on the high-school level. The learning patterns have served as a communication tool for bridging the cultural and academic gap between the various team members involved in designing learning materials in Computer Science education. At meetings, when discussing curricular and application details, appropriate patterns were introduced. They provided a clear, well-defined framework for practical use of important learning tools and technique.

We have found that each time a course was taught, learning patterns have helped us pinpoint areas needing to be improved and how to do so. Some specific examples of use of learning patterns used in designing the college-level course:

1. *Dynamic equilibrium*. This learning pattern was introduced when discussing the appropriate order of topics to be introduced in the course. An awareness of this pattern helped us design the

course so that the students are left at the end of each unit in a state of stability, in preparation for the next topic to be taught.

2. *Induction, deduction, abduction*. The different forms of learning were clearly described as learning patterns and an attempt was made to choose the most appropriate form for teaching different concepts. Abstract concepts such as inheritance, polymorphism, and dynamic binding were broken down into sub-topics and specific examples. Each learning pattern was introduced; subsequently, each topic was analyzed to determine the most appropriate form of learning.
3. *Advanced organizer*. Much explicit use of this pattern was made, in order to provide a setting for meaningful learning. This most commonly affected the order of topics to be taught, and the structure of each lesson. Each lesson began with an introduction stemming from previous knowledge, and ended with a section laying the foundation for the next lesson. We discovered that staff members without background in education or psychology were easily able to pinpoint and define appropriate advanced organizers within the learning units, after this was introduced as a learning pattern.
4. *Zone of proximal development*. An awareness of this pattern provided those teaching the course with an important tool to judge how to efficiently bring across many abstract notions. This was most explicit in teaching topics such as object-oriented programming, graphic user interface development, and network programming. A clear understanding of each student's zone was important in order to adapt the same material to the current range of student knowledge.

The team involved in designing the high-school level course has witnessed practical use of learning patterns in forming a basic language of learning theories in a particular framework. In particular, problematic topics such as the use of constructors and destructors, operator overloading, and inheritance were analyzed and researched for teaching purposes by the committee. Learning patterns were useful in guiding the team members to practical solutions. These patterns included misconceptions, reflection, internalization, and externalization.

For example, the concept of a class is fundamental in object-oriented programming. The committee has debated whether it is more appropriate to introduce the concept as an extension of lists and records (topics which the students have been taught in previous learning units), or as a new concept. The analysis of the various didactic and subject matter problems involved was more easily expressed using learning patterns such as induction, deduction, and conceptual change, to pinpoint the various pitfalls in each method.

The use of pointers in Java programming, particularly in lights of the students' previous exposure to pointers in data structure implementations in Pascal or C, was also defined and analyzed within the framework of learning patterns. For example, we discussed students' misconceptions of pointers and memory allocation, and the applicability of accommodation and assimilation learning patterns.

Software design patterns are not a cure for all of the ills of software engineering. However, their widespread applicability is undisputed. We view this work as a preliminary presentation of learning patterns as a pedagogical tool, primarily for Computer Science instructors, but also for science education in general. The definitions of learning patterns presented here are intended to be an invitation to the research community, to expand our repertoire and present practical applications.

4. REFERENCES

[1] Appleton, B. Patterns and Software: Essential Concepts and Terminology. http://www.enteract.com/~bradapp/patterns-intro. html, 2000.

[2] Bergin, J., J. Eckstein, M.L. Manns, and E. Wallingford. Patterns for Gaining Different Prespectives. *Proceedings of PLoP 2001*.

[3] Coplien, J.O. A pattern definition. (from the Patterns Home Page). http://hillside.net/patterns/definition.html, 1996.

[4] Eckstein, J., J. Bergin, and H. Sharp. Feedback Patterns. *Proceedings of EuroPLoP 2002*.

[5] Eckstein,J., J. Bergin, H. Sharp, and M. Sipos. Teaching from Different Prespectives. *Proceedings of EuroPLoP 2003*.

[6] Meszaros, G., and J. Doble. A pattern language for pattern writing. http://hillside.net/patterns/Writing/patterns.html, 1997.

Issues to consider when designing ILEs that take into account students' learning goals

Erika MARTÍNEZ-MIRÓN, Amanda HARRIS,
IDEAs Laboratory
Department of Informatics and Psychology,
University of Sussex
[E.A.Martinez-Miron,A.L.Harris]@sussex.ac.uk

Abstract

There is a large evidence-based literature which supports the notion of mastery and performance approaches to learning and which identifies distinct behavioural patterns associated with each. However, it remains unclear how these orientations manifest themselves within the individual: an important question to address when applying goal theory to the development of a goal-sensitive learner model. This paper addresses some of these issues: firstly, by discussing the dimensionality of goal orientations and secondly, by exploring their dispositional vs situational components.

1 Introduction

In order for a software system to improve a learners educational experience it needs, to some extent, to be able to emulate aspects of the role of a skilled teacher. Part of this role involves the ability to respond to an individuals emotional and motivational state; characteristics identified as important influences affecting the learning process. It is only relatively recently that these issues have been addressed in relation to the development of Intelligent Learning Environments (ILEs). In this paper we explore the increasing interest in learners' achievement goal orientation and the impact this can have upon their learning. In attempting to apply achievement motivation theory to the design of two separate educational software systems we identify the need for a deeper understanding of the very nature of learning goals.

Achievement goal theory argues that the goals an individual pursues in an achievement or learning environment create a framework, or orientation, from which that individual interprets and reacts to subsequent events. These goals mediate internal processes and external actions and are important contributors to the self-regulatory processes involved in learning (Elliot & Dweck, 1988). Examining the achievement goals a learner holds, therefore, informs our understanding of how individuals behave in learning contexts; vital information in the design of adaptive learning environments.

Two distinct orientations or patterns of achievement goals have been identified. A *performance goal orientation*, in which individuals interpret success as a reflection of their ability, they strive to receive positive judgments of their competence and avoid negative ones. In other words, these individuals regard learning as a vehicle to public recognition rather than as a goal in itself. A *mastery goal orientation*, on the other hand, regards success as developing new skills, understanding content, and making individual progress, that is, learning is the goal itself.

These different learning goal orientations are associated with distinct behavioural patterns and learning strategies, with mastery goals being considered more adaptive. If a system can respond to the motivational orientation of individual learners, something expected of a human teacher, a more adaptive approach to learning may be encouraged, either by highlighting a mastery approach or by responding to the individual's own learning goal orientation. Further research is needed to investigate the extent to which goals impact on the way in which learners interact with a computer system. We believe that having a better understanding of how individuals feel and act when interacting with a system could help with the ultimate goal of intelligent tutoring systems (ITSs) in customizing instruction for different student populations by, for instance, individualizing the presentation and assessment of the content. Exploring achievement goals may therefore be an important aspect of designing and constructing a learner model. However, our empirical work has raised several questions about the nature of learning goals and the application of achievement theory to everyday educational contexts.

2 Two empirical studies

Two separate studies were carried out as part of different projects. However, both studies revealed similar problems with achievement goal theory. The first study looked at the way children interacted with two versions of an interactive learning environment that emphasized a particular goal orientation by means of the feedback provided and some elements of the interface. The second study was classroom-based and explored how goal orientations influence the way in which learners engaged in a computer-mediated collaborative task.

Both these studies addressed the individual differences that exist when different learners engage in the same task and the learning consequences these differences may have. They both frame this investigation against the backdrop of an achievement goal perspective. Both use a standard method of measuring learning goals; the Patterns of Adaptive Learning Scales questionnaire (PALS) (Midgley, Maehr, Hruda, & Anderman, 2000). Furthermore, both studies encountered similar theoretical and methodological issues about the way in which learning goal orientations are understood and consequently measured. We argue that these need to be addressed before achievement goal theory can be appropriately applied to the design of ILEs and, therefore, devote the remainder of our discussion to highlighting the common problems we encountered.

3 Current limitations of achievement goal theory

3.1 Dimensionality

There is no clear consensus within the literature about how to understand the constructs underlying mastery and performance goal orientations. For example, many authors understand the mastery/performance distinction as the end points on a single bipolar dimension, with a strong mastery goal orientation at one end and a strong performance goal orientation at the other (Ames, 1992; Dweck & Leggett, 1988). Within this framework an individual can either be mastery-oriented or performance-oriented to a greater or lesser degree but not both. The other way learning goals have been understood are as separate dimensions that are neither mutually exclusive nor contradictory, but independent (e.g. (Valle, Canabach, Nunez, Pienda, Rodriguez, & Pineiro, 2003; Meece & Holt, 1993)). Although Dweck and Leggett seem to acknowledge the possibility that individuals can, to some degree, hold both types of goals simultaneously (Dweck & Leggett, 1988), the general perception from their research is that performance and mastery goal orientations are part of a single dimension. While this is a theoretical issue, it has important consequences for studying achievement goals in real world learning contexts, an issue highlighted by difficulties we encountered in measuring learning goal orientations in the current two studies.

The PALS questionnaire (Midgley et al., 2000) adopts an independent dimensions approach to the measurement of learning goals. Both studies found a similar effect using this scale, in that it was difficult, if not impossible, to classify individuals as having either mastery, performance-approach or performance-avoidant orientations. This was due to the fact that many scored either highly or lowly on all 3 dimensions. This suggests that it is not only possible to hold both mastery and performance approach goals simultaneously but also performance avoidance goals; a seemingly distinct construct. The authors suggest the measure should be used rather as an indication of an individual's achievement goal tendency than a means of classification into one orientation or another (Midgley et al., 2000). However, in our studies there only ever appeared very slight tendencies one way or the other, with most students being rated similarly on all three goal dimensions. These results question the independent dimensions approach to the study of learning goals, because if measuring goals in this way can mean an individual can hold different goals to the same extent at the same time, it does not account for the different cognitive, affective and behavioural patterns which have been observed and associated with the different orientations.

The alternative is a forced choice measure which involves giving participants the choice between one of two tasks (Dweck, 2000). Each of the tasks appeals either to a mastery orientation, emphasising a learning dimension, or a performance orientation, emphasising the potential for demonstrating existing knowledge. The choice made by the participant is then taken as the measure of their goal orientation. This method adopts a dichotomous approach to learning goals in that the individual can't choose both tasks and, therefore, can only be either performance- or mastery- oriented. While this solves one of the problems presented using the PALS questionnaire, in that an individual cannot be both orientations, it raises another, in that it does not assess the strength of an individual's goal orientation. It forces participants into making the distinction, thereby pigeonholing them into one or other category, without any opportunity to indicate the strength of their behavioural tendency. It also relies on making an inference between the behaviour displayed and the reason behind or motivation for that behaviour.

Neither of these approaches to the measurement of learning goal orientation takes into account the specific context in which a goal may be salient. The PALS questionnaire asks very broad questions about an individual's attitude toward learning, for example, "One of my goals is to show others that I'm good at my classwork." (Midgley et al., 2000) (p.12). No reference is made to the specific type of classwork, the particular domain, or to whom the "others" refers, be they classmates, teachers or parents. In this sense the authors have attempted to keep each item on the questionnaire as context-free as possible. A similar attitude to context appears too in Dweck's task choice measure where she asks the participant whether they prefer "problems that aren't too hard" or "problems that I'm pretty good at" (Dweck, 2000)(p. 185).

Theorists have, therefore, deliberately attempted to decontextualise the way in which learning goal orientations are measured. However, it may be the very issue of context and how context influences the adoption of different learning goals that is fundamental to understanding the impact of learning goals on a learners achievement behaviour. Theorists tend to sit on either side of this issue with few addressing the conflict that exists and even fewer attempting a resolution. We argue that this is exactly what needs to be addressed if achievement goal theory is to have any practical use in the design and implementation of educational environments, computer supported or otherwise.

3.2 Dispositional *vs.* situational approach

The influence of context on learning goal orientation is related to the question of whether goal orientations can be considered personality traits, stable across time and contexts, or situational states which vary according to specific contexts. They have been considered to be situational variables, when goals have been manipulated for the purposes of a given study (e.g. by means of task instructions (Elliot & Dweck, 1988; Deci, Betley, Kahle, Abrams, & Porac, 1981), type of feedback (Butler, 1987), or retesting opportunities and criterion-referenced grading (Covington & Omelich, 1984)). Studies which have attempted to do this have created mastery or performance contexts for short-term empirical measurements and have not followed up the extent to which goals have remained altered after experimental manipulation. The alternative perspective views goal orientation as stable and measurable dispositional traits. Studies adopting these perspective tend to measure the individual's orientation and how this influences their response patterns across situations (e.g. (Valle et al., 2003; Barron & Harackiewicz, 2001)).

Theorists adopt either a situational state or dispositional trait approach depending on their emphasis i.e. either developing classroom styles that are specifically designed to foster mastery goals (Ames, 1992; Covington & Omelich, 1984) or understanding more about multiple goal perspectives before concluding that a mastery goal perspective is more adaptive (Harackiewicz & Elliot, 1998). Few have addressed the issue directly. However, it is our belief that this is another essential element in the understanding of learning goals and how they manifest themselves which needs more empirical evidence.

The resolution of this argument has implications for the way in a system might use motivational dimensions to enhance a learning experience. For example, if goals are primarily dependent on context, regardless of an individuals goal orientation, a context can be created to encourage the adoption of a specific goal. Alternatively, if the individuals orientation or tendency is stronger than environmental cues, then learning activities can be designed to appeal and match particular orientations. A sensible approach to investigating how dispositional and situational variables might interact would be to manipulate a context, thereby encouraging the adoption of particular goals, and also to measure the individuals dispositional traits. If a particular goal-oriented context proves to be "enough" to achieve a general improvement in learning, then it would be advisable to design learning activities according to that goal orientation. However, if more learning gains are found when individuals are exposed to goal-oriented contexts that match their own orientation or tendency, then more attention needs to be focused on the simultaneous effects of both aspects: dispositional and situational.

4 Conclusions

The main goal in ITSs is to design systems that individualise the educational experience of students according to their level of knowledge and skill. Recent research suggests that their emotional state should also be considered when deciding the strategy to follow after an action has been taken.

This paper has focused on the importance of students' goal orientation. Achievement goal theory argues that different patterns of achievement behaviour become evident depending on the type of motivational orientation a learner adopts. However, we argue that further empirical investigation is needed, particularly as results from classroom-based studies question the way in which learning goal orientations, and their impact, are currently understood.

References

Ames, C. A. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology*, *84*, 261–271.

Barron, K. E., & Harackiewicz, J. M. (2001). Achievement goals and optimal motivation: testing multiple goal models. *Journal of Personality and Social Psychology*, *80*, 706–722.

Butler, R. (1987). Task-involving and ego-involving properties of evaluation: Effects of different feedback conditions on motivational perceptions, interest, and performance. *Journal of Educational Psychology*, *79*(4), 474–482.

Covington, M. V., & Omelich, C. L. (1984). Task-oriented versus competitive learning structures: motivational and performance consequences. *Journal of Educational Psychology*, *78*(6), 1038–1050.

Deci, E. L., Betley, G., Kahle, J., Abrams, L., & Porac, J. (1981). When trying to win: competition and intrinsic motivation. *Personality and social psychology*, *7*(1), 79–83.

Dweck, C. S. (2000). *Self-theories. Their role in motivation, personality, and development.* Psychology Press, Taylor and Francis Group.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychology Review*, *95*(2), 256–273.

Elliot, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology*, *54*, 5–12.

Harackiewicz, J. M., & Elliot, A. J. (1998). The joint effects of target and purpose goals on intrinsic motivation: A mediational analysis. *Personality and Social Psychology Bulletin*, *24*(7), 675–688.

Meece, J. L., & Holt, K. (1993). A pattern analysis of students' achievement goals. *Journal of Educational Psychology*, *85*(4), 582–590.

Midgley, C., Maehr, M., Hruda, L., & Anderman, E. (2000). *Manual for the Patterns of Adaptive Learning Scales (PALS).* Ann Arbor, MI: University of Michigan.

Valle, A., Canabach, R. G., Nunez, J. C., Pienda, J., Rodriguez, S., & Pineiro, I. (2003). Multiple goals, motivation and academic learning. *British Journal of Educational Psychology*, *73*, 71–87.

Could help-seeking behaviour be improved? Reporting the effect of motivational facilities in a learning environment: a pilot study

Genaro REBOLLEDO-MENDEZ
IDEAS Lab, Dept. of Informatics, University of Sussex
Brighton, BN1 9QH, UK
G.Rebolledo-Mendez@sussex.ac.uk

Abstract. An exploration of the use of motivational facilities in an intelligent tutoring system is presented. The M-Ecolab is a Vygotskyan system that provides a test-bed for incorporating an explicit more-able partner capable of providing affective feedback. A pilot study of the effects of the M-Ecolab in learning was carried out in a real-class situation. The results of this study showed that less motivated learners tended to have greater learning gains group. Further data analysis suggests that less motivated students tended to look more effectively both for the quantity and quality of help that they needed, resulting in more fruitful interactions.

1. Introduction

Effective educational settings often involve the complementary factors of the learner's cognition and affect. What is needed for the design of systems are models and theories that integrate the various cognitive and affective components [1]. Research in cognitive science has provided the means to understand better the learning process [2], and shown that meta-cognition is a crucial aspect of learning [3]. One of the meta-cognitive strategies that seems to have a great impact in learning is help-seeking [4]. This paper addresses the issue of help-seeking and its interaction with the student's state of motivation. In particular, our project focuses on the effects of motivational scaffolding in the M-Ecolab, a Vygotskyan learning system that, in earlier versions Ecolab and Ecolab II, has shown the effectiveness of scaffolding the learner's activities. The M-Ecolab provides a test-bed for modelling and reacting to different motivational states, allowing an investigation of the effect on help-seeking behaviour. This paper presents the results of an exploratory study that suggest that motivating strategies do indeed have an effect on help-seeking behaviour.

2. Practical and theoretical background.

Help-seeking allows the learner to manage academic problems by keeping her actively involved in the learning situation [5]. The importance of this particular learning strategy lies in the fact that it can create means to acquire skills or knowledge not only for immediate but also for future application.

To shed some light onto the influence of motivational scaffolding in help-seeking behaviour, we have developed the M-Ecolab, an extension of the Ecolab software. The rationale of the M-Ecolab was that an underpinning model of the learner's motivation could also be built by assessing her activities with the system by considering the learner's cognitive and meta-cognitive state and relating it to motivational variables [6] such as the student's effort, independence and confidence. The M-Ecolab not only assesses different degrees of motivation but also reacts accordingly by offering motivating elements that vary according to the perceived cause of de-motivation. Since the original Ecolab was based on a Vygotskyan model, we wanted to explore whether by making the more-able partner explicit through the use of on-screen characters, de-motivated learners could be engaged in a more fruitful interaction with the system. In particular we were interested in whether by scaffolding motivation, the learner could not only be made aware of her help-seeking deficiency but also advance her help-seeking behaviour. The motivational learner model was implemented so that motivating scaffolding is available during the interaction with the software via a button within the interface.

Two types of motivating facilities exist in the M-Ecolab. The first type consists of a quiz asking the learners questions related to the domain of food-chains and food-webs. The second type consists of spoken feedback given by a more-able partner, a character called Paul. Since the system maintains a motivational model of the learner, Paul is able to alter his voice tone according to the perceived state of de-motivation in order to encourage the learner: be it to put more effort, to be more independent or to become more confident. There exist two classes of spoken feedback: pre- and post-activity. Pre-activity feedback informs the learner of the objectives of that learning node whereas post-activity feedback offers motivating scaffolding making the learner reflect on her behaviour.

3. Preliminary evaluation of the M-Ecolab

An exploratory study of the effects of the M-Ecolab was conducted in a local primary school at the end of the academic year 2003-2004. We measured the students' learning with the M-Ecolab using the same pre- and post-tests as in previous Ecolab evaluations [7]. The learners' motivation was assessed with an adaptation of Harter's test [8]. The participants were members of two fifth grade classes aged between 9-10. There were 10 students in the control condition, 5 girls and 5 boys and 19 learners in the experimental condition, 9 girls and 10 boys. All the students had learnt food-chains and food-webs prior to the study. The students were asked to complete a pre-test for 15 minutes and then a five-minute motivational questionnaire. Assistance was provided to the students who requested help to read the questions. Two weeks later, the M-Ecolab was demonstrated with the use of a video-clip showing its functionality. It was at this point that the researcher answered questions regarding the use of the software. One tablet PC was provided for each learner, with the appropriate version of the software (control = Ecolab II, experimental = M-Ecolab). The students were then allowed to interact with it for 30 minutes. Immediately after the interactions, the pupils were asked to complete a post-test. Four weeks after the interaction the students were asked to complete a delayed post-test.

5. Results

In order to assess the overall learning gain in the M-Ecolab an analysis of covariance (ANCOVA) on the post- and delayed post-test data with three covariates: ability, motivation and performance on the pre-tests, indicates that the difference between the control and experimental groups is significant for both the post- and delayed post-test (post-test: $F(4,28) = 9.013$, $p<.001$; delayed post-test: $F(4,27)=4.0$, $p<.02$). In the M-Ecolab [6], independence was modelled in terms of effort and the degree of collaborative support. In order to deepen the analysis of independence, as it was the component that showed more changes, an examination of the type of collaborative-support that learners had during their interactions and its relation to independence was undertaken. Students having greater degrees of collaborative-support and showing lower effort were considered to have less independence from the tutor. As it was presented before, students in the M-Ecolab were less independent than students in the control group but they also were more successful in their pre-, post-test learning gain as revealed by a within-subjects test ($t(18) = -3.815$, $p < .01$). To throw more light on the aspect of help that accounted for the learning gains, an analysis of help-seeking was undertaking distinguishing quantity from quality of help and trying to understand the nature of collaborative support requested by the students:

- Participants having an above-average quantity of help, whether provided by the software or requested by the student, were catalogued as having "lots" of help, otherwise as having "little" help.
- The Ecolab provides help at four levels: The higher the level, the greater the control taken by the system and the less scope there is for the pupil to fail [9]. The mean level of help was calculated for all the participants, if learners requested an average level of help greater than the group's mean then they were considered to have "deep" help, or "shallow" otherwise.

The results of a within-subjects tests indicated that students in the M-Ecolab condition who had little help increased their learning from the pre- to the post-test ($t(9)=-3.381, p<.01$). Moreover, participants requesting for "deep" help in the M-Ecolab condition accounted for a greater learning gain ($t(8)=-4.239, p<.01$) than those in the control group. In this evaluation, it seems that quality rather than quantity of help accounts for a greater impact in learning. In order to have an insight into the role of the motivating facilities provided by the M-Ecolab a new category of collaborative-help was defined as follows: Participants having an above-average request for motivating facilities (both in the form of Paul and the quiz) were catalogued as "engaged", otherwise they were considered "disengaged".

A paired-samples test was used to see whether students being engaged or disengaged improved their learning from the pre- to the post-test, the results indicated that engaged students accounted for a greater learning ($t(8) = -4.807$, $p < .01$) but not the disengaged students. Following these results, it was interesting to find out which combination of cognitive and affective collaborative support was found to be a characteristic of the pupils who learned the most. A further analysis on the data showed that:

- 45% of the pupils who achieved above-average learning gains were engaged students and requested above-average qualities of help ("deep" help). The majority of these learners also happened to be using higher quantities of help. To give account of the rest of students, we discovered that a further 34% of the students achieving above-average learning gains did not use any of the system's motivating or help facilities. In contrast:
- 11% of the students who did not achieve above-average learning gains were engaged students who in combination requested higher quantities and qualities of help, which suggest that the majority of students with below-average learning gains did not make use of the combination of motivational facilities with higher quantities and qualities of help.

6. Conclusions

This exploratory study has presented evidence that motivating facilities can improve help-seeking behaviour in the M-Ecolab. An analysis of motivation and motivational change suggests that low-motivated learners in the experimental group seemed to have more learning gains than those in the control group. An analysis of the motivational components that make-up the underpinning motivational model suggested that the main difference between the two conditions was independence. In the M-Ecolab, the motivational model assesses independence in terms of effort and the model's belief about the collaborative support needed. The rationale is that a more developed ZPD [10] implies more independent behaviour on the part of the learner. The lack of independence prompts the M-Ecolab to provide feedback aimed at creating awareness about help-seeking and we could argue that learners, particularly those who are de-motivated, might improve their help-seeking behaviour. A further analysis of the help-seeking behaviour showed that, in correspondence with previous evaluations, it was the learners who asked for a deeper quality of help rather than more help the ones who achieved better learning outcomes. A new collaboration profile has been defined focusing on the quantity of motivating facilities asked for by the learner during the interaction. The evidence suggests that within the experimental condition, learners making more use of the motivating facilities were also those requesting higher quality of help. The findings of earlier Ecolab evaluations [7] highlighted the importance of providing the learner with challenging activities but also of offering help at the meta-level, so making the learners more aware of their help-seeking needs, which is consistent with the process of teaching within the ZPD [10]. This is also valid in the M-Ecolab but now it also seems that by providing an explicit more-able partner learners, particularly those seeking the more-able partner's assistance, seemed to engage in more fruitful interactions as evidenced by the fact that the learning gains were higher for the students using the M-Ecolab. It also seems that the factor prompting the learners to ask for the help they need is the presence of the motivating facilities, as it was engaged students the ones who improved their learning most.

References

[1] Pintrich, P.R. and T. Garcia, *Student goal orientation and self-regulation in the college classroom*. Advances in Motivation and Achievement, 1991. **7**: p. 371-402.

[2] Lajoie, S.P. and S.J. Derry, *Computers as cognitive tools*. 1993, Hillsdale, NJ: Lawrence Erlbaum Associates.

[3] Flavell, J.H., *Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry*. American Psychologist, 1979. **34**: p. 906-911.

[4] Nelson-Le Gall, S., *Help-seeking: An understudied problem solving skill in children*. Developmental Review, 1981. **1**: p. 224-246.

[5] Nelson-Le Gall, S. and L. Resnich, *Help seeking, achievement motivation and the social practice of intelligence in school*, in *Strategic help-seeking. Implications for learning and teaching*, S.A. Karabenick, Editor. 1998, Lawrence Erlbaum Associates, Inc.: London.

[6] Rebolledo, G. *Motivational Modelling in a Vygotskyan ITS*. in *Artificial Intelligence in Education*. 2003. Sydney, Australia: IOS Press.

[7] Luckin, R. and L. Hammerton, *Getting to know me: helping learners understand their own learning needs through Metacognitive scaffolding*, in *Proceedings of the sixth Conference on Intelligent Tutoring Systems*. 2002, Berlin : Springer: Biarritz, France.

[8] Harter, S., *A new self report scale of intrinsic versus extrinsic orientation in the classroom: motivational and informational components*. Developmental Psychology, 1981. **17**(3): p. 300-312.

[9] Wood, D.J. and H.A. Wood, *An experimental evaluation of four face to face teaching strategies*. International Journal of Behavioural Development, 1978. **1**: p. 131-147.

[10] Vygotsky, L.S., *Mind in society : The development of higher psychological processes*. 1978, Cambridge, MA: Harvard University Press.

[11] Tobias, S. and H.T. Everson, *Knowing what you know and what you don´t: further research on metacognitive knowledge monitoring*. 2002, College Entrance Examination Board: New York. p. 25.

Zombie Division: Intrinsic Integration in Digital Learning Games

M.P. Jacob Habgood – mph@cs.nott.ac.uk
The Learning Sciences Research Institute
The University of Nottingham

The past twenty-five years has produced a substantial body of psychological, educational and development literature highlighting the educational potential of digital games (e.g. Gee, 2003; Kafai, 2001; Loftus & Loftus, 1983; Malone & Lepper, 1987; Prensky, 2001; Reiber & Matzko, 2001). However, this enthusiasm is tempered by the recognition that the majority of commercial 'edutainment' products have been wholly unsuccessful in harnessing this potential to effective educational use (e.g. Kirriemuir & McFarlane, 2004; Trushell, Burrell, & Maitland, 2001). Whilst budget and market considerations have obviously contributed towards this gulf, theoretical contrasts are evident and their identification is both commercially and theoretically important. One of the earliest and most frequently cited explanations offered for the contrast between effective and ineffective educational games is that of intrinsic and extrinsic fantasy (Malone, 1980). This work used computer games as a platform for studying intrinsic motivation, highlighting fantasy as a key element of its motivational taxonomy of games. Malone (1987) defines an intrinsic fantasy, as one in which there is an integral and continuing relationship between the fantasy context and the instructional content being presented. Nonetheless, this is a concept that appears to have a confused standing within the literature. Whilst many works, such as Reiber (1996) and Dempsey (Dempsey, Lucassen, Gilley, & Rasmissen, 1993) cite the concept of intrinsic fantasy without reanalysis, others including Kafai (1996), Fabricatore (2000) and Prensky (2001) offer their own reinterpretations. Some works, such as Loftus & Loftus (1983), Driskel and Dwyer (1984), Parker & Lepper (1992) and Kirriemuir & McFarlane (2004) cite Malone's work in other respects, but do not address this fundamental aspect of his theory. Despite the apparent contention, the literature has not produced a critique of intrinsic fantasy. However, our own work has examined its theoretical and empirical foundations and concluded that it cannot be justified as a critical means of improving the educational effectiveness of digital games. Instead the roles of flow, representations and game mechanics have been highlighted as factors more likely to create effective integration of learning content within digital games.

Flow, core mechanics and representations

Research on optimal experience and flow was a central reference in the justification of challenges as part of the motivational taxonomy for computer games (Malone, 1981). Flow theory proposes that clear goals, achievable challenges and accurate feedback are required to achieve a state of flow in an activity (Csikszentmihalyi, 1988, p. 34). Feelings of total concentration, distorted sense of time, and extension of self are experiences that are as common to game players as Csikszentmihalyi's rock climbers and these seem to be at the root of the engagement power of digital games. Furthermore, these seem to be the very kind of experiences that are missing in the majority of edutainment products and could be a major factor in the distinction between extrinsic and intrinsic learning in digital games.

Whilst most game players would identify with flow experiences, it is unlikely that they would agree on which games provide them with the greatest sense of flow. Digitally induced flow experiences are now offered in the form of immersive adventure stories, strategic war games, physical dancing games, intense sports games and gory shooting games, to list but a few. The range of game genres provides a good example of why the emphasis on fantasy within games can be so misleading. Consider these three games all based around the same fantasy of being an army commander in a medieval battle: the first gives you first-person control of your commander, furiously fighting your way through the throngs of enemy soldiers; the second gives you strategic control of the battlefield, determining when your troops should advance and who they should attack; the third puts you in charge of training your army, making allies and managing the resources for the whole campaign. All of these examples could employ fantasies with the same storyline, the same characters and even the same imagery, but represent a spectrum of game genres that appeal to completely different audiences. The differences between game genres are not directly attributable to the fantasy of a game but the "mechanism through which players make meaningful choices and arrive at a meaningful play experience" (Salen & Zimmerman, 2004, p. 317) – commonly referred to by game developers as the core mechanics. Core mechanics are the procedural mechanisms of a game that provide the essential interactions required to create a meaningful gaming activity. So the core mechanic of Breakout is in controlling the horizontal position of one object in order to intercept another moving object and keep it bouncing around a confined space. Whether the game uses the fantasy context of a bat and ball or (as in a later interpretation of the game) a space ship and energy bolt, it makes no difference to the fundamental gaming activity – or the flow experience that it creates.

Malone observed that, "Endogenous fantasies can also provide useful metaphors for learning new skills […] , and they can provide examples of real-world contexts in which the new skills could be used" (Malone & Lepper, 1987). There is a long tradition of research exploring how information should be represented to best support learning. One point of contact with digital games is in research concerning representations that make key features of the domain explicit, particularly through use of visual features. Another is research that explores how including dynamic or interactive features can enhance learners' understanding. Visual representations can also enhance learners' metacognitive strategies encouraging them to make more productive use of materials and to learn complex topics more completely (Ainsworth & Loizou, 2003). Through employing visual representations in environments such as Microworlds and Simulations (de Jong & van Joolingen, 1998; Papert, 1980) learners can be encouraged to participate in interactive exploration of learning content (Miller, Lehman, & Koedinger, 1999; Papert & Talcott, 1997) and the links between these approaches and those employed by digital games are evident (Reiber, 1996). Whilst visual representations are often employed to aide understanding in edutainment software it is rarely possible for the learner to interact with them in an active way. All this research seems to suggest that educational games would be more effective if they have intrinsic learning content, which is represented within the structure and interactions of the gaming world, and provides an engaging metaphor for understanding and exploring the learning content.

Guidelines for achieving intrinsic integration in digital learning games

Based on my own theoretical analysis, the following design guidelines are suggested for more intrinsic integration of learning content in digital games:

1. Deliver learning material through the parts of the game that are the most fun to play, riding on the back of the flow experience produced by the game, and not interrupting or diminishing its impact.

2. Embody the learning material within the structure of the gaming world and the player's interactions with it, providing an external representation of the learning content that is explored through the core mechanics of the gameplay.

However, whilst this may seem to represent a better definition of intrinsic integration than intrinsic fantasy, there is still no evidence to suggest that such an approach would produce more effective learning. In fact, this definition actually makes it easier to see how a more integrated approach might produce less effective learning, as an intense state of flow is likely to inhibit the reflection required for metacognition and the acquisition of declarative knowledge. This may raise further questions about the type of learning material appropriate for intrinsic games and whether their true potential is in the proceduralisation of knowledge rather than its initial acquisition. These are just some of the issues that need to be empirically investigated before any useful conclusions can be drawn from the concept of intrinsic integration.

Zombie Division: An experimental evaluation of intrinsic integration.

The next stage of our research is to design an empirical study to investigate the relative effectiveness of intrinsic and extrinsic approaches in creating educational games. The Zombie Division concept integrates mathematical division strategies into the combat mechanic of a mathematics game for primary school children. This is a third person action adventure game in which the player must defeat skeletal enemies in hand-to-hand combat in order to progress. Enemies take the form of long deceased athletes from the time of Ancient Greece, who have risen from the dead to prevent the hero from completing his quest. As a result each enemy has a competitor number on their chest, which provides the key to defeating them in combat. Different attacks divide skeletons by different numbers and skeletons are only defeated if the attack will exactly divide their number without a remainder. Defeated skeletons break into smaller skeletons with appropriate numbers on their chests in order to reinforce this external representation of division.

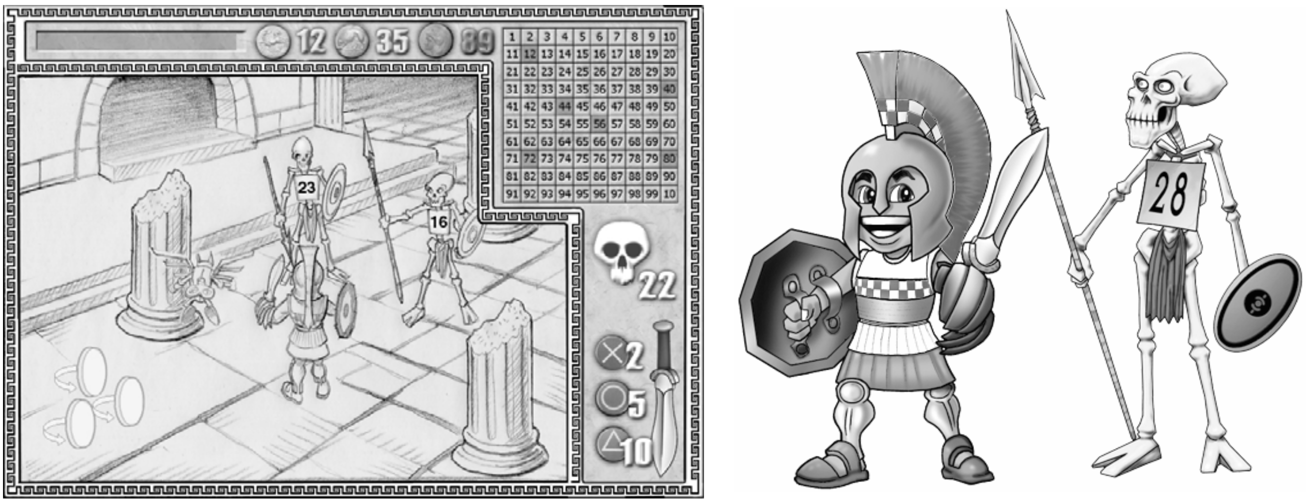


Figure 1: The Zombie Division Concept

The learning content will be augmented by a number grid highlighting the patterns and relationships between weapons and the defeated skeletons. There will also be mathematical relationships between the different attacks so, for example, chopping a skeleton once with a sword divides by 2, twice divides by 4 and three times divides by 8. All this should ensure that learning material is embedded within the structure of the gaming world and the player's interactions with it, providing an external representation of the learning content that is explored through the core mechanic [1]. Choosing an action adventure format with a strong emphasis on combat should ensure that it is a game that creates a flow experience for the target audience through exactly the same core mechanic that is delivering the learning material [2].

An extrinsic version of the same game would be produced for the purposes of the comparative study. Many considerations need to be made to ensure that it is truly comparable, and there are too many to go into here. However, broadly speaking this would be identical in all respects to the intrinsic version except that the numbers on the skeletons and their relationship to combat would be removed. In it's place the player would be drilled on the same mathematical content at the end of each level.

The first planned study using this software will compare learning outcomes given a fixed amount of time in the classroom. Process measures will be taken in addition to (pre and) post tests to compare the difference between transferable learning outcomes and learning outcomes in the gaming context. A later study is also planned to look at free use of the different versions without artificial time constraints.

References

Ainsworth, S., & Loizou, A. T. (2003). The effects of self-explaining when learning with text or diagrams. *Cognitive Science, 27*, 669-681.

Csikszentmihalyi, M. (1988). The Flow Experience and Human Psychology. In M. Csikszentmihalyi & I. S. Csikszentmihalyi (Eds.), *Optimal Experience* (pp. 15-35). Cambridge, UK: Cambridge University Press.

de Jong, T., & van Joolingen, W. R. (1998). Scientific Discovery Learning with Computer Simulations of Conceptual Domains. *Review of Educational Research, 68*(2), 179-201.

Dempsey, J., Lucassen, B., Gilley, W., & Rasmissen, K. (1993). Since Malone's Theory of Intrinsically Motivating Instruction: What's the Score in the Gaming Literature? *Journal of Educational Technology Systems, 22*(2), 173-183.

Driskell, J. E., & Dwyer, D. J. (1984). Microcomputer Videogame Based Training. *Educational Technology, 24*(2), 11-17.

Fabricatore, C. (2000). Learning and Videogames: An unexploited synergy. *the International Conference of the Association for Educational Communications and Technology*.

Gee, J. P. (2003). *What Video Games Have to Teach Us About Learning and Literacy*. New York: Palgrave Macmillan.

Kafai, Y. B. (1996). Learning Design by Making Games. In Y. B. Kafai & M. Resnick (Eds.), *Constructionism in Practice. Designing, Thinking, and Learning in a Digital World* (pp. 71-96). Mahwah, NJ: Lawrence Erlbaum Associates.

Kafai, Y. B. (2001). *The Educational Potential of Electronic Games: From Games-To-Teach to Games-To-Learn*. Retrieved 1st January, 2004, from http://culturalpolicy.uchicago.edu/conf2001/papers/kafai.html

Kirriemuir, J., & McFarlane, A. (2004). *Literature Review in Games and Learning*. Bristol: NESTA Futurelab.

Loftus, G. R., & Loftus, E. F. (1983). *Mind at Play. The Psychology of Video Games*. New York: Basic Books.

Malone, T. W. (1980, September 19). *What Makes Things Fun to Learn? Heuristics for Designing Instructional Computer Games.* Paper presented at the Association for Computing Machinery Symposium on Small and Personal Computer Systems, Pal Alto, California.

Malone, T. W. (1981). Toward a Theory of Intrinsically Motivating Instruction. *Cognitive Science, 5*(4), 333-369.

Malone, T. W., & Lepper, M. R. (1987). Making Learning Fun: A Taxonomy of Intrinsic Motivations for Learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, Learning and Instruction: III. Conative and affective process analyses* (pp. 223-253). Hilsdale, NJ: Erlbaum.

Miller, C. S., Lehman, J. F., & Koedinger, K. R. (1999). Goals and Learning in Microworlds. *Cognitive Science, 23*(3), 305-336.

Papert, S. (1980). *Mindstorms: Children, Computers and Powerful Ideas*. New York: Basic Books.

Papert, S., & Talcott, J. (1997). The Children's Machine. *Technology Review, 96*(5), 29-36.

Parker, L. E., & Lepper, M. R. (1992). Effects of Fantasy Contexts on Childrens Learning and Motivation - Making Learning More Fun. *Journal of Personality and Social Psychology, 62*(4), 625-633.

Prensky, M. (2001). *Digital Game-Based Learning*. New York: McGraw-Hill.

Reiber, L. P. (1996). Seriously Considering Play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research and Development, 44*(2), 43-58.

Reiber, L. P., & Matzko, M. J. (2001). Serious design of serious play in physics. *Educational Technology, 41*(1), 14-24.

Salen, K., & Zimmerman, E. (2004). *Rules of Play*. Cambridge, MA: The MIT Press.

Trushell, J., Burrell, C., & Maitland, A. (2001). Year 5 pupils reading an "Interactive Storybook" on CD-ROM: losing the plot? *British Journal of Educational Technology, 32*(4), 389-401.

Domain-Independent Strategies for an Affective Intelligent Tutoring System

Mohd Zaliman YUSOFF
IDEAS lab, Department of Informatics, School of Science &Technology, University of Sussex, UK
m.z.yusoff@sussex.ac.uk

Abstract: Identifying and reacting to the student's affective state in an affective Intelligent Tutoring System framework has gained researchers' attention in recent years. In general, an affective Intelligent Tutoring System (ITS) framework has two components: 1) to detect the student's affective state and 2) to react to the student's affective state by providing appropriate strategies as a means to help the student learn. Although emotional regulation theory suggests that individuals use both domain-dependent and domain-independent strategies, current ITS frameworks exploit domain-independent strategies only. In this paper we indicate how domain-independent strategies and their components can be integrated into an affective ITS framework.

Keywords: affective framework, domain-dependent, domain-independent.

1. Introduction

Identifying and reacting to the student's affective state in an Intelligent Tutoring System framework has gained researchers' attention in recent years (e.g Conati, 2002; del Soldato & du Boulay, 1995; Chaffar & Frasson, 2004; Burleson & Picard, 2004). The use of animated pedagogical agents in a tutoring system to improve student's engagement in learning (Lester et al., 1997), the development of strategies to identify the student's motivational state during the lesson (de Vicente & Pain, 1999) and the consideration of the student's emotional state in a system (Kort & Reilly, 2001) are examples of the integration of affect and ITS in an education system.

There is evidence that the student's affective state is highly correlated with the student's performance and engagement in learning. Bryan & Bryan (1996), for instance, observed that students in a positive affective state performed better in the classroom. Moreover, Isen (2000) suggests that positive affect produces a "broad, flexible cognitive organization and ability to integrate diverse material". Although Isen's work does not directly involve students, it provides strong evidence that positive emotions can enrich the quality of an individual's problem solving strategies. Positive affect appears to increase learning by engaging higher brain mechanisms that enrich and consolidate long-term memory, and enhance the learner's ability to make diverse associations (Fredrickson, 1998). In fact, the student's affective state was identified as an important domain in Bloom's learning taxonomy almost 40 years ago (Bloom et al., 1964).

A general affective ITS framework has two major components: the detection of the student's affective state phase and the reaction phase to the student's affective state (see e.g Conati, 2002; del Soldato & du Boulay, 1995). Several methods have been deployed to infer the student's affective state. Del Soldato & du Boulay (1995) and de Vicente & Pain (1999), for instance, inferred the student's affective state through the interaction between the student and the ITS. Picard (1997), on the other hand, inferred the student's affective state using special wearable and sensor devices such as cameras and microphones. In her research, Conati (2002), used a Dynamic Decision Network to model the user's affective state in an educational game. In the reaction phase, although present ITSs deploy various techniques, the emphasis is mostly on the use of domain dependent strategies to manage the student's affective state. These include, provision of feedback or solution to the student's problem, or scaffolding the student with appropriate help level to suit his or her individual learning style.

However, according to emotion regulation theory (Gross, 1999, Lazarus, 1991), an individual uses two strategies to manage his or her affective state: the emotion-focused strategies and problem-focused strategies. Emotion-focused strategies refer to thoughts or actions whose goal is to relieve the emotional impact of stress. Examples of emotion-focused strategies are avoiding thinking about trouble, denying that anything is wrong, distancing or detaching oneself as in joking about what makes one feel distressed, or attempting to relax. Problem-focused strategies, on the other hand, refer to efforts to improve the troubled person-environment relationship by changing things: for example, by seeking information about what to do, by holding back from impulsive and premature actions, and by confronting the person or persons responsible for one's difficulty. We postulate that an affective ITS framework must deploy both domain-dependent and domain-independent strategies in order to help students manage their affective states effectively.

2. Emotional Affective Framework (ESA)

The ESA framework consists of two phases: the detection of student's affective state and the reaction to the student's affection state. However, unlike other ITS frameworks, the reaction phase of the ESA framework deploys both domain-dependent and domain-independent strategies as a means to help students to manage their affective states.

The domain-independent strategies in the reaction phase involve three different stages: receiving feedback, doing relaxation activities and reading appropriate coping statements repeatedly. In the ESA framework, the student will be given affective feedback after he has been inferred to be either in a positive or in a negative affective state. The student's affective state is affected by two factors: the difficulty level of the lesson which is based on the nature of the lesson and the student's control over that lesson (Yusoff & du Boulay, 2005). Statements such as "you have done well" and "never mind, it is nothing to worry about" are examples of feedback used in ESA framework.

The second stage of the domain-independent strategies is the relaxation activities. The student who is experiencing either a positive or a negative affective state is encouraged to do various relaxation activities as a means to improve his or her affective state. Progressive relaxation and breathing techniques for specific body parts such as the head and shoulders, arms or legs are examples of the relaxation activities offered in the second stage in the ESA framework.

The improvement of the student's self-esteem through the use of coping statements can improve the student's performance in learning. For instance, coping statements are capable of helping the patient to cope with their illness (Fredrickson, 1998). Ntoumanis & Biddle (1998), in their study, concluded that there is a positive correlation between athlete's performance and the use of coping statements during competition. In another experiment, Bryan & Bryan (1991) deployed coping statements to improve disabled students' performance in learning. So, it is postulated that coping statements can be used in pursuit of improving student's self-esteem. For example, for a student in a negative affective state, who has given up on a difficult lesson task, the ESA framework will suggest that he takes a deep breath several times, and repeatedly reads coping statement such as "I won't let my sadness affect my performance".

The overall framework of the domain-independent strategies in ESA is summarised as in Figure 1.

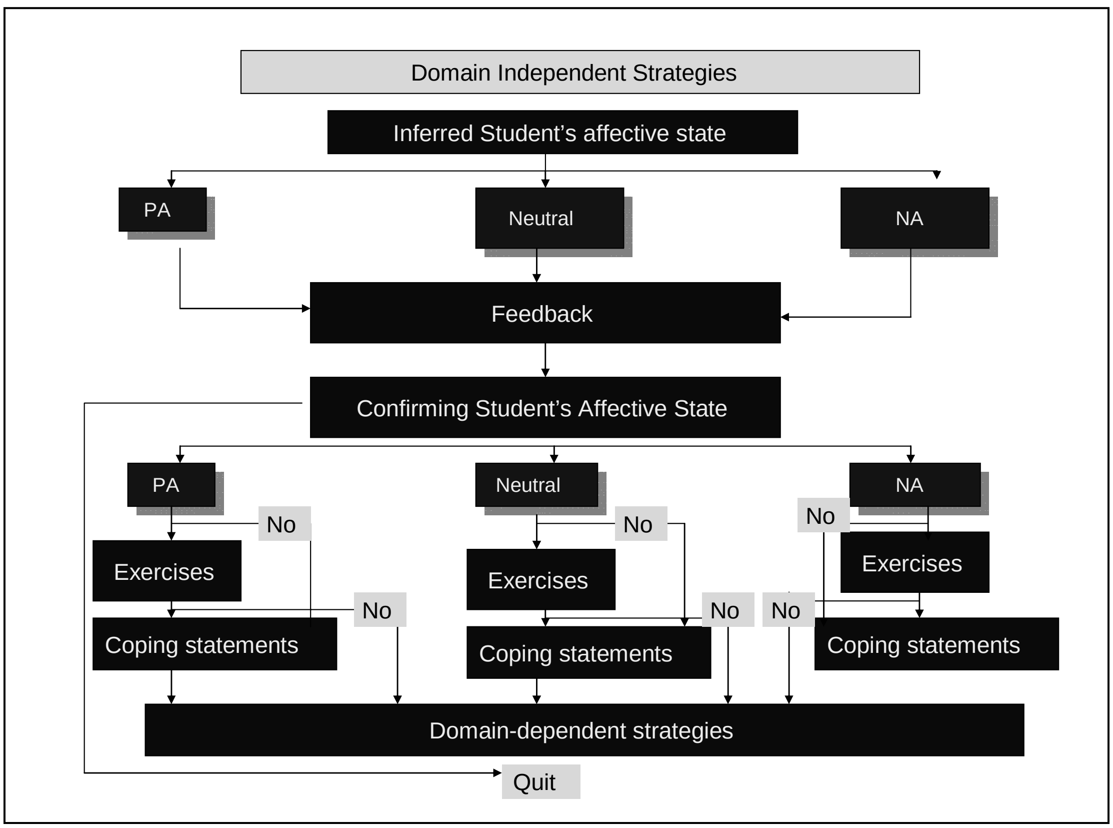


Figure 1: The domain-independent strategies in an affective framework

3. Conclusion

In the near future, a prototype system of ESA framework that combines both domain-dependent and domain-independent strategies will be implemented. Apart from implementing the prototype, research will be conducted on the efficiency of domain-independent strategies in laboratory environments. An initial study has shown that students perceived that both dependent and domain-independent strategies are seen to be equally important in order to help them manage their affective state in learning.

References

[1] Bloom, S. J, Mesia, B. B. & Krathwohl, R. D. (1964). Taxonomy of Educational Objectives (two vols: The Affective Domain & The Cognitive Domain). New York. David McKay.

[2] Burleson, W., & Picard, R. (2004). Affective Agents: Sustaining motivation to learn through failure and a state of "stuck". In Social and emotional intelligence in learning Environments workshop, 7th International Conference on Intelligent Tutoring System, 30 August – 3rd September 2004, Brazil. (pp. 29-36)

[2] Bryan, T., & Bryan, J., (1991). Positive mood and math performance. Journal of Learning Disabilities, 24, 490-494.

[3] Chaffar, S., & Frasson, C. (2004). Using an emotional intelligent agent to improve the learner's performance. In Social and emotional intelligence in learning Environments workshop, 7th International Conference on Intelligent Tutoring System, 30 August – 3rd September 2004, Brazil. (pp. 37-43)

[4] Conati, C. (2002). Probabilistic assessment of user's emotions in education games. Journal of Applied Artificial Intelligence, 16(Special Issue on managing cognition an Affect in HCI), 555-575.

[5] de Vicente, A., & Pain, H. (1999). Motivation self-report in ITS. [Proceeding of the Ninth World Conference on Artificial Intelligence in Education]S. P. Lajoie & M. Vivet (Eds.), (pp. 651-653). Amsterdam: IOS Press.

[6] del Soldato, T., & du Boulay, B. (1995). Implementation of motivational tactics in tutoring system. *Jounal of Artificial Intelligence in Education*, 4(6), 337-378.

[7] Fredrickson, B. L., & Levenson, R. W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition and Emotion, 12,* 191-220.

[8] Fredrickson, L. (1998). What good are positive emotions? *Review of General Psychology*, 2, 300-319.

[9] Gross, J. J. (1999). Emotion and emotions' regulation. In L. A. Pervin & O. P. John (Eds.), Handbook of Personality: Theory and Research (2nd Edition) (pp. 525-552). Guildford, New York.

[10] Isen, A. M. (2000). Positive affect and decision making. In M. Lewis & Haviland-Jones J. M. (Eds.), Handbook of Emotions 2nd Edition (pp. 417-435). New York: Guilford Press.

[11] Kort, B., & Reilly, R. (2001). An affective model of interplay between emotions and learning: reengineering educational pedagogy- building a learning companion . In Proceedings of International Conference on Advanced Learning Technologies (ICALT 2001), Madison, Wisconsin, August 2001.

[12] Lazarus, S. R. (1991). Emotion and Adaptation. Oxford U. Press.

[13] Lester, J. C., Converse, S. A., Stone, B. A., Kahler, S. E., & Barlow, S. (1997). Animated pedagogical agents and problem-solving effectiveness: A large-scale empirical evaluation. In Proceedings of the Eighth World Conference on AI in Education (pp. 23-30). IOS Press.

[14] Nkambou, R., & Heritier,. V. (2004). Facial expression analysis for emotion recognition in ITS. *In Social and emotional intelligence in learning Environments workshop, 7th International Conference on Intelligent Tutoring System*, 30 August – 3rd September 2004, Brazil. (pp. 84-93)

[15] Ntoumanis, N., & Biddle., J.H.S (1998). The relationship of coping and its perceived effectiveness to positive and negative affect in sport. Personality individual differences, Vol 24, No. 6 pp. 773-788

[16] Picard, R. W. (1997). Affective computing. MA: MIT

[17] Yusoff, M.Z & du Boulay,B.(2005) Integrating Domain-Independent Strategies into an Emotionally Sound Affective Framework, (to be presented) at Agents that want and like: motivational and emotional roots of cognition and action: Symposium of AISB, 12-14 April 2005, University of Hertfordshire (in press).

Can Technology Support the Development of Students' Epistemological Beliefs?

Katerina Avramides
IDEAS lab
Department of Informatics
University of Sussex
Brighton, UK
K.Avramides@sussex.ac.uk

Introduction

There is growing evidence that epistemological beliefs play an important role in student learning (Hofer, 2001). Personal epistemology has been found to influence many aspects of learning such as comprehension, persistence, and engagement (Schommer, 1994). The development of students' personal epistemology has been described in terms of multidimensional stages that correspond to progressively more sophisticated beliefs (e.g. Perry, 1970). Given the evidence of their importance in student learning, the development of epistemological beliefs has been recognised as an important goal of teaching (Laurillard, 2002). However, little research has been done to identify how the structure of learning environments actually influences their development. To what extent does engaging students in certain types of activity support their epistemological development? Moreover, given the integral part of technology in higher education, the question arises of what role technology plays and can play in supporting students' epistemological development. More specifically, I am interested in exploring how the ways of conveying information through different forms of technology influences students' conception of knowledge and learning.

Epistemological beliefs and learning

Epistemological beliefs are beliefs about the nature of knowledge and how one can come to know. There is no single theoretical framework for conceptualising epistemological beliefs (Hofer & Pintrich, 1997) and a number of different schemes have been developed for classifying them along a continuum of increasing complexity (e.g. Perry, 1970). In general terms, simple epistemological beliefs are those that define knowledge as objective and handed down by authority, whereas complex beliefs are those that view knowledge as relative and socially constructed.

Recent research indicates that students' epistemological beliefs play an important role in learning. More complex epistemological beliefs have been associated with more sophisticated thinking and problem-solving skills, higher motivation, and persistence (e.g. Schraw, 2001; Hofer & Pintrich, 1997; Schommer, 1994). Moreover, a study by Jacobson and Spiro (1995) suggests that students with simple epistemological beliefs have difficulty with hypertext systems. Thus it appears that students' epistemological beliefs will affect the way they engage in learning and utilise learning resources that in turn will influence their epistemological development. It is, therefore, important to study the impact of different learning environments.

The impact of learning environments on students' epistemological development

The progression from simple to more complex epistemological beliefs is not uniform amongst students in higher education. Each individual student will possess different beliefs on entering university and will develop in a different way from their peers. Moreover, large student populations, the short length of the majority of university courses, and the lack of resources for supporting small group face-to-face interactions between students and tutors are all factors that make supporting students' epistemological development a difficult task. Hofer & Pintrich (1997) argue that the type of tasks that students are required to engage in will affect their epistemological development. Laurillard (2002) suggests that students' epistemological development can be supported by engaging them in activities that support active, collaborative and independent learning. It appears reasonable to assume that when students are exposed to a variety of opinions, are forced to elaborate and support their own views, are given the responsibility of finding information themselves and are not allowed to rely on the lecturer to supply them with knowledge, that they will develop more complex understanding of what knowledge is. However, it is necessary to understand how such activities actually support epistemological development for different students and what factors determine their success.

There is limited research that has explored how course structure and, in particular, new technology-supported learning environments affect epistemological development. It is becoming increasingly important to study the impact of computer technology as it is now an integral part of higher education. In particular, the web is a major source of information for students and also an important form of communication for face-to-face as well as online courses. Through the web students now have easy access to a wealth of information of many different forms, such as online journals and books, online discussion forums, student essays, unpublished papers, peer discussion groups, and personal web-sites.

Existing research findings suggest that students' epistemological beliefs are influenced by the learning environments they participate in (Tolhurst, 2004; Jacobson & Spiro, 1995). Tolhurst (2004) reports on a study which investigated how changing the structure of an undergraduate course to make students more active learners would influence students' epistemological development. The results indicated that the course structure had a positive effect on students' epistemological development as measured by some scales, but also a negative or no effect as measured by others. They concluded that encouraging students in being active and independent learners can support their epistemological development, but that further research is clearly needed.

Evaluating the role of technology in learning environments

I am interested in studying the relationship between students' epistemological beliefs and computer-supported collaborative learning environments. The research questions I am interested in exploring are how students' epistemological beliefs affect their learning experience within computer-supported collaborative learning environments and how in turn such environments impact on students' epistemological development.

Although existing research has begun to investigate the relationship between technology-supported learning environments and epistemological beliefs little is yet understood about the process of epistemological development.

It is necessary to adopt a working definition of epistemological beliefs and identify appropriate measures. Perry's (1970) original framework, which was based on Harvard students in the 1950s, has been extended and modified and other frameworks have been developed to reflect epistemological development in different populations of students. Related factors also need to be taken into account, such as student goals, approaches to study, prior experience with technology, and individual differences in technology use. Moreover, an appropriate framework must be utilised for describing students' interaction with different forms of educational technology that takes into account the social context in which the interaction takes place. Part of the difficulty I am facing is relating the theory to a methodology that will take into account the social and cultural context but also appropriately defining student epistemological beliefs.

References

Hofer, B. (2001) Personal epistemology research: implications for learning and instruction. *Educational Psychology Review, 13*(4), 353-382

Hofer, B. & Pintrich, P. (1997) The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, *67*, 88-140

Jacobson, M.J. & Spiro, R.J. (1995) Hypertext learning environments, cognitive flexibility, and the transfer of complex knowledge: An empirical investigation. *Journal of Educational Computing Research, 12*, 301-333

Laurillard, D. (2002) *Rethinking university teaching: a conversational framework for the effective use of learning technologies* (2nd Edition). London: Routledge Falmer

Perry, W.G. (1970) *Forms of Intellectual and Ethical Development in the College Years: A Scheme*. NY: Holt, Rhinehart and Winston.

Schommer, M. (1994) Synthesising epistemological belief research: Tentative understandings and provocative confusions. *Educational Psychology Review*, *6*(4), 293-319

Schraw, G. (2001) Current themes and future directions on epistemological research: A commentary. *Educational Psychology Review*, *13*(4), 451-464

Tolhurst, D. (2004) The influence of web-supported independent activities and small group work on students' epistemological beliefs. *Proceedings of the sixth conference on Australian computing education, 30,* 311-316 (Dunedin, New Zealand)

Teachers need help too: aiding the marking process through a Human-Computer Collaborative approach

Craig Jones
School of Computer Science, The University of Manchester
jonesc@cs.man.ac.uk

Introduction

When looking at how computerised technology can improve the learning process it is important not to overlook the potential benefit to teachers. Assessments are used frequently in education and require substantial work on the part of the teacher. Tools can be developed to aid in both the setting and marking of assessments. Our research looks at how a Human-Computer Collaborative (HCC) approach can be used to improve the marking process.

The marking of paper-based assessments is inefficient as it involves a lot of shuffling between different student answer papers. Computer-Aided Assessment (CAA) systems can make the process more efficient by transferring assessments to an online format. While Multiple-Choice Questions (MCQs) can be marked automatically by computer, answers where the input is not constrained – be it in the form of free text, diagrams or mathematical equations – are considerably more problematic. Student answers to even the simplest of free-text questions can be enormously variable [1].

Previous approaches have tended to concentrate on creating a detailed model of the answer in advance and then leaving the computer to mark automatically based on this model. *C-rater* breaks an answer down into simple subject-verb-object concepts and concentrates on short answers [2]. Systems such as *Intelligent Essay Assessor* take a holistic approach; answers are compared to other answers through statistical methods such as Latent Semantic Analysis and assigned marks based on their similarity [3].

With these approaches human involvement is limited to the setting of the original model. This can cause problems when answers don't match the model. We are looking at a Human-Computer Collaborative (HCC) approach in which the model, or *answer judgement representation*, is grown dynamically during the marking process. A HCC approach combines the best aspects of both a human and computer marker [1]. A computer does not get bored or tired and can mark large numbers of similar answers faster and more consistently than a human. A human is better able to recognise those answers which convey the correct meaning, but in an unanticipated form. Challenges lie in determining whether an answer is similar, and then displaying this information clearly to the human user.

Developing a Marking Tool

A CAA system – Assess By Computer (ABC) [4] – has been in place at the University of Manchester for the past three years. It has been successfully used in a number of assessments including first year exams in Artificial Intelligence Fundamentals, and Java at both the third year B.Sc and M.Sc level. This provides a great wealth of "real" data with which to test possible marking aids.

A marking tool was begun as an M.Sc project [5] by a former student. Presenting answers online to the marker offers immediate benefits. All answers to the same question are presented together and there are no longer any problems trying to decipher student handwriting.

Currently the marking tool is being developed further with the addition of functions to cluster similar answers together and present them clearly to a human marker. It is hoped that marks can be assigned by cluster rather than by individual answer, with this marking information clearly displayed to a human user.

Preliminary work has focused on questions where the answer is a simple key word or key phrase. An example question is (from first year Artificial Intelligence Fundamentals): *"What are the three components of a production system?"*

The answer consists of three key phrases: *"Rule memory, World memory, Interpreter."*

A computer marking automatically on the presence of these key words would be overly harsh. A human would give credit to answers that contained a typographical or spelling error (*"Interpretor")* and to answers that contained a correct synonym (*"Inference engine"* instead of *"Interpreter"*).

Edit distance algorithms [6] can be used to allow the computer to accept words that fall within a chosen error tolerance, while a human marker can either specify acceptable synonyms in advance or add them as they are encountered during the marking process.

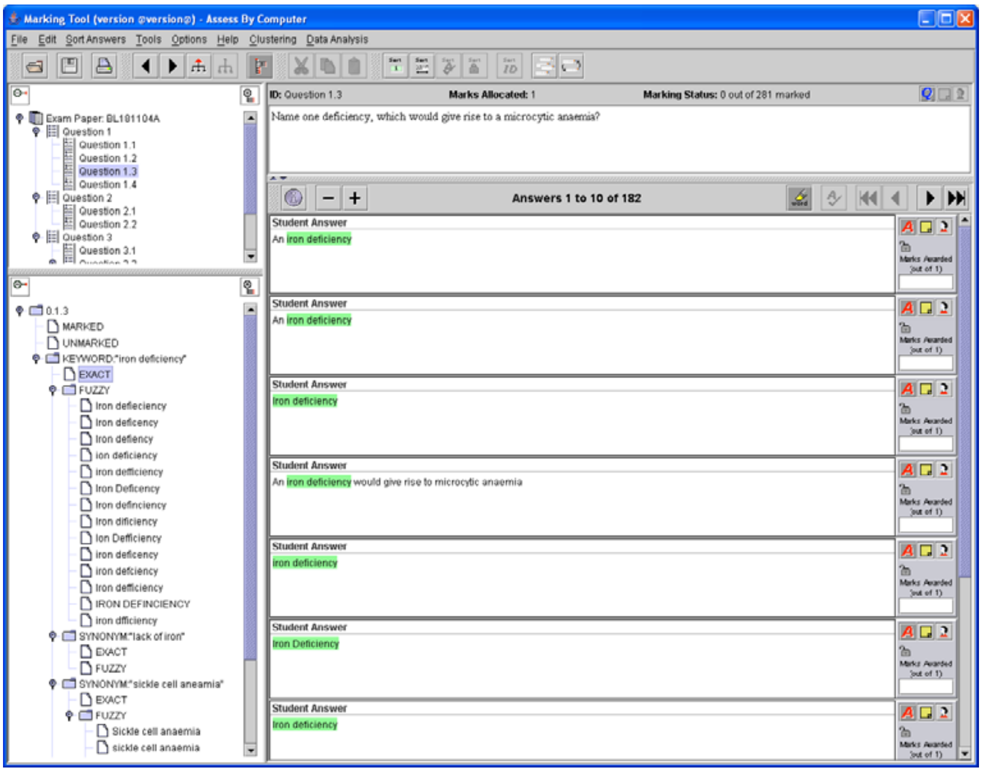


Figure 1. Screenshot of current marking tool. The bottom left panel displays a navigable tree of answer clusters representing variant spellings and synonyms to the key phrase *"iron deficiency"*. The bottom right panel displays student answers within the selected cluster (exact matches)

There is a danger that making the conditions for matching answers too lax would allow incorrect answers to be assigned a greater mark than they deserve. For example, for the question *"Name one deficiency, which would give rise to a* *microcytic anaemia?"* with the correct answer *"Iron Deficiency"*, an answer of *"Ion Deficiency"* may represent a simple typographical error or a fundamental lack of understanding.

With a HCC approach this is less of a problem as the human marker is there to handle this kind of ambiguity. The computer clusters answers based on whether they contain the key word or key phrase. These clusters contain sub-clusters representing weaker matches. By presenting this information to the user as a navigable tree as in Figure 1 a human marker can review the variants accepted by the computer and remove those answers where the match is an incorrect term with a small edit distance from the key word (for example any cluster where "*iron*" is "*ion*".)

Conclusions and further work

Increased consistency and transparency in both formative and summative assessment does improve quality of learning. A more efficient marking process frees up more time a teacher can spend with their students. Accurate fully automatic marking of free-text answers by computer is difficult if not impossible. A HCC approach is a pragmatic solution that allows the computer to automate what it can while passing the more awkward Natural Language problems to the human marker.

Further work needs to move onto other types of questions where the presence or absence of certain keywords is not enough to establish whether answers are similar. Currently the author is experimenting with vector-based approaches from the field of information retrieval to calculate similarity between answers. This will then need to be expanded further to take into account word order. Also of importance is developing ways to display these clustering decisions clearly to a human user so that they can efficiently correct any points of ambiguity.

References

[1] Sargeant, John, McGee Wood, Mary and Anderson, Stuart. (2004). *A Human-Computer Collaborative Approach to the Marking of Free Text Answers.* Proceedings of the 8th CAA Conference, Loughborough University.

[2] Leacock, C., & Chodorow, M. (2003). C-rater: Scoring of short-answer questions. *Computers and the Humanities, 37*(4), 389-405.

[3] Landauer, Thomas K et al. (2003). *Automated Scoring and Annotation of Essays with the Intelligent Essay Assessor.* Automated Essay Scoring. Edited by Shermis, Mark. D and Burstein, Jill C. Lawrence Erlbaum Associates, inc. Mahwah, NJ. ISBN 0-8058-3973-9.

[4] Sargeant, John. The ABC online exam software
http://peve02.cs.man.ac.uk/examweb/introduction.htm (last accessed 28th Feb 2005)

[5] Anderson, Stuart. (2002). *Computer-Assisted Marking of Structured Examinations.* M.Sc Dissertation, Manchester University.

[6] Levenshtein, V. I. (1966). *Binary codes capable of correcting deletions, insertions and reversals.* Cybernetics and Control Theory, 10(8), 707-710.

‘StoriesAbout… Assessment’: On-line storytelling to support collaborative reflective learning

Chris McKillop
Gray’s School of Art,
Robert Gordon University, Aberdeen, AB10 7QD
prs.mckillop@rgu.ac.uk

Abstract

By applying a Constructivist approach to on-line learning environments - where students actively engage in the learning process rather than obediently waiting for the next chunk of information to be learnt - we can go some way to advancing computerised technology’s potential for learning. Computer technology has the potential to support fundamental aspects of the learning process, such as reflection. This paper will describe an on-line learning environment, ‘StoriesAbout... Assessment’, which has a dual role: to investigate the extent to which on-line storytelling can be used as a collaborative reflective tool to enable students to reflect on, and learn from their assessment experiences; and to understand students’ experiences of the assessment process in art and design.

Introduction

Many on-line learning environments have an inbuilt passivity not conducive to a Constructivist model of learning, being merely tools to deliver information and instruction to students. A Constructivist model encourages students to actively engage with the learning process as they seek to make meaning out of their interactions. Using computers as ‘cognitive tools’ can support the cognitive processes required for learning and promote the reflective thinking required for meaningful learning to take place (Jonassen & Reeves, 1996).

The introduction of the Personal Development Planning (PDP) document has emphasised the importance of the reflective process in learning and the need to ensure students are able to reflect on their progress and plan for future development. The specific context of this research, art and design, has also seen changes which have sought to encourage independent learners who take a deep approach to learning, the importance of transferable skills and skills related to self, peer and group assessment (Davies, 1997).

This paper proposes that we should explore the potential of storytelling as a reflective tool in the education process. The act of telling a story requires us to do more than passively review an experience: we need to reflect on that experience, reconstruct it from a particular perspective and convey that to an audience in a way in which they can engage with (McDonnell, Lloyd, & Valkenburg, 2002). On-line storytelling is proposed as it enables the storytelling to be done at any place, any time. The student can read a story and take time to reflect on it before making a response in their own time.

Storytelling in Art & Design Education

The concept of the critically reflective practitioner (Schön, 1983) is significant in art and design as it is through students’ engagement with studio-based activities and critical reflection that enable them to gain the tacit knowledge they need to become successful practitioners. However, asking students to reflect on their learning is simple, but ensuring students learn from this is another matter. It is all to easy to introduce reflective processes which can lead to a surface approach to learning through students following a reflection checklist (Boud & Walker, 1998)

The nature of art and design can lead to a surface learning approach being adopted as the quality of the artefact is often focussed on rather than what the student has learnt during the process (Davies, 1997). Students need to be supported in developing the skills they need to assess concepts such as creativity rather than relying on their tutor's judgment. However, these concepts have intangible qualities which make reflection more difficult. Nevertheless, this very fact opens up possibilities for discussion and exploration of these difficult to assess, as well as define, concepts such as creativity, tacit knowledge, and aesthetics. Storytelling is and ideal process for discussing these more intangible concepts

Art and design students naturally employ storytelling techniques during their 'crits' where they present their work to their tutors and peers to discuss the nature of the work they have produced. This reflective process necessitates them going beyond the initial understanding of the artefact to explain their decision making process and how the 'user' may interact with, or interpret, the artefact. Artefacts naturally convey stories, though it is often up to the viewer to make sense of the narrative when it is not explicitly represented (Schirato & Webb, 2004). Stories are fundamental to us and we continually use them in our natural desire to understand each other (Read & Miller, 1995), and the objects we make.

'StoriesAbout... Assessment'

'StoriesAbout... Assessment' has been designed using an underlying Constructivist philosophy to support reflection where reflection is not just viewed as just a solitary pursuit but as a collaborative activity which can enhance the process (Moon, 2002).

The storytelling model used is derived from McDrury & Alterio's (2003) five stage model of storytelling in higher education: story finding, telling, expanding, processing, and story reconstructing which in turn relate to Moon's (2002) five stages of learning. Each type of story that can be told takes the student through these stages of learning by moving from a surface to a deeper approach to learning. Figure 1 shows an initial story in the top left pane with a list of response stories in the right pane grouped according to four response types: a 'viewpoint story' where students can look at the story from different viewpoints, e.g. the tutor's; a 'wonder if story' allows students to explore different possibilities in the story; a 'similar story' is where a student responds with a similar experience; a 'what learnt story' describes what students have learnt from reading the story. One 'seed' story was provided as an example story.

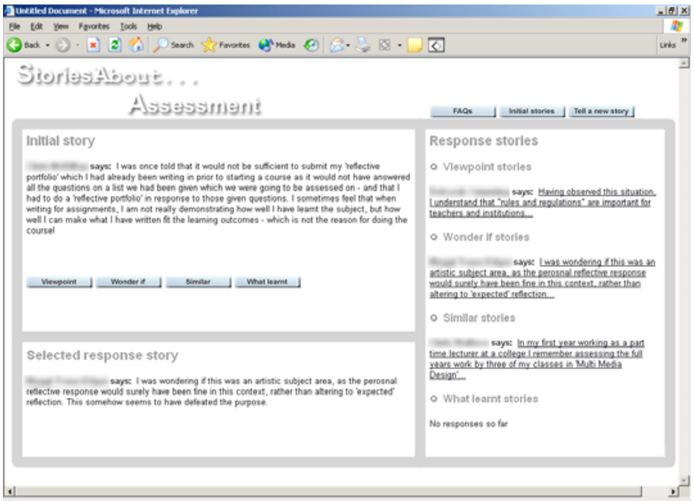


Figure 1
Main storytelling page

Pilot Study Findings

A small pilot study was conducted which used four methods to investigate the initial stage of this research: observation of students, analysis of the stories, a focus group and follow up questionnaire. The observed students were undergraduate digital design students who were taking part in a course-related lab session. They were observed on their first interactions with the system to gauge their reactions to it. The other students involved were postgraduate students.

Students' experiences of 'StoriesAbout... Assessment'

Students had no problems using the environment and felt that the interface was clear and uncluttered and did not hinder them from telling their stories. There was some reluctance to tell stories as there was only one 'seed' story and students did not want their story to be in the spotlight. Students were unsure whether their experiences were the type of stories they should tell and this uncertainty was most likely made worse due to the lack of seed stories. Students wanted stories grouped according to themes to help them focus their stories.

They were also uncertain who would see their stories, and given the personal nature of their experiences, this put off some students or made them more aware about what they were writing. Students expressed a natural curiosity about other students' stories which was a prime reason for reading them. One student even stated that they were interested in 'sensational' stories, the more sensational the better. Overall, students were happy to tell their stories on-line, but some would have preferred a face to face setting.

Students' stories

The stories that students told were largely about negative experiences of the assessment process and some were about how a previous negative experience had left lasting effects on them. Although largely negative, many of the stories showed that the students were attempting to take a deep approach to their learning, but were being hindered by factors outside their control, often the management of the course or the assessment process. The introduction of story themes may redress this emphasis on negative stories and will actively encourage positive assessment stories as well. Students stated that themes with examples would help them think about their own experiences.

Reflection

Students commented that writing their stories had made them re-evaluate the experience they had written about and reflecting on it and writing it down had served to reinforce and clarify important aspects of it. They found it helpful to read other students stories and compare them with their own experiences. Students had also spent some time thinking about their assessment experiences even if they had not told a story. This resulted in some students recounting their stories orally to the author of this paper and although they were encouraged to put these stories on-line they did not appear. This perhaps highlights the cathartic nature of telling a story (McDrury & Alterio, 2003) and once they had told their story they did not feel the need to tell it again.

Changes

The interface is being redesigned to enable stories to be grouped around themes, for example, peer assessment, feedback, assessing creativity. Each of these themes will have seed stories to help spark off stories and should address peoples' natural reluctance to tell stories (Lawrence & Thomas, 1999). A facility to upload an image to illustrate a story will also be added as students felt that this feature would be useful. Introductory sessions to the new system will be broadened to explore issues concerning reflection, assessment and storytelling to help familiarise students with the process. The main study will involve a larger number of students from a number of art schools and it is hoped that this increased collaborative discussion will provide a wider range of experiences for students to discuss and learn from.

Conclusions and future work

Rather than view computer-based learning environments as an all encompassing alternative to the teaching and learning process, we can use computers as cognitive tools to support and enhance aspects of the learning process, such as reflection. Research is demonstrating that computers can be used to support collaborative reflection (see, for example, Kim & Lee (2002). 'StoriesAbout... Assessment' enables students to reflect on their experiences of the assessment process and share them with other students.

The next stage of the research will explore in more detail what students are learning from this collaborative experience. It is hoped that through these stories we can also learn more about the student experience as well as enhancing the learning experience. The negative reaction to assessment highlighted by this study will be further investigated by, for example, analysing the language used by students to describe their experiences of assessment compared with their overall learning experience. In addition to attempting to understand students' experiences of the assessment process through the stories they tell, this research will also look at students' visual representations of their experiences of the assessment process.

Systems like this can help us exploit our natural curiosity to compare our experiences with others and provide rich material for the learning process. However, the student must actively engage in the collaborative process as the system described here is not an oracle providing the answers, it is a bard recounting stories (Masterton & Watt, 2000). The interpretation and making of meaning is up to the student.

References

Boud, D., & Walker, D. (1998). Promoting Reflection in Professional Courses: the challenge of context. *Studies in Higher Education, 23*(2), 191-205.

Davies, A. (1997). *Assessment and Transferable Skills in Art and Design. (DeLiberations)*. Retrieved March, 2005, from http://www.lgu.ac.uk/deliberations/Subjects/art_design/davies_res.html

Jonassen, D. H., & Reeves, T. C. (1996). Learning With Technology: Using Computers As Cognitive Tools. In D. H. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology* (pp. 693-719). New York: Macmillan.

Kim, D., & Lee, S. (2002). Designing Collaborative Reflection Supporting Tools in e-Project -Based Learning Environments. *Journal of Interactive Learning Research, 13*(4), 375-392.

Lawrence, D., & Thomas, J. C. (1999). *Social Dynamics of Storytelling: Implications for Story-Base Design.* Paper presented at the AAAI 1999 Fall Symposium on Narrative Intelligence, North Falmouth, Massachusetts.

Masterton, S., & Watt, S. N. K. (2000). Oracles, Bards, and Village Gossips, or, Social Roles and Meta Knowledge Management. *Journal of Information Systems Frontiers, 2*(3/4).

McDonnell, J., Lloyd, P., & Valkenburg, R. (2002). *Using video-story making to encourage a deeper reflection on learning experiences.* Paper presented at the UCL Conference on Teaching and Learning, London.

McDrury, J., & Alterio, M. (2003). *Learning through Storytelling in Higher Education: Using Reflection & Experience to Improve Learning*. London: Kogan Page.

Moon, J. A. (2002). *Reflection in Learning & Professional Development*. London: Kogan Page.

Read, S. J., & Miller, L. C. (1995). Stories are Fundamental to Meaning and Memory: For Social Creatures, Could It Be Otherwise? In R. S. Wyer Jr. (Ed.), *Knowledge and Memory: The Real Story. Advances in Social Cognition. Volume VIII*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Schirato, T., & Webb, J. (2004). *Understanding the visual*. London: Sage.

Schön, D. A. (1983). *The Reflective Practitioner: How Professionals Think in Action*. Aldershot: Ashgate Publishing Ltd.

"All My Own work" Are we Supporting or Subverting Learning in Higher Education Students Through the use of Technology?

Diane Brewster
Ideas Lab; Informatics Department
University of Sussex
Falmer BN1 9QH

Abstract. *My research is located within the theoretical domain of student learning. It seeks to extend the literature in that domain by investigating the ownership relationship of students to their digital resources. The issue of plagiarism is being examined as an interesting example of the relationship between ownership of resources and ownership of learning within higher education, where students are claiming ownership of "stuff" which is not their own and integrating it into their own work*[1].

The issue of how to support Higher Education students with technology is often framed in terms of the provision of resources. Is it really sufficient to supply rooms full of internet capable PCs and a wireless network to access "our" VLE? The specific questions addressed by this research arose from a previous study within the IDEAS Lab at Sussex University (Luckin et al., 2004). Do students perceive their ownership of digital data differently from their ownership of physical data such as books and lecture notes? What impact, if any, does this have on ownership of their own learning process and what are the implications of this for supporting student learning with technology? Additionally, has technology already changed the nature of knowledge and learning with Higher Education (HE), has the way in which students learn *changed* since the advent of technology in education? Do our current models of student learning need to be revised to take account of this?

This research has involved a number of different studies. Initial data[2] was obtained from an exploratory study with a cohort of 38 students (3rd year undergraduate and Masters students) on an Informatics course. A second study has been done on plagiarism cases during one academic year at a UK university and a final phase will involve both a lab-based study on student's perceptions of their ownership of digital resources and in depth interviews about their perceptions of the relationship between ownership of learning and ownership of their learning resources.

1. Ownership of Learning

Within the last decade the 'place' that students go to get information for assignments has undergone a radical change. When asked how far they agreed with the statement 'the web is a valuable source of information in my studies' the students in the exploratory study either simply agreed (87%) or agreed 'somewhat' (13%). These students inhabit a digital world, only 10% of them did not have a large collection of digital files (text, music, images) and more than half of

[1] With thanks to Lene Nielsen of Copenhagen Business School who first suggested this relationship to me at the HCT workshop Dec.2003

[2] Questionnaire data adapted from the 'Learning and Studying Questionnaire' developed at Edinburgh University as part of the 'Enhancing Teaching-Learning Environments in Undergraduate Courses' project (http://www.ed.ac.uk/etl/) by adding some questions with a more technological focus.

them (53%) would have preferred their course material to be available as digital files rather than hard copies. So what is the impact of this on student attitudes to their learning resources?

Thomas Mallon (2001) writes that he believes an *epistemological shift* has happened in the student world '*The web*' he writes '*makes it impossible for students to value originality or writing itself, in quite the same way. If all writing is instantly available, none of it can be worth all that much*'. (p.244) Mallon cites a pamphlet on referencing from Vasser University – *Originality and Attribution* – in which the College states that there are *not* different rules for the citing of electronic texts to physical ones, in terms of the student's responsibility to cite correctly nothing has changed '*and yet'* says Mallon, '*the pamphlet betrays an awareness that everything has changed*' (p.245) in that it states '*students have claimed before the Academic Panel that they did not consider an electronic file, because of its nature, to be property as 'personal' as a book or paper.*' (*ibid*). This view is echoed in numerous articles in journals and in conversations with other academic staff at a wide range of institutions as well as from the current study. Some students are claiming that because the text was electronic they did not believe it had to be acknowledged in the same way a *paper based* text would have to be. Have we opened Pandora's box and unleashed students who not only have diminished attention spans but who also subscribe to the creed that '[digital] information wants to be free' and so cannot even begin to buy into the academic model of the acknowledgment of ownership of ideas?

2. Stolen Words?

This current paper outlines the most recent study, an analysis of all reported student misconduct cases, in one UK university, from the academic year 2003-4, plus some undergraduate cases from the previous year, 130 cases in all. Demographic data has been logged, along with, where possible, what the plagiarism sources used by the students were (web or paper). Again, where possible, the kinds of arguments students have used in their defence have been analysed as well as those made by academic staff to either to make the case against a student, or to defend them. One key question being, what are the expectations on *both* sides about correct academic behaviour? From the point of view of the wider research the aim is to understand how students view themselves as learners. When they subvert the system, especially through plagiarism or collusion, why are they doing it? How conscious is the rule breaking? Are students taking strategic decisions about their own learning? Are they simply 'cheating' and taking shortcuts to good marks or fundamentally misunderstanding what is required of academic assignments at this level?

In the current study it was found that few of the plagiarism cases were spotted by a lecturer *recognizing* the source of unattributed text, it was generally the case that there was a *suspicion* that the text was not the student's own work and this was then confirmed simply by using a search engine. With concerns about plagiarism and academic standards hitting the world's media, and a university Vice Chancellor losing his post because of past plagiarism (Knight, 2002), is it the case that the culture we are creating is an unduly negative culture of *detection*? Should we be looking for cheats and developing and buying into expensive systems to detect them? Or, is the real need for intelligent systems that have an accurate user model of the student struggling to understand what is required of them, i.e. that the domain they are expected to master generally includes the literature of their subject area, not simply the subject area itself. Only 13% of the plagiarism cases investigated involved a full download of web-based material, while 48% of the cases involved student assignments that could be characterised as *interwoven* or *patchwork*. This was where unacknowledged pieces of text, sometimes as short as a phrase, were interwoven either with other unacknowledged text or with the student's own words. These figure are consistent with studies done at other UK institutions (Carroll, 2002). In the small number of cases (17%) where students had used paper sources alone these were usually course texts and/or recommended reading that the lecturer was very familiar with. Either these students were very poor at cheating or they are a very good example of what may be the main issue, i.e. that some students fundamentally misunderstand what is required of them at this level, which is to demonstrate mastery not only of the subject but also of its literature. Plagiarism is usually defined as follows

> **Plagiarism** is the use, without acknowledgement, of the intellectual work of other people, and the act of representing the ideas or discoveries of another as one's own in written work submitted for assessment. To copy sentences, phrases or even striking expressions without acknowledgement of the source (either by inadequate citation or failure to indicate verbatim quotations), is plagiarism; … (University of Sussex handbook for undergraduate examiners Section 12.1(b))

Ownership of the intellectual work of others must be recognised and acknowledged by students – failure to do so is considered academic misconduct. This makes the issue of ownership of resources for learning a central one in academic life (Robin, 2004), students must come to understand that ideas have to be attributed, that they *belong* to someone. In critiquing Lave and Wenger's (Lave and Wenger, 1991)concept of *situation learning* within an academic context Laurillard (2002) writes that learners have to engage '*not just with their own experience, but with knowledge derived from someone else's experience'* (p.19). There is a difference, she argues, between academic knowledge and everyday knowledge; '*The point about academic knowledge is that, being articulated, it is known through exposition, argument, interpretation. It is known through reflection on experience and represents therefore a second-order experience of the world'* (p.21). This second order experience of the world, Laurillard terms, after Vygotsky, *mediated learning*. This mediated learning, relies heavily, she argues, upon 'symbolic representation as the medium through which it is known'(p.22), teaching in this context is a *'rhetorical activity, … allowing students to acquire knowledge of someone else's way of experiencing the world'*(p.24).

3. The 'Good' student

What we are expecting of students in Higher Education then, is a mastery of their subject area, not simply a mastery of the subject, and this will generally involve the subject literature. To get a 'good' degree in the UK (a first or upper second) a student has to demonstrate that they recognise the authorship and ownership of ideas (including concepts, perspectives and theories) within their subject domain. They have to demonstrate an ability to place these ideas within a coherent and generally agreed context, showing where the owners of these ideas agree with each other and where they diverge. When Laurillard (p.220) talks about mediated learning she notes that not a lot of research has been done on how students read academic texts. Where she does refer to that work she emphasises again the difficulty students have with apprehending the structure of the text and *'for many of the ideas students have to grapple with, their only access to them is via the text'* (p.45). One of the questions this research seeks to address is; does the format in which that text is presented to students, digital rather than physical, have an impact upon their ability to adequately recognise both the authorship of others *and* the author's ownership of the *ideas* within the text? If this is the case, as has been suggested in earlier studies then how can we model this in order to develop systems that can effectively support student learning, in the HE sector?

4. Conclusion - 'It's all because of the Internet'?

It must also be remembered that plagiarism existed before the advent of electronic texts (Carter Simmons, 1999) and also occurs in situations where students do not have access to electronic texts (Angélil-Carter, 2000). Concerns within the HE community about the apparent rise in plagiarism are, however, increasingly being phrased in terms of easy access to electronic sources. A recent article in the UK HE newspaper, The Times Higher Educational Supplement, quotes the support officer from the UK's Higher Education plagiarism detection service as saying that *'It's down to things like the internet and the very different make-up of the student population that is under more pressure to perform well*' (Thomson, 2004). Raising the question again as to whether students plagiarise using electronic sources just because it is easy to do so – and they are fully aware of what they are doing, or whether they have different perceptions of ownership / authorship of digital texts.

Having explored the attitudes to students and digital resources in study one, and looked at the date arising from plagiarism cases in study two, the proposed lab-based study is designed to clarify this research question by determining whether or not students **do** attribute differently when their sources are digital (online) rather than physical (books and hard copies).

References

Angélil-Carter, S. (2000) *Stolen Language? Plagiarism in Writing,* Pearson Educational, Harlow.

Carroll, J. (2002) *A Handbook for Detering Plagiarism in Higher Education,* Oxford Centre for Staff Learning and Development, Oxford.

Carter Simmons, S. (1999) In *Perspectives on Plagiarism and Intellectual Property in a postmodern world*(Eds, Buranen, L. and Roy, A. M.) State University of New York Press, New York.

Knight, B. (2002), Vol. 2005 http://www.abc.net.au/am/stories/s604015.htm.

Laurillard, D. (2002) *Rethinking University Teaching: A conversational framework for the effective use of learning technologies,* RoutledgeFalmer, London and New York.

Lave, J. and Wenger, E. (1991) *Situated Learning: Legitimate Peripheral Participation,* Cambridge University Press, Cambridge.

Luckin, R., Brewster, D., Pearce, D., Siddons-Corby, R. and du Boulay, B. (2004) In *Learning with Mobile Devices*(Eds, Attwell, J. and Savill-Smith, C.) Learning and Skills Development Agency, London.

Mallon, T. (2001) *Stolen Words,* Harvest, New York.

Robin, R. (2004) *Scandals and Scoundrels: Seven cases that shook the Academy,* University of California Press, Berkley, LA, London.

Thomson, A. (2004) In *The Times Higher Educational Supplement*London.

Educational Technology and Issues of Power and Trust: barriers to the use of technology due to concerns over knowledge ownership, surveillance and power balance shifts

Hilary Spencer, *University College London*

Background

This paper starts from two premises: that it is necessarily a good thing to "advance the potential for communicating and learning with digital technology" (one of today's themes); and that the response of teachers to the technology is an important factor in the success of that aim. The former is taken as almost self-evident by many bodies, including presumably the current government when it poured over _50 million into its e-university (ad)venture. Personally, I don't think there's been enough research in this country to either support or refute this assumption but I have none-the-less taken it as a working hypothesis, at least for the duration of this conference!

I discussed the second premise at length in my last paper to HCT two years ago. In summary, I argued that a Higher Education Institution (HEI) has many stakeholders, including its teachers, managers, students and funding bodies, and if any of them become dissatisfied with a significant aspect of its operation, such as its increasing use of technology, all stakeholders will suffer. I further argued that the attitudes of *students* to the increasing use of technology in UK universities had attracted a fair amount of research in this country but the same did not apply – at least when I started my research three years ago – to that of their *teachers*. This was therefore the starting point for my research: to explore in depth how some university teachers in the UK are responding to the advent of advanced educational technology in their teaching practices.

The purpose of this paper is to describe the conclusions which I am currently drawing from my research. Although I concentrate primarily on my findings and conclusions, I will first briefly describe the methodology I used, to put these in context.

Methodology

My research used qualitative methods including "InterViews" (Kvale, 1996) and grounded theory (Glaser and Strauss, 1967). I chose a qualitative, rather than a quantitative, approach because the research was about feelings and it seemed inappropriate to try to measure them, analyse these measurements statistically, and draw conclusions based on this analysis. I felt that statistical surveys could only report percentages of recorded replies, leaving open the question of how well these reflected the teachers' actual feelings. Interestingly, I found that my interviewees often professed to have a particular feeling when asked about it directly then contradicted this later, when expanding on that, or another, subject. For example, one interviewee started by saying "I *love* the technology, I've no reservations at all" then went on later to describe several aspects of the technology with which he had problems. I therefore felt that a questionnaire might not uncover the complexities and contradictions inherent in people's feelings, and that a qualitative approach would be more useful.

My adoption of Kvale's approach to interviews, his view that they are not just one-sided question-and-answer sessions, followed from my own background and my experiences during my pilot study. My experience is primarily in computing, focussed on the HEI sector. I therefore felt I was unlikely to be a neutral interviewer and that my active participation in the conversations might stimulate teachers to express their views more fully. I experimented during the pilot stage, first trying simple questions and structured interviews, but soon found a relaxed exchange of views to be more fruitful.

My use of grounded theory again came out of my experiences during the pilot study. I started with a fairly clear idea of my research question ("How satisfied are university teachers with the technology they use?") and a small set of topics to talk about. However, I found that the conversations quickly extended to a much broader scope, and that some topics which I had expected to be interesting proved to be dead ends while other, more illuminating ones, emerged. I therefore adopted the approach of starting each interview with very open questions ("Just tell me a bit about how you use the technology and what you feel about it") and minimal responses from me ("Mmm?") then generally allowed conversations to progress naturally until the interviewee was beginning to run out of steam. At this point I usually introduced new topics, such as their opinion of Virtual Learning Environments (VLEs), a subject which had arisen more than once in other conversations.

To summarise, I engaged in a series of one-to-one conversations, each lasting about 90 minutes, with twenty university lecturers, exploring their responses to VLEs – both proprietary and 'home grown' – and other technology that they were using or had used in recent years. I recorded each interview, transcribed it and analysed the dialogues in a variety of ways to derive themes. For example, I looked for points where interviewees had used emphasis, raised their voices, or started talking more quickly as this often seemed to indicate a particular strength of feeling. I also looked at the metaphors people used, contradictions in what they said, and above all I searched for remarks which supported or opposed what others had said on the same topic.

Themes and issues

From this analysis, I found a number of recurring issues which I grouped together to form themes, and focussed on three which I felt might be related by 'meta-themes'. The themes were: *knowledge ownership* (including intellectual property rights and plagiarism); *control* (including perceived loss of control and status); and *privacy*, (including issues of surveillance by and over themselves). The meta-themes were *power* and *trust*. I will now describe these three themes and the meta-themes further.

Knowledge ownership cab be a problem for educationalists. There is a school of thought, including Michel Montaigne (Compayré, 1908), Roland Barthes (Barthes, 1975) and others, which holds that knowledge cannot be owned because it is different each time it is retold or reread. However, this concept does not appeal to some modern academics. David Noble, for example, argues strongly in favour of teachers fighting for the right of ownership of their works, whether or not published electronically (Noble, 2001) and Jan Newmarsh similarly speaks out against the idea that universities have the right to sell the 'courseware' written by their staff (Newmarsh, 2000). Student plagiarism has also been a contentious issue with some, like Kim Morgan, claiming it is more important to encourage students to learn than to quibble when they copy over-enthusiastically (Morgan, 2005). Many of my interviewees seemed to feel, like Noble and Newmarsh, that any scholar had ownership rights over his or her written works and that the easier access to published works provided by educational technology was causing problems. The concerns expressed by my interviewees regarding knowledge ownership could be loosely grouped as follows:

- the possibility that their work, if stored on line – for example in a VLE or on a web site – may be more readily copied and used by other academics or their managers;
- a lack of understanding about what constitutes proper use by themselves of other academics' work when they have accessed it electronically; and

- plagiarism: its apparent increase in student work as a result of the new technologies, how "it" is clearly to be defined, and how they should react to it.

My interviewees varied as to which of the above issues they were concerned about. Most said that they did not mind their work being copied by other academics provided they were given due credit and only about half said they were worried about inadvertently copying an other academic's work. However, almost every interviewee expressed disquiet about student plagiarism and all who voiced concerns about any of these issues seemed to feel that they had been significantly exacerbated by the advent of the internet and educational technology such as VLEs.

Control issues included the perception – and in some cases the fear – that:

- teachers might lose control over the method and/or the content of their teaching;
- they had no control over the nature or pace of changes that were taking place; and
- the balance of control was shifting towards, variously: the students; the university's 'management'; the technologists; and the Government's educational policy makers.

Most researchers in this area (for example: Clegg et al, 2003; Holley & Oliver, 2000; McWilliam & Taylor, 1997; and Paechter et al, 2001) appear to view this loss of power or status as a threat to teachers and to the teaching profession. This was not always the case with my interviewees. Some expressed the view that their status relative to the students was irrelevant ("I see teaching as a partnership between me and them") and some were positively exhilarated by the change ("I **love** it when they take control like that"). On the other hand, every interviewee who discussed the possibility of their managers, the technologists or an external body taking more control over their teaching methods or subject matter was horrified at the prospect. However, most of my interviewees seemed resigned to their lack of control over the nature and pace of the changes in the use of technology that were being introduced in their university.

Privacy issues certainly pre-date the internet. The ability to monitor students' or teachers' activities covertly through technology such as VLEs has been likened (Land & Bayne, 2002) to Bentham's panopticon, a "surveillance machine" designed over 200 years ago. However, although Jeremy Bentham envisaged the panopticon as a **benign** prison where prisoners could be kept under control through the **possibility** that the guards were monitoring them, whether or not they actually were doing so (Bentham, 1962), the panopticon was still a prison, and this parallel to a teacher's working environment makes for uncomfortable reading.

Few of my interviewees seemed particularly aware that their work on the VLE could be monitored – some even described the idea that it could happen as ridiculous – but Land and Bayne, among others, claim that this is an issue which **should** concern academics. When the topic arose (or, more often, was introduced by me), discussion centred around two aspects of the issue:

- the (disquieting) feeling that the privacy of both student and teacher was in danger of being compromised by the new techniques; and
- the concern that this would seriously damage the relationships between students and their teachers, on the one hand, and teachers and their managers on the other.

Only a few of the interviewees admitted to using their VLE's inbuilt student monitoring facilities, only one of these had told the students he was doing so, and none had asked for the students' permission to monitor them. However, almost all my interviewees thought that any monitoring of their own use of the VLE without their knowledge and permission would be unacceptable and that it implied (or would lead to) a breakdown in relationships in the university. Some tried to differentiate between monitoring for 'benign' purposes (which was acceptable) and malign purposes (which was not) but had difficulty in clearly differentiating between the two. In all, the interviewees' ideas seemed to be unclear but there was an element of concern underlying any thoughts they expressed on the subject.

Conclusions

Analysis of these concerns has led me to conclude that two related meta-themes – ***power*** and ***trust*** – are an underlying link between them all. Many of the interviewees talked in terms of their sense of power and how the introduction of the technology was affecting this. The 'control' issues were the most obviously related to power. When interviewees talked of losing, or abrogating, control to their students, they seemed to feel they are giving up a proportion of their power. Some said they didn't mind but others seemed to feel threatened, or that they would be less able to teach well if their power was reduced in this way. And when interviewees talked of lack of control over which technologies they used and over their choice of teaching methods, they frequently added a rider that "they" (*management* or *Government*) were "taking over" in areas where teachers had traditionally been in charge – implying, or even saying explicitly, that these groups were being empowered at the expense of the teachers.

Perhaps less obviously, when interviewees expressed concerns over privacy or copyright, they also appeared to relate these issues to a loss (to themselves) and a gain (to others) of power. Through the VLE, they felt, their managers obtained the power to 'snoop' on what they were doing, just as Foucault had made the link twenty five years earlier (Foucault, 1979) between the panopticon, privacy and power. It also gave their students the power to distort their grades by unattributed plagiarism, their colleagues the power to copy their work and infringe their intellectual property rights, and so on. That is, there seemed to be an element of power-shift underlying all these concerns.

It also seemed that many of the concerns they described had only become issues when there had been a related breakdown of trust – between teacher and student, management, government or even other teachers. While scholars trust their peers, they don't worry about infringement of their intellectual property rights; teachers who trust their pupils don't rush to catch them out in deeds of plagiarism; and if management is trusted, teachers spend little time worrying about surveillance or sinister motives underlying the introduction of new tools. The issue of trust has received some recent attention, both as regards academic behaviour (for example, Elton, 2004) and general public life (O'Neill, 2002). O'Neill and Elton both hold the restoration of trust as a precursor to improvement in public and professional behaviour but maintain that there are things to be done before trust can be rebuilt such as (Elton) improved professional development programmes and accountability requirements for teachers. The implied sequence is: better training, professional development and accountability for university teachers⇨increased trust all round⇨less discomfort with innovation such as educational technology⇨improved teaching and learning and happier teachers and students. This may be far fetched, but it is still worthy of consideration.

In fact these problems, for which the technology was apparently being blamed, can all arise without any involvement of technology. Plagiarism, surveillance and power shifts have always been possible, although the technology has certainly made them easier. What is more significant is that, when something new – and educational technology is still regarded as new by many university teachers – is introduced to a situation where there is an atmosphere of mistrust, then it will be unfairly blamed for a multitude of ills and resisted by those who are expected to welcome it.

Coping strategies and side effects

During the interviews, the conversations often moved from concerns to coping strategies. These varied with the issue and the interviewee, but all contained significant elements of technology avoidance. From the teacher who said he was not yet clear about the rules for avoiding IPR issues ("that's the main reason why I'm being so cautious in using it"), and the one who mistrusted the university's motives for introducing a institution-wide VLE ("I just won't use it – I don't trust what they are up to"), to the many who resented having no control over the changes or reduced control over teaching methods ("if they start to dictate how I teach, then I'll not use it at all"), the message came over loud and clear – mistrust was causing reluctance to use the technology. The discussions also spread to other effects on the interviewees of the concerns they had voiced. There were signs of stress ("I don't know what this is going to do to my career – it's a real worry") and of more innovation and better communication in the teaching methods of those who had little or no issue with the technology than in those of their more anxious colleagues. The latter effect was particularly marked: a great deal of creative pedagogy and a positive thirst for communication was apparent in the technophiles and relatively little of either among the 'phobes.

It would therefore appear that barriers to the use of the technology, and to better communication through the technology, are more complex than simply a lack of training, an increase in work pressure, or the similar factors frequently suggested by those trying to understand academic caution in welcoming the new tools. And, my research suggests, a lack of understanding of the effect of these issues, themes and meta-themes may be a limiting factor in the benefits that the technologies can bring to the university environment. Finally, my research concludes that where these feelings exist, they may be buried well below the surface or not recognised at all, even by those who experience them. They will therefore not be easy to eradicate.

So what can, and should, be done about it? There is no point taking the attitude that teachers "should" welcome the technology, that they "should not" have such feelings, that the tools "should" make their teaching better, and (eventually) easier and more enjoyable. Feelings are not easily controlled and cause responses which may not be logical, especially if they, and their underlying causes, are not recognised and understood. A better solution may be for technologists to take these feelings into account when designing, developing and implementing the tools. If designers understood teachers' concern about surveillance (of teachers or students) through the VLE, they could deal with the problem openly – for example, by directly clarifying how surveillance can be prevented if it is unacceptable to the monitored party. If concerns about plagiarism were properly understood, software manufacturers might spend less time promoting software to catch plagiarists and more in developing tools for better assessment of students' developing skills and understanding, regardless of whether some copying has occurred. And if the resistance to technology is seen as an inevitable result of a profession – an era – experiencing a breakdown in trust, user-centred software developers might turn their attention to the problem of how to address this issue, rather than how to design more tools through which people can exercise their mistrust.

If they don't, teachers may, at the very least, limit their use of the tools and so deprive themselves, their institutions and their students of the full benefits which these technologies are intended to impart. And at worst, we may see an accelerating exodus of academics from our universities, leaving the technology with an impossible job of trying to promote better communication and learning in a teacher-free vacuum.

References

Barthes, R. (1975). "*S/Z*', (Tr. Miller, R.). London, Jonathon Cape

Bentham, J. (1962). "Panopticon; or the Inspection-House'. *The Works of Jeremy Bentham*. J. Bowring. New York, Russel and Russel.

Clegg, S., Hudson, A. & Steel, J. (2003). "The Emperor's New Clothes: globalisation and e-learning in Higher Education", *British Journal of Sociology of Education*, **24** (1)

Compayré, G. (1908). "*Michel de Montaigne and the Education of the Judgement*". London, George Harrap

Elton, L. (2004), "Continuing Professional Development in Higher Education: Trust and Accountability". *Higher Education Digest* **49**, Digest Supplement, pp. 5-7.

Foucault, M. (1979). "*Discipline and Punish: the birth of the prison*". Harmondsworth, Penguin

Glaser, B.G. & Strauss, A.L.(1967). "*The discovery of grounded theory: Strategies for qualitative research*". Chicago, Aldine

Holley, D. & Oliver, M. (2000). "Pedagogy and the New Power Relationships", *The International Journal of Management Education*, **1** (1), 11-21

Kvale, S (1996). "*InterViews: An Introduction to Qualitative Research Interviewing".* London, Sage Publications.

Land, R. and Bayne S. (2002). "Screen or monitor? Surveillance and disciplinary power in online learning environments". In C Rust (ed.): *Improving student learning through learning technology*, Oxford, OCSLD.

McWilliam, E & Taylor, P.G. (1997). "*Teacher Im/material: Challenging the new pedagogies of instructional design*", www.aare.edu.au/97pap/mcwie526.htm

Morgan, K. (2005). "*Plagiarism: does it matter?*", http://canberrac.act.edu.au/plagiarism.htm

Newmarsh, J. (2000). "*Who owns University Web Courseware*?", http://jan.netcomp.monash.edu.au/ausweb00/paper.htm

Noble, D.F. (2001). "*Digital Diploma Mills: the automation of higher education".* New York, Monthly Review Press.

O'Neill, O. (2002), "*A Question of Trust*", http://www.bbc.co.uk/radio4/reith2002/

Paechter et al, (2001). "*Knowledge, Power and Learning*". London, Paul Chapman.

Ubiquitous Computing and Smart Homes – Distribution of Data within Domicile

Gaurav Sondhi, Andy Sloane
School of Computing and Information Technology
University of Wolverhampton, Wulfruna Street, Wolverhampton
West Midlands, WV1 1SB, UK
{G.Sondhi, A.Sloane}@wlv.ac.uk

Abstract

Ubiquitous Computing is a multidisciplinary field of research that explores computing technology as it moves beyond the desktop environment and becomes increasingly interwoven into the fabric of our lives [2]. It is this idea of interweaving technology into our daily lives, which will be looked at in this research. This paper presents the development of a generic Home Information System (HIS), which will allow us to support everyday activities in domestic settings. A typical domestic setting has a vast variety of data coming into the environment, some of which is in different formats (Digital/Analogue) and use different proprietary protocols to interact with relevant devices and applications. The aim of the prototype will be to allow for the distribution of data coming into the house to various devices. The data could incorporate Audio/Video, Telecom, Images/Photos, and user input etc.

Keywords: - Ubiquitous Computing, Smart Homes, Centralised Control, Data Distribution, Standardisation, System Integration, User Centred Technology, and Home Information System.

1. Ubiquitous Computing and Users in Smart Homes

It is widely recognised that Mark Weiser is the father of Ubiquitous Computing as he introduced the concept in 1988 [3]. Weiser has put forward some ideas as to how the future of computing should allow the users to interact more freely. The technology should allow the user to do multiple tasks simultaneously and should be a quiet and an invisible servant [4]. The prediction about the future by Weiser has to some extent been realized and extended to other domain of daily lives by system designers, however unless this technology is at a very low price, the consumer market will not be tempted into such an expense. An important factor for the future of ubiquitous computing will be the comfort with which the users and technology can co-exist.

Ubiquitous computing will allow automation of routine physical tasks, which will liberate us from all the hard work in the home and help us live more independently. This is achieved by introducing the technology in the home at three levels, which are external infrastructure, basic utilities, and domestic appliances [4]. The use of these technologies tends to change our traditional perceptions of space and time, breaking away from the limits imposed by physical limitations of the home. Smart Home systems could simply offer additional convenience in everyday activities adding to the benefits provided by the mechanical and electrical technologies. One of the many projects [4,6,7,8,10] that have been researched towards making our lives more enjoyable in the home is the Smart Home Project by the Personal Electronics Group [5]. The idea behind this project is to design and develop electronic devices to be used in home technology. They will be devices that a user could not perceive, until he would actually use them. The project included technologies like a plant watering monitor, motorised curtains, intelligent locks, controllable lights, centralized equipment control, identification of inhabitants, air quality measurements, floor sensors etc. the home of the future will need to provide an environment where so many technologies can interact with the user and with each other without causing interference to the user's natural instincts and to each other.

In doing so, it is important to construct electronic devices which are small in size, use wireless communications, have low power consumption and visually difficult to detect i.e. embedded into the fabric of the home and should not restrict the natural movement of the user within the home environment. The Smart Home project [5] points out that the control of the devices could be a PC, Laptop, or a smaller handheld device. This means that the control of these devices should be centralized. The project brings us one step closer to controlling the home technology by voice and remote controls. A truly ubiquitous technology will allow the focus to be completely shifted from the enabling technology to the application and delivered services, for example the computer system built inside a MP3 player is natural to use. However no one cares if there is Java inside it or how the TCP/IP stack is implemented [4].

One of the challenges of making technology ubiquitous in the home is the variety of proprietary protocols that different devices use to interact with the user. This multiplicity of devices is obscuring the convergence of the technologies and a multi-purpose home information and communication system is a clear alternative to the many and varied formats in operation at present. What we need is a way by which we can accommodate all these different protocols into a single system and use it to interact with all the other devices and applications in the house. The aim is not only to converge the different protocols but also the data that is coming into the house. The design guidelines for smart homes of the future have been mentioned in [9] and show a multitude of technologies required to achieve this. For smart homes to be successful the different control and communication functions need to converge in order to avoid compatibility problems.

2. The Project – Data Distribution

The use of technology in the home has grown rapidly in recent years with the introduction of television with the capability of interactive data sources from digital terrestrial and satellite systems. Technology like audio and video recording has improved, with a multiplicity of devices and formats available to home users. Different forms of information being used in the home as well as the media type that is used to access that information has been summarised in [11]. With so much diversity in the types of applications being used in the house, what we need is a centralized system capable of distributing data to these separate devices as required, this will collate and synthesise the various information sources (e.g. Photographs, Audio, television, telephone, user input, fax etc) and provide a range of user interface devices that will allow convenient and timely access to the information.

The central aim of the proposed study is to design, develop and evaluate a prototype for a generic HIS device, which will allow for the distribution of data coming into the house. This need is driven by the prospect of data in various forms (e.g. Audio/Video, Telecom, Images/Photos, user input etc) coming into the home from a combination of devices which include PC's, Notebooks, PDA's, TV's (Interactive and Normal), Projectors, VCR, DVD Players, Laser Discs, Tapes, CD, Camera's (Analogue/Digital/Camcorder/Mobile Phone), Hi-Fi, Telephones etc. These devices use a multiple interaction medium to communicate with the user. The HIS will allow users to store, process, and access information regarding the data coming into the house in a convenient manner, this will allow for the limitations in diversity that is apparent in home systems at present [11]. The need for industry-wide standards that will allow the exchange of information and commands between various interactive technologies will need to be achieved [12]. Currently there are various proprietary protocols that are being used in home technology, which makes using the technology harder for the inexperienced. However the research will be looking at one aspect of the incoming data i.e. Digital Photographs. With the advent of digital photography there seems to be endless stream of pictures that we want to share with our friends and loved ones. Digital images have allowed us to capture our emotions and build a kind of time travel machine that we can look at.

The project will initially involve carrying out a scenario-based survey regarding the concept of the data Distribution device. The questionnaire will help in measuring attitudes towards the proposed features of the HIS, and its future developments. Upon receiving feedback from the survey, the project will use a top down approach to the system. This will allow us to start with a top-level description of a system and then refine this view step by step. With each refinement, the system will be decomposed into lower-level and smaller modules. The major higher-level system requirements and functions will be identified, and will be broken down in successive steps until function-specific modules can be designed. The prototyping will help in collecting feedback from the users who have used the system. This will be an iterative process, which will allow us to implement a usable interface for the system. Novel developments are expected in the methodological approach used, the devices developed and the results of the evaluation of these interfaces will provide insight to how users cope with the technology and the ubiquitous paradigm.

The project is concerned with extending/improving the quality of life for the people in their home in the future. However, consideration will also be given to the features provided by such a system, and the user's motivation to employ those features. It is envisaged that there will be a large number of influencing factors affecting the adoption of home technology by home users. The research will help in finding the factors, which influence the performance of the user and their interaction with the interface, both positively and negatively. What will be required is technology that will create a calm and comforting environment within our homes. The research aims at answering some of the questions about the adoption of ubiquitous technology in the home by people and how this change is going to affect the social interaction between home occupants. The research will address the factors, which will affect the design of interfaces to interact with the technology, and what are the best ways in which people can interact with this ubiquitous technology. The more you can do by intuition the smarter you are and the computer should extend your subconscious [4].

The prototype will be tested in a laboratory setting, which will simulate the home environment. It will then assess the feasibility of the system under conditions that equate to everyday use. In addition to experimental collection of data, attitudes to home technology and motivation towards its use will be measured using custom survey tools and a limited-ethnographic approach. Ethnographic evaluation will be used to compose a description of a group or culture, by focusing on the more predictable patterns of thought and behaviour when using the technology. As the system is going to be used by the general public in their home, it is necessary that they test the interface. The testing of the interface by the users will help in providing feedback, which will help the development of the application. The development of interface will consist of close consideration of its various aspects including a combination of different Human Computer Interaction (HCI) evaluation techniques [13]. The project will involve a combination of methods for evaluating usability (Cognitive walkthrough, Heuristic Evaluation, Model-based, and User-based evaluation [14]) and collecting relevant data from the user. The interviews and questionnaires will allow us to collect information regarding interface styles, what influences people to use the system, HCI, and the future trends of home technology. This will provide the essentials needed for technology adoption and their affect on human living. The proposed research will concentrate on the utilisation of information systems in the home by people. A retrospective comparative study of other applications and their uses will be included to provide a picture of developments in the field of ubiquitous computing, which may help determine the influences, that affect the inclusion of home technology into the daily fabric of the home and becomes a daily routine for the people at home. It is envisaged that there will be a large number of influencing factors affecting the adoption of home technology by home users. The research will help in finding the factors, which influence the performance of the user and their interaction with the interface, both positively and negatively.

3. Conclusion and Future work

The rapid growth in ownership of home-based leisure goods including PC's, video-recorders, fitness equipment, gardening, DIY etc. suggests that people's lifestyles have become increasingly home-centred. Involving real users in the design of smart homes projects and in the evaluation process is critical to the development of new technologies. Failure to involve users can lead to products and services which are poorly matched to their requirements, and which seriously under-perform from a users perspective. In the long run this is likely to result in persistent disappointment with new technologies and financial costs arising from poor market take-up.

The future implementations of technologies for smart home systems will largely depend on the extent to which they offer improvements in the quality of life, solutions to actual household problems and reductions in cost. The technology will have to prove its benefits and not prove a burden by their installation. The use of smart home technologies offers prospects of removing some of the more mundane daily tasks of carers by facilitating new combinations of home care; medical support and remote care delivery. The problem with large scale of legacy information, which could be in different formats, needs to be overcome [11]. The legacy data needs to be brought together into the standard format. This digitisation will require time and effort, which may ultimately determine the initial take-up of HIS in the market. There needs to be more research into understanding the benefits and potential problems of using smart homes. We also need to explore issues regarding human adaptation to these technologies and need to convince general users about the technology, and its benefits, as they are sceptical about adopting any new technology. We also need to build technologies that will take into consideration the natural ageing process of human beings and the home environment.

The research will provide the link between users and the interface, spatial, and sequential aspects of actions required to fully understand the tasks. The benefits from this research work will be wide-ranging, as it has the potential to be used by many companies, which produce, are involved in home technology. It will contribute to creating a living environment in the home of the future and in realizing the ethical issues as well as answer some health and safety problems that might be faced with this type of technology. The next step of the project will be coming up with a design for the Generic HIS, which will be starting in March 2005. Once the prototype has been developed, it will go through rigorous user evaluation, which will give us feedback regarding the usability of the system and its embracing features.

4. References

1. Mark Weiser, The Open House, March 1996, Written for "Review", the web magazine of the Interactive Telecommunications Program of New York University. Appeared in March 1996, ITP Review 2.0.
2. Joseph F. McCarthy, J. R. Jenkins, David G. Hendry: The Ubiquitous Computing Resource Page, www.ucrp.org. Proceedings from UbiComp 2003.
3. http://www.ubiq.com/hypertext/weiser/UbiHome.html
4. David Gann, James Barlow, and Tim Venables, Digital Futures: Making Homes Smarter, ISBN – 1900396149, 1999.
5. http://www.ele.tut.fi/research/personalelectronics/projects/smart_home.htm
6. Michael C. Mozer, The Neural Network House: An Environment that Adapts to its Inhabitants, Proceedings of the American Association for Artificial Intelligence Spring Symposium on Intelligent Environments, 1998.
7. Venkatesh A, Kruse E, and Shih E, C-F. (2001). 'The Networked Home: An Analysis of Current Developments and Future Trends', CRITO Working Paper, 34pp. (available online at www.crito.uci.edu).
8. http://machen.mrl.nott.ac.uk/Projects/DomesticEnv/INDEX.HTM
9. Van Berlo Ad, Bob Allen, Jan Ekberg, Klaus Fellbaum, Maik Hampicke, Charles Willems: Design Guidelines on Smart Homes. A COST 219bis Guidebook. European Commission. Oct.1999
10. http://www.smart-homes.nl/engels/index.html
11. Sloane A, Harris A and Huang W (2000b) "Home information systems: the storage problem" in Sloane A and van Rijn F (Eds.) "Home Informatics and Telematics: Information, Technology and Society", Kluwer Academic publishers, Boston MA. ISBN 0-7923-7867-9.
12. Richard Harper: Inside The Smart Home, Springer, 2003, ISBN 1-85233-688-9.
13. Dix A, Finlay J, Abowd G, & Beale R. (2004). Chapter 9: Evaluation Techniques. In Human-Computer Interaction (Third ed.).
14. Nielsen, J. (1993). What is Usability? Usability Engineering (pp. 23-48).

The effect of verbalisation on collaborative software development

Sallyann Bryant, *IDEAS laboratory, University of Sussex, Falmer, BN1 9QH, UK*
s.bryant@sussex.ac.uk

Introduction

This paper looks at a number of potentially conflicting findings regarding the effect of verbalisation on performance and applies them to collaborative software development. In particular, pair programming is considered, which is a technique where two developers sit side by side at a single computer and develop software together. The three approaches considered are: Self-explanation (e.g. Chi, de Leeuw et al. (1994); The effect of verbalisation on performance speed (e.g. Ericsson and Simon (1980)); and verbal overshadowing (e.g. Schooler, Ohlsson et al. (1993)). The combined evidence from these three approaches is then applied to the practice of Pair Programming and the final section defines an experiment that might be used to further understand these issues in relation to programming in pairs.

Self-explanation

Chi considers self-explanation `a constructive inferencing activity'. In an initial study, half of the participants were asked to self-explain after each line of a biology text they read (i.e. to provide utterences that went beyond the information already provided). The more self-explanations produced, the greater the gain in understanding. Furthermore, those who self-explained performed better on trickier questions. Similarly, in physics, high explainers were shown to have a more correct and complete mental model. Therefore self-explanation is considered to assist learning and help deepen understanding. This is despite the fact that up to a quarter of the utterances articulated incorrect information - perhaps these utterances are somehow useful in helping to highlight conflicting points or detect incorrect or missing information? One might question the extent to which these findings can be applied to problem solving, however, it could be that verbalisation generally assists task performance by forcing the participant to clarify a poorly defined mental model. Cox (1999) suggests that the process of translation from one mode to another (here from diagrammatical to verbal) can help to make information explicit. This suggests a similar process to the findings of Voss and Post (1988), who suggest that a large part of problem solving involves structuring the problem. Perhaps verbalisation somehow assists in this problem restructuring.

Other studies showing related performance improvements when self-explaining include work by Pirolli and Recker (1994) which shows that acquiring cognitive skills is assisted by lots of self-generated explanation, and suggest that self-explanation helps to encourage meta-cognition. Similarly, Ainsworth and Loizou (2003) show that self explaining provides computational offload and helps improve verbal declarative knowledge.

The effect of verbalisation on performance speed

Ericsson and Polson (1988) suggest that collecting verbal protocols by encouraging participants to `think aloud' does not effect the manner in which a task is performed but only slows the process down (similar to counting). This might however be due to the fact that the tasks being performed may not have necessitated the translation of information from another form of representation to verbal, or that verbalisation is more beneficial for certain types of task (for example, when digesting information). Ericsson and Simon (1980) suggest that thinking aloud merely decreased the speed of performance due to the additional processing required to find understandable referents.

Verbal overshadowing

Schooler, Ohlsson et al. (1993) posit that creative thoughts and insights are distinct from language processing and that, as verbalisation can interfere with non-verbal tasks as varied as face recognition, the memory for colour and jam tasting trials, this might be extrapolated to all insight problems. Insight problems are defined as those which have a high probability of an impasse followed by a `eureka' moment and their solutions often involve a sudden reorganisation of information. Schooler et al. (1993) performed a series of studies to further investigate this phenomenon and assess the limits of its effect. The findings show that verbalisation significantly effects performance on insight problems and does so differently than other similar types of interruptions. It is suggested that verbalisation may cause the participant to favour working memory manipulation rather than long term memory retrieval, and that it may overshadow the critical, non-reportable processes required in order to solve insight problems. However, they also suggest that, for problems that can be solved in a more step-by-step manner, verbalisation either has no effect or may even help to highlight useful information. Work by Meissner and Memon (2002) also suggests that verbal overshadowing takes place when stimuli are 'difficult to describe', and notes that this is particularly apparent when participants are asked to verbally describe their mental model of a spatial map. Alongside knowledge on expertise, for example findings by Adelson (1984) showing expert representations to be more abstract than those of novices, one might consider that verbalisation could prove a hindrance to expert problem solving in many domains.

Verbalisation and Pair Programming

There are a number of ways in which the findings discussed above can be related to the practice of pair programming. First, a number of studies show that pair programming takes more programmer hours (but sometimes less elapsed time) to produce the same amount of work (e.g. Cockburn and Williams ,2001). This is consistent with the findings of Ericsson and Polson (1988) and Ericsson and Simon (1980) that verbalisation increases the amount of time it takes to perform a task. A more complex issue relates the findings regarding verbalisation to studies showing that pair programming improves software quality. On one hand, verbal overshadowing would seem to suggest that verbalisation would have a negative effect on software quality, but on the other, self-explanation suggests that the effect would be positive. There are a number of factors that might help to resolve this potential conflict, amongst them are the nature of the task, the type of verbalisation and the profile of the programmer performing it. It would be interesting to consider whether the same quality improvement would be found if a single programmer were to spend the same amount of time producing the final product, or whether particular types of verbalisation (e.g. suggestions or explanations) which are prevalent in expert pair programming sessions, particularly assist in programming tasks.

As verbal overshadowing has been shown to be a factor in solving insight problems and those that are not 'naturally' verbal in nature, one might suggest that verbalisation would therefore be a serious hindrance in software production. In particular, work by Petre and Blackwell (1999) shows that expert system designers prompted to verbalise found mental images of many kinds - including visual, mental machines, methods of traversing the problem space, landscapes and presences - many of which may not easily be translated into verbalisation. However, these studies also found that experienced designers performed a lot of labelling and naming, both of which may be considered verbal in nature. In the case of pair programming however, the majority of pair programming tasks assigned to a pair when following the eXtreme Programming methodology are relatively small (usually around a days worth of elapsed effort). Thus the system design tasks considered by Petre and Blackwell might well be of a different enough nature (that is, of a higher level of complexity and abstraction) to be less relevant in this area.

Adelson and Soloway (1985) showed that the expert designers began with an abstract mental model of the problem, which they incrementally refined to be more concrete. This also suggests that there may be a level of abstraction or a particular place in the software design process where verbalisation becomes appropriate and helpful. Perhaps XP supports this by recommending pair programming on a programming task, where a high proportion of the abstract, high level work may have already taken place.

However, perhaps the usefulness of verbalisation through pair programming is merely dependent on a number of inter-related factors, including the level of abstraction of the task, the mode in which the programmer envisions the problem, the type of verbalisation and the costs and benefits of translating information between modes. It is possible that the eXtreme Programming methodology creates an environment that fosters this by enforcing a maximum task size, discouraging the use of diagrammatic representations and encouraging verbal communication. It is also feasible that it may be the additional monitoring or some other facet of pair programming which assists in the production of higher quality software, either as well as or instead of verbalisation.

Proposed experiment

A study is planned comparing the quality of software and the process by which it is produced in a number of conditions. Similar tasks will be performed by experienced programmers working alone silently, prompted to self-explain, working with a non-programming partner, and working with another experienced programmer to address the following questions:

1. How do different modes of verbalisation affect software quality?
2. How do different modes of verbalisation affect the process by which software is developed?
3. Do the frequency and types of interactions produced when pairs of programmers work together under the experimental conditions suggest that these findings are relevant to commercial pair programmers already observed ‘in the wild’? This will be achieved by comparing interactions during the test with those observed in previous studies of pair programmers ‘in the wild’ (Bryant, 2004).

Each participant will be asked to complete a pre-test questionnaire exactly the same as those filled in by commercial programmers in a previous study. On completing each programming exercise, software quality will be measured in terms of the number of pre-defined automated tests the software successfully passes. Qualitative data will be collected in the form of video and audio tapes of the development session. These will then be analysed in a manner consistent with that used for the commercial programmers already studies at work. The hypotheses are:

1. That the mere process of verbalising, even to oneself, will provides some benefits in terms of software quality and process over and above working silently.
2. That there will be additional quality gains and distinguishable process differences when two programmers work collaboratively on solving a task.

It is hoped that these differences will assist in identifying a more detailed model of the effect of verbalisation and collaboration on computer programming.

Bibliography

Adelson, B. (1984). "When novices surpass experts: the difficulty of task may increase with expertise." Journal of experimental psychology: Learning, memory and cognition **10**(3): 483-495.

Adelson, B. and E. Soloway (1985). "The role of domain experience in software design." IEEE Transactions on Software Engineering **11**(11): 1351-1360.

Ainsworth, S. and A. T. Loizou (2003). "The effects of self-explaining when learning with text or diagrams." Cognitive Science **27**: 669-681.

Bryant, S. (2004). "Double trouble: Mixing quantitative and qualitative methods in the study of extreme programmers". Visual languages and human centric computing, Rome, Italy. IEEE Computer Society.

Chi, M., N. de Leeuw, et al. (1994). "Eliciting self-explanations improves understanding." Cognitive Science **18**: 439-477.

Cockburn, A. and L. Williams (2001). The costs and benefits of pair programming. Extreme programming examined. G. Succi and M. Marchesi, Addison Wesley.

Cox, R. (1999). "Representation construction, externalised cognition and individual differences." Learning and instruction **9**: 343-363.

Ericsson, K. and P. Polson (1988). A cognitive analysis of exceptional memory for restaurant orders. The nature of expertise. M. Chi, R. Glaser and M. Farr. Hillsdale, New Jersey, Lawrence Erlbaum Associates.

Ericsson, K. and H. A. Simon (1980). "Verbal reports as data." Psychological review **87**(3): 215-251.

Meissner, C. A. and A. Memon (2002). "Verbal overshadowing: A special issue exploring theoretical and applied issues." Applied Cognitive Psychology **16**: 869-872.

Petre, M. and A. Blackwell (1999). "Mental imagery in program design and visual programming." International Journal of Human-Computer Studies **51**: 7-30.

Pirolli, P. and M. Recker (1994). "Learning strategies and transfer in the domain of programming." Cognition and instruction **12**(3): 235-275.

Schooler, J. A., S. Ohlsson, et al. (1993). "Thoughts beyond words: When language overshadows insight." Journal of experimental psychology: General **122**(2): 166-183.

Voss, J. and T. Post (1988). On the solving of ill-structured problems. The nature of expertise. M. Chi, B. Glaser and M. Farr. Hillsdale, New Jersey, USA, Lawrence Erlbaum Associates**:** 261-286.

Seeing Eye-To-Eye: Supporting Transdisciplinary Learning

Greg Turner (greg@gregturner.org)
Creativity and Cognition Studios, University of Technology, Sydney

What is Interactive Art? What is Programming? For the purposes of this paper, interactive art is an art system that changes as a result of the presence of or action by the audience-participant. Viewing interactive art as an art system shows us that it is actually quite a complex field, involving various creators and audiences, not just a set of computational artefacts with an 'optimal' configuration.

We can say that programming is the articulation of statements in a programming language. Yet any reasonable definition of programming today (for example, the common one that programming is a specification of a computation) can describe all uses of a computer. This means that there is no particular ontological distinction between programming a computer and using it, so we might as well call *all* uses of a computer different forms of 'programming'. We can use differences between different levels of programming to place programming languages on a continuum between two poles, termed here 'popular programming' and 'deep programming'. 'Popular programming' ranges from simple direct manipulation, through developing spreadsheet formulae, to, at best, hacking another's JavaScript, Max or Director code. 'Deep programming' is characterised by expert usage of a general-purpose language, such as C or assembly language, in combination with an expert knowledge of computer architecture.

For the sake of simplicity, the term 'programming' will from now on be used to refer to the entire continuum between popular and deep. So, by 'ability to program', I mean 'ability to deep program'.

Why is Programming Important to Art? We have known for some time that computers allow us to think thoughts that are impossible to think with any other tool, but what is it about the tool that allows new thought? An examination of the important developments in computing history indicates following four technological strengths, which I call the four Ss: speed, slavery, synaesthesia and structure. Other significant developments (such as the Internet) exploit one or more of these.

Treated briefly here, 'Speed' refers to the computer's ability to do certain things quicker than we can. In interactive art, the goal is often to generate the response 'in real time'. 'Slavery' is descriptive of both the incredible cheapness and unquestioning obedience of computation, allowing artists and programmers to create massive and wide-ranging programmatic edifices. Such power carries with it the danger of genie-in-the-bottle or sorcerer's apprentice-style mishaps. 'Synaesthesia' is another way of describing that all a computer does is perform operations on collections of 1s and 0s, which means it is possible, for example, to combine media and convert between them. Synaesthesia is itself strongly exploited in interactive art, probably as a consequence of this quality. 'Structure', that mysterious descriptive power of computing, is the hardest quality to nail down, perhaps because it has no direct analogue in the physical world. Abstracting situations into structures is the current distinctive speciality of programmers and systems analysts, and may be an important reason why artists employ them. Understanding the potential of abstract structure is the key to fully engaging with the computing medium.

Expressivity support. An important issue at stake is language expressivity (expressivity presumably being valued in tools for artists). Broadly speaking, popular programming languages allow us to make "big brush strokes", and achieve impressive things with not much effort, but at the expense of flexibility. Less limited are deeper programming languages, but it is difficult to construct large systems from small articulations. A truly expressive language would allow both large and small granularity, both obvious gestures and subtle nuances. One way of achieving expressivity is to have the entire computer system built around a single, universal, concept that can be used at both microscopic and macroscopic levels of systems, and everywhere in between, a bit like glass lenses in microscopes and telescopes. Any single Turing-complete system would do for such a concept, but of particular power is Squeak

Smalltalk [4], because it is written in itself (beyond fundamental logic and some hardware calls), which means that the language and environment itself can be modified.

Creativity support. There is a need for an interactive art programming environment to support the creativity, as well as the expressivity, of its users. Earlier work [7] reviewed the work of creativity support researchers, in particular the generalised operations which they had identified as being useful for creative workers, and how existing computer applications address those needs. For example, in a COSTART (Computer SupporT for ARTists, a large research programme instituted by Creativity and Cognition Studios) study, empirical evidence was used to identify some examples of aspects of creative exploration: Breaking with convention, immersion in the activity, holistic view and parallel channels of exploration [2].

Methodological support. It is unclear whether and how methodologies for making interactive art differ from conventional software development methodologies, not least because not much is known about the practical realities of either of these. As Kautz et al. relate, “The literature on [Information Systems development methodologies] is extensive and wide-ranging. It consists however largely of prescriptive and normative textbooks and work that is based on anecdotes, but there is limited scientifically collected and analyzed empirical documentation…” [5].

The supportive role of the programmer.

The preceding material leads one to ask: how good are programmers at living up to the need for them? Specifically, which facets of the programmer’s role are supportive to the artist, and which are obstructive? How can technology enhance the support and ameliorate the obstruction? To answer these questions, I carried out a social study on the role of the programmer in art collaborations. An approach based upon grounded theory was adopted for this study. Grounded Theory [3, 6] is an approach where the theory emerges from the data itself, and is thus grounded in it, rather than being an approach which tests existing theories. The theory’s emergence from the data is good for discovery of the important issues in a field, because biases or preconceptions held by the researcher should have minimal impact.

The preliminary source for open coding was the collected Case Reports for the COSTART project, which centred round seven intensive artist-technologist collaborations. Artist, technologist and observer statements, from recordings, interviews and diaries, for seven projects, were coded by hand, and arranged to produce a list of categories. More codes were then taken from other primary data – transcripts of interviews with artists and technologists from the larger and more meticulous COSTART 2 project [1], which involved nine further residencies, bringing the total to 16 artists, 6 technologists and 4 observers. These were coded using NVivo software.

It was decided that an appropriate way to gather some of the data needed to saturate some of the categories that had emerged was to conduct qualitative interviews with artists and programmers who had been involved in collaborations. In order to distinguish the feelings and actions of people in the artist role from the feelings and actions of people in the programmer role, and to explore the issues facing non-programmers, six subjects were selected—two interactive artists who do not program, and four programmers who program for such artists. The interviews were semi-structured and qualitative, based upon the concepts that were popular, but as yet unsaturated. After the several iterations of selective coding and data gathering, a hierarchy of about 200 codes and categories of codes emerged, with associated memos describing the relationships between codes according to grounded theory analysis.

The memos from the study were collected to form the theory, highlights of which follow:

Findings

Approach to problem-solving. In all cases where it was mentioned, artists initially presented, or were characterised as initially presenting, very imprecise descriptions of the systems they envisaged. The form of these high-level descriptions ranged from using ‘vague language’ through describing it ‘in terms of effect’ to communicating a ‘metaphorical understanding’. There was some evidence of dismay at this approach amongst programmers who wanted more specificity, logic and sequentiality. However, this metaphorical communication is the first stage of the attuning process.

What then appears to immediately take place is a process of transforming this high-level conceptual description directly into low-level terms. This was mainly achieved by question asking on the part of the programmer – about critical detail, what-if scenarios, and so on. We can speculate, with two data points, that this is a comfort-bringing process of changing the problem domain from an open world into a hermetic system.

The low-level result is often a perception of what technology will be used, or what potential technology needs to be researched, first in terms of hardware, then programming environment, then fundamental algorithms (a reversal of this process was found in one collaboration where the piece was characterised as 'an engine' around which input and output could be added). This bottom-up approach seems to be because technologically the system is so dependent on these things. This causes the artist in turn to ask the technologist several questions about this low-level technology. The artist and technologist get attuned over the low-level technology.

Both artist and technologist seem to agree that 'knowing the rules' for the system allows the system to be developed. But here arises a dilemma: the programmers in the study indicated a greater level of comfort with and satisfaction from achieving set rules and goals within a design, whereas it was difficult to get these rules from the artists, and the artists indicated a need to 'play' in order to discover what the system should do. This is essentially analysis versus synthesis.

Developing subsystems. Regardless of the goals of the approach, bottom-up development was used in all of the studies. Small programs are developed by the programmer to test each of the fundamental technologies. One respondent likens the process to sketching, as a process of finding out more about the sub-problem. As another respondent puts it, "usually I want everything to talk to everything else before I start working on how decisions are made … invariably you'll make the brain wrongly if you don't have the right shaped skull for it".

Once sufficient understanding of the sub-problem has been acquired, the programmer begins to generalise and build up the sketch: "small parts of the system [are] being experimented with and you see really how they operate and you, as in the artist, or me, as in the programmer, are having to think about how these things fit into the system, then that's where the ideas of generality and structure and abstractions start to come in. It's an interesting thing."

Play and Language-Learning. Reports about the level of engagement that artist had with the system varied from being interested in everything (itself associated with desire to learn programming), to being interested only in 'front-end' facets, i.e. those aspects which would have an effect on the audience. The points at which the artist made decisions was described by one programmer as a way of adding the 'character' to the system.

An encouraging approach, in terms of the goal of creating a supportive environment, was for the programmer to build a technological 'toy' for the artist. This is useful for several reasons. Firstly, concept of a toy directly aligned with the oft-reported behaviour of artists 'playing' with systems, data, mappings and algorithms, in order to discover both the necessary rules for the system (remember the earlier concept that finding the rules would allow the problem to be solved), and exploring what one artist called 'probabilities and tendencies' within the data. Secondly, producing the toy is a way for the programmer to take himself 'out of the loop'; this means that, as one programmer put it, 'by taking myself out of the loop it makes it really clear what the dynamics of the system are as opposed to what my interpretation is'.

Thirdly, and crucially, as one artist stated, "instead of [the programmer] just doing it and you saying 'can it be more squiggly?' and him going back and changing parameters, I found I understood the language of the algorithm just by playing with the parameters and understanding what the software developer, how they had broken down this organic thing" (my emphasis, edited for repetition and anonymity). The attuned manipulation of a system's language produces meaning both technically and aesthetically.

Implications: As mentioned earlier, structure is both the most unique and most difficult-to-learn aspect of current computing environments, and this social study has indicated that the only way that programmers learn structure is a combination of instruction and use. I propose a number of things to make learning structure easier: Firstly, that having a single universal concept to base programming around will mean a simpler structure paradigm to learn and explore, as opposed to the chimeric amalgamation that today's applications, languages and operating systems impose. Secondly, that programming environments need to represent structure (in terms of concrete objects, not just abstract classes) in an appropriate, manipulable, navigable form (in other words, not as static diagrams, or pages of ASCII) Messy programming should look messy, clean programming should look clean. Thirdly, in the case of interactive art, structure proceeds bottom-up, so it would be useful to visualise ways of making low-level toys easily abstractable within the environment. Fourthly, ways of seeing programming elements already situated within a structural context would be useful, so interactive working toys within the help system for the environment would assist in discovering the use of structure (one interview respondent mentioned that the quality of the help infrastructure was a crucial element of his decision to use any given tool).

Which brings us on to the next important finding – that 'play' is crucial to the development of interactive art systems – for finding rules, developing the 'character' of the system, learning the 'language' of the system, making the toy's place within the system apparent, producing technical and aesthetic meaning simultaneously (which also assists transdisciplinary collaboration), and making the artist feel more comfortable and empowered. So making 'toys' is useful, and consequently should be easy, and therefore well visualised. One way this could happen is to automatically generate a control panel for a chunk of code as the development of that code chunk progresses, which would act as a 'toy' for that code chunk, allowing people to play with the toy and become acquainted with the behaviour of the code chunk, particularly in terms of its inputs and outputs.

These recommendations also align well with the creativity support guidelines listed earlier. Edmonds and Candy's guidelines are largely satisfied by implementing an expressive system and its technological consequences: For example, having no technological distinction between programming and using the system mean that there is no distracting code-compile-execute cycle, allowing 'immersion in the activity'; having the environment written in itself allows the 'breaking' of its own 'convention', and 'breaking of convention' is supported within a system where only fundamental limits exist; a single universal concept aids the production of 'holistic views'. Terry and Mynatt's 'near-term experimentation' and 'evaluation of actions' are also addressed with the support of toy creation.

Conclusion. The topics dealt with in this paper have important high-level implications for designers of programming support environments. Such designers must learn to free themselves from thinking of programming as the manipulation of a one-dimensional ASCII language; abandon the concept of algorithms as 'recipes', and treat them more as situated actors in a system; abandon the code-compile-execute cycle; and to become aware that the programming environment is not hermetic, but situated within an interactive art system, a transdisciplinary collaboration, and the wider cultural society.

References

1. Candy, L. and Edmonds, E.A. Explorations in Art and Technology. Springer, 2002.
2. Edmonds, E.A. and Candy, L. Creativity, Art Practice and Knowledge. Communications of the ACM, 45 (10). 91-95, 2002.
3. Glaser, B.G. Basics of Grounded Theory Analysis. Sociology Press, 1992.
4. Ingalls, D., Kaehler, T., Maloney, J., Wallace, S. and Kay, A., Back to the Future: The Story of Squeak, A Practical Smalltalk Written in Itself. in OOPSLA'97 Conference, (Atlanta, Georgia, 1997), 1997.
5. Kautz, K., Hansen, B. and Jacobsen, D. The Utilization of Information Systems Development Methodologies in Practice. Journal of Information Technology Cases and Applications, 6 (4), 2004.
6. Strauss, A.L. and Corbin, J. Basics of qualitative research: Techniques and procedures for developing grounded theory. SAGE Publications Ltd., Thousand Oaks, CA, 1998.
7. Turner, G. and Edmonds, E.A., Towards a Supportive Technological Environment for Digital Art. in OzCHI 2003: New directions in interaction, information environments, media and technology, (Brisbane, Australia, 2003), 2003.

An Intelligent Cognitive Tool To Foster Collaboration In Distributed Pair Programming

Edgar **ACOSTA CHAPARRO**
IDEAS Lab, Dept. Informatics, University of Sussex
Brighton, BN1 9QH, UK
+44 1273 877939
E.A.Chaparro@sussex.ac.uk

ABSTRACT

This papers reports a research proposal that investigate the suitability of the Task Sharing Framework[1] in the design and implementation of a prototype of an intelligent tool that monitors and enhances the collaboration between distributed pair programmers facilitating their efforts at learning programming

1. Introduction

Teaching programming is not an easy task and for many years, it has been subject of study. Brusilovsky et all. [2], for example, in a review of approaches and tools for teaching procedural programming, noted that programming causes cognitive overload and for this reason should be taught in small subsets. With Object Oriented Programming, an approach that is increasingly finding agreement in academic environments it is not different. The large number of concepts, whose familiarity is required for handling object oriented programming constitutes a major difficulty for novices [3]. Thus, it must be explored new tools and methods that could facilitate the learning of programming.

A novel well-accredited approach in teaching programming is pair programming. A pair working together in solving a programming exercise could minimize the cognitive load [4]. Flor[5], who analyzed the collaboration of a pair of programmers on a debugging task, noted that this condition maximize the space of solutions because combine two different cognitive systems (each peer). Despite its benefits, some studies [6, 7] have showed that sometimes pair programming simply does not work.

Therefore, the proposed doctoral research first explores the benefits and limitation of pair programming, taking a deeper look into the possibilities open by distributed pair programming (section 2.1). Secondly, it discusses pair programming grounding it with social constructivism theories of learning (section 3). Later, it outlines a research proposal that intends to investigate the suitability of the TSF [1] in the design and implementation of a prototype of an intelligent tool that monitors and enhances the collaboration between distributed pair programmers facilitating their efforts at learning programming (section 4). Finally, it suggests a scenario to test the effectiveness of the proposed tool (section 5).

2. A look into Pair Programming

Pair programming is the situation in which two programmers work side by side, designing and coding, while working on the same algorithm. A relevant aspect of pair programming is that it transforms what used to be an individual activity into a cooperative effort [8, 9]. Typically there are two roles in pair programming: the driver who controls both the computer keyboard and the mouse, and the navigator who examines the driver's work, offering advice, suggestions and corrections to both design and code [9].

According to Cockburn and Williams [8] who observed the method in academic environments, Pair Programming improves the quality of the software design, reduces the deficiencies of the code, enhances technical skills, improves team communication and is considered to be more enjoyable for the participants. Other studies [10-13] that compared the performances of pair programming students and solo students showed that the former were more likely to hand in solutions for their assignments, that were of higher quality.

Despite some criticism [6, 7, 14], there is enough evidence to suggest that pair programming in some situations appears to be more engaging and enjoyable [15].

2.1 Distributed Pair Programming

It is well known that distance matters [16]. Consequently, as argued in [17] collocated pair programming will most likely outperform distributed pair programmers in terms of productivity. On the other hand, it is difficult to ignore some enthusiasm for distributed learning. Indeed, there are many factors motivating distributed technologies. Organizations have offices in multiple locations with teams interacting across geographical sites in different time zones. Universities are launching distance learning courses to reach wider populations and, of course, expecting students to work together [10].

With this idea in mind, Baheti, Gehringer et all [18] conducted an experiment with 132 student, 34 of whom where distance learning. They concluded that distributed programmers foster teamwork and communication. Furthermore, they argued that distributed pair programming seems to be comparable to collocated pair programming in terms of productivity and quality. Hank (2002) also showed some evidence of the efficiency of distributed pair programming.

Considering the literature it follows that more research must be done in the field to understand the gains and costs of distributed pair programming; however, it is reasonable to argue that a tool that successfully supports distributed pair programming will bring many benefits. For example, it will remove conflicts with collocation requirements [10] and it could support synchronous and asynchronous cooperation among student who will be geographically distributed [18]. Therefore, Distributed Pair Programming will help to address at least one of the three problems mentioned earlier in this document: Schedule Conflicts.

What about the others issues? Indeed, in the design of tools for supporting pair programming less importance has been given to pair incompatibility and unequal contribution of participants. However, these two problems has been subject of study in the important field of Collaborative Learning for a long time. As argued in [19], just putting people together does not mean that they will collaborate. Furthermore, it is interesting to note that although there have been some attempts to build tools to support pair programming, none of them mentioned, so far, have had any influence of pedagogical theories. Therefore, before going any further, it is necessary to find in the field of Collaborative Learning some grounding theory to support the development of a tool that could support distributed pair programming.

3. Collaborative Learning: Constructing Knowledge in a Social Context

Learning in a collaborative environment is a process that could be subject of two different perspectives [19, 20]: individual effort and social sharing of knowledge. The first derives from the approach known as Cognitive Constructivism [21]; the second instead derives from the one known as Social Constructivism [22].

Social Constructivism focuses on learning as an action that occurs within a social context during the interaction between the learner and its interlocutor(s). It has tended to stress cooperation rather than conflict. This approach differs stresses learning as a process triggered by social interaction in a context of dialogue (ie. tutor-learner). Because of the engagement in collaborative activities, individuals can master something that they could not do before the collaboration [20, 23, 24]. From a Social Constructivist perspective, learning would occur in social environments with rich interaction between a learner and his/her peers.

Dillenbourg [19] defined collaborative learning as follow:

> "... the words "collaborative learning" describe a situation in which particulars forms of interaction among people are expected to occur, which would trigger learning mechanisms, but there is no guarantee that the expected interactions will actually occur. Hence, a general concern is to develop ways to increase the probability that some types of interaction occur"

According to Dillenbourg, in order to maximize the likelihood of such specific forms of interaction, there are four conditions to accurately set a collaborative context: (1) set up the initial conditions, (2) over-specify the collaboration contract with a scenario based on roles, (3) scaffold productive interactions by encompassing interaction in the medium, and (4) monitor and regulate the interactions.

Considering the conditions suggested by Dillenbourg it is possible to argue that the teacher plays an essential role to maximize the possibility of collaborative learning and that having a teacher to monitor each pair interaction would be an ideal situation. Compared with traditional classroom models, in which one teacher has to deal with many students, one-to-one tutoring is highly effective (Self 1999). Unfortunately, this approach is typically not feasible because the number of students generally outnumber the number of teachers.

Therefore, aiming to maximize the conditions proposed by Dillenbourg, a tempting idea is use of intelligent cognitive tools that could foster the collaboration among peers, that could establish rules in the medium and monitor interactions. This intelligent cognitive tool could have a pedagogical model [25] and should have embedded a model of collaboration.

4. Research Proposal

The aim of this doctoral research is to investigate the suitability of the TSF [1] in the design and implementation of a prototype of an intelligent tool that monitors and enhances the collaboration between distributed pair programmers facilitating their efforts at learning programming. The goal of the intelligent tool is to support their collaboration, by monitoring and occasionally prompting with feedback or suggestions. The tool will search for signs of collaboration difficulties or breakdowns of pair programmers solving a pre-determined exercise of object oriented programming.

In dealing with difficulties, the proposed prototype will extend the work done in [26] where a simulated student detects and repairs difficulties in collaborative learning in the domain of programming. The prototype will consider situations where (1) students having difficulty solving the exercise, (2) one student is being passive and (3) when a pair is spending too much time in off-topic conversations. The cognitive tool will have a pedagogical model based on social constructivism. In particular the scaffolding idea introduced in Wood et al. [27] and refined by Bruner [23], which explores how a more competent peer can provide support for a less able learner.

This study is also strongly influenced by the work produced in IHELP [28]which is a distributed multi-agent based collaborative environment for peer help. More details of this work can be found in [29]. Therefore, on the basis of a student model, the learning companion would match good pairs, considering cognitive styles, learning goals, interests, etc.

5. Discussion

This doctoral research proposes the design and implementation of an intelligent tool prototype supported by the TSF to coordinate and stimulate the collaboration between peers in distributed pair programming. Students learning via Computer Supported Collaborative Learning need guidance and support on-line, just as students learning in the classroom need support from their instructor [30]. This prototype will be task specific. The author is interested in exploring the learning gains and the peer collaboration with different versions of the intelligent tool using the TSF. Each participant will do a pre-test to evaluate her level of expertise in object-oriented programming. The learning gain and the collaboration will be measured comparing the results from pre and post-tests, plus analysing verbalizations and performance on the task.

If the design of a cognitive tool to foster collaboration can be established and prove that it can be effectively used by students pair programming remotely, it will not only extend the benefits of pair programming to a large population but also support a better learning situation for its users. Progress in this area would be of major significance in the area of intelligent learning environments and in particular to tutoring systems for teaching programming.

References

1. Pearce, D., et al., *The task sharing framework for collaboration and meta-collaboration*, in *to appear in proceeding of 12th International Conference on Artificial Intelligence in Education*. 2005: Amsterdam - Netherlands.
2. Brusilovsky, P., et al. *Teaching programming to novices: a review of approaches and tools*. in *World Conference on Educational Multimedia and Hypermedia*. 1994. Vancouver, BC, Canada.
3. Detienne, F., *Assessing the cognitive consequences of the object-oriented approach: A survey of empirical research on object-oriented design by individuals and teams.* Interacting with Computers, 1997. **9**(1): p. 47-72.
4. Williams, L., et al., *In Support of Pair Programming in the Introductory Computer Science courses.* 2003.
5. Flor, N.V. and E. Hutchins. *Analyzing Distributed Cognition in Software Teams: A Case Study of Team Programming During Perfective Software Maintenance*. in *Proceedings of the Fourth Annual Workshop on Empirical Studies of Programmers*. 1991. Norwood, NJ: Ablex Publishing.
6. Gittins, R. and S. Hope. *A study of Human Solutions in eXtreme Programming*. in *13th Workshop of the Psychology of Programming Interest Group*. 2001. Bournemouth UK.

7. Tessem, B. *Experiences in Learning XP Practices: A Qualitative Study*. in *Extreme Programming and Agile Processes in Software Engineering, 4th International Conference*. 2003. Genova, Italy: Springer.
8. CockBurn, A. and L. Williams, *The cost and benefits of pair programming*, in *Extreme Programming Examined*, I.G.S.a.M. Maresi, Editor. 2001, Addison-Wesley. p. 223-247.
9. Williams, L. and R. Kessler, *Pair Programming Illuminated*. 2002, Boston, MA, USA: Addison-Wesley Longman Publishing Co., Inc.
10. Hanks, B. *Empirical Studies of Pair Programming*. in *Position paper for EEAP '03 - 2nd International Workshop on Empirical Evaluation of Agile Processes*. 2003. New Orleans, Lousiana, USA.
11. Hanks, B., et al. *Program Quality with pair programming in CS1*. in *ITiCSE '04: Proceedings of the 9th annual SIGCSE conference on Innovation and technology in computer science education*. 2004. Leeds, United Kingdom: ACM Press.
12. McDowell, C., et al. *The impact of pair-programming on student performance, perception and persistence*. in *ICSE '03: In Proceedings of the 25th International Conference of Software Engineering*. 2003. Portland, Oregon: IEEE Computer Society.
13. Williams, L., et al., *Strengthening the case for pair-programming.* IEEE Software, 2000. **17**(4): p. 19-25.
14. Melnik, G. and F. Maurer. *Perceptions of Agile Practices: A Student Survey*. in *Extreme Programming/Agile Universe*. 2002. Chicago, IL.
15. Bryant, S. *XP: Taking the psychology of programming to the eXtreme*. in *16th Workshop of Psychology of Programming Interest Group*. 2004. Institute of Technology, Carlow, Ireland.
16. Olson, G.M. and J.S. Olson, *Distance Matters.* Human-Computer Interaction, 2002. **15**((2/3)): p. 139-178.
17. Stotts, P.D. and L. Williams, *A Video-Enhanced Environment for Distributed Extreme Programming*. 2002, Department of Computer Science. University of North Carolina.
18. Baheti, P., E.F. Gehringer, and P.D. Stotts. *Exploring the Efficacy of Distributed Pair Programming*. in *Second XP Universe and First Agile Universe Conference on Extreme Programming and Agile Methods - XP/Agile Universe 2002*. 2002.
19. Dillenbourg, P., ed. *What do you mean by collaborative learning?* 1 ed. Collaborative learning: Cognitive and Computational Approaches, ed. P. Dillenbourg. 1999, Pergamon: Oxford. 246.
20. Lipponen, L. *Exploring foundations for computer-supported collaborative learning*. in *Proceedings of the Computer-supported Collaborative Learning 2002 Conference*. 2002: Mahwah: Erlbaum.
21. Piaget, J., *The judgement and reasoning in children*. 1928, London: Routledge and Kegan.
22. Vygotsky, L.S., *Mind in Society: The development of higher Psychological Processes*. 1978, Cambridge: MIT Press.
23. Bruner, J., *Vygotsky: A historical and conceptual perspective*, in *Culture, Communication and Cognition: Vygotskian Perspectives*, J. Wertsch, Editor. 1985, Cambridge University Press: Cambridge.
24. Mercer, N., *The guided Construction of Knowledge: Talk among teachers and learners*. 4th ed. 2003, Clevedon: Multilingual Matters. 135.
25. Chan, T.-W., *Artificial Agents in Distance Learning.* International Journal of Educational Telecommunications, 1995. **1**((2/3)): p. 263-282.
26. Vizcaíno, A. and B. du Boulay. *Using a Simulated Student to Repair Difficulties in Collaborative Learning*. in *Proceeding of ICCE*. 2002.
27. Wood, D., J. Bruner, and G. Ross, *The role of tutoring in problem-solving.* Journal of Child Psychology and Child Psychiatry, 1976. **17**: p. 89-100.
28. Greer, J., et al. *The Intelligent Helpdesk: Supporting Peer-Help in a University Course*. in *Fourth International Conference on Intelligent Tutoring Systems*. 1998. San Antonio, Texas.
29. Vassileva, J., G. Mccalla, and J. Greer, *Multi-Agent Multi-User Modeling in I-Help.* User Modeling and User-Adapted Interaction, 2003. **13**(1-2): p. 179-210.
30. Soller, A., *Supporting Social Interaction in an Intelligent Collaborative Learning System.* International Journal of Artificial Intelligence in Education, 2001. **12**(1): p. 40-62.

Diagrammatic Representations of Online Discussions: Maximising Communication and Learning Potential By Supporting User Tasks Without Forcing Their Choice

Emanuela Moreale
Learning Sciences Research Institute (LSRI)
University of Nottingham
ema@cs.nott.ac.uk

Online discussions have been around for a quarter of a century (USENET) and have recently become more popular and ubiquitous thanks to newsgroup archives (e.g. Google™ Groups) and the availability of web interfaces. E-learning initiatives (e.g. Ikarus 2004 Online Seminar) invariably include discussion components, due to the perceived importance of online discussions in e-learning. Compared to face-to-face meetings, asynchronous discussions have the advantages of convenient "any time, any place" access, allowing the development of parallel discussions and providing permanent written records. Their main disadvantage is that of creating "overload" in discussion participants (Erickson and Kellogg 2000, Jarrett *et al*. 2003, Newman 2002, Smith and Fiore 2001, Xiong and Donath 1999). In fact, they require users to carry out costly operations to "make sense of" and track the current state of a discussion, whether this is a "new" discussion ("overview" task) or just new developments in a discussion they have previously participated in ("catch up" task).

It is known that external representations (ERs) such as diagrams play facilitatory roles in inference, problem-solving and understanding by reducing working memory load, serving as retrieval cues for long memory and promoting discovery and inference (Larking and Simon 1987, Suwa and Tversky 2002). ERs may thus help alleviate cognitive load in users of online discussions.

Users sometimes experience "co-text loss" (Pimentel *et al*. 2003) across messages: this may lead to incorrect mappings of the referent and misunderstandings in discussions. Quoting is (often but not always skilfully) used to maintain context (Severinson Eklund and Macdonald 1994). However, it inflates messages and long postings tend to obscure the structure of a discussion.

Current interfaces do a poor job of representing the structure and temporal development of conversation threads. These limitations add to the cognitive overload in users and contribute to the erosion of the perceived value of these channels (Neustaedter *et al.* 2003). Also, they allow little customisation and impose a programmer-defined representation of the discussion on the user. This is at odds with the principles and practices of user-centred design (Abras *et al*. 2004).

We therefore need better ERs to help alleviate the cognitive load of the user in online discussions. Yet, ERs should not be forced on users. One reason is that we want to abide by the principles of user-centred design and not frustrate users; another is that low ER knowledge users often prefer less "ideal" representations (that however they can cope with) while high ER knowledge users are more likely to choose the "best" representation for a task (Grawemeyer 2003). I therefore propose to use diagrammatic representations to offer users help with their tasks, leaving the choice to them. I believe that offering users a choice of ERs will help optimal interaction with the discussion and optimise the potential for communication and learning through this means.

This paper will focus on visualisation of threads and quoting in online threaded discussions.

Research on Diagrammatic Representations of Discussion Threads

Research efforts into ERs of online discussions threads have so far focused on research prototypes that feature brand new visualisations and often multiple linked (or composite) ones. New thread visualisations include Smith and Fiore's (2001) classical tree diagram of messages, which was rated useful for long threads, as it gives a good overview of the branching of the discussion ("parallel" threads). Space-efficient trees for displaying huge threads have also been investigated (Newman 2002). However, tree representations (even when clicking on a node displays the message) do not seem particularly suitable for following the evolution of an argument across messages, partly because they do not represent quoting.

Thererefore, a few sequential ERs focused on quoting by attempting to "reconstruct" the conversational turn-taking indicated by quoting mechanisms (Yabe 2000, Yee 2002). While these ERs are good for detail (e.g. following a small part of a discussion), they do not seem appropriate for overview tasks, particularly as they abandon the idea of message. ConverSpace (Popolov 2000) instead maps paragraphs in a message to the chunks (in a preceding message) that they refer to, thus highlighting quoting while keeping the message unit that may help readers keep their bearings.

Overall, there is a tendency to use multiple ERs together to represent a discussion, whether they represent the same item (e.g. messages in a thread, as in.Yee 2002) or instead visualise various aspects of a discussion. i.e. authors and their activities in time, in a dashboard (e.g. Smith and Fiore 2001). However, their paper suggests that users found the overall ER somewhat difficult to use.

Limitations and Proposal

Limitations of the approaches introduced above include their being research prototypes – and not widely used, full implementations - having undergone little and generic evaluation, which was not generally directly related to user tasks. The second issue is that, although research prototypes for visualisation of threaded asynchronous discussions usually provide users with multiple representations to support them in this complex activity, there is a lack of evidence in favour of this approach. In particular, this approach raises questions such as "are multiple linked representations indeed better than a single one" when online discussions are concerned? If (or when) this is the case, what is their overall pattern of use? Are they used concurrently or one after the other? Is this pattern of use constant or does it depend on type of task or possibly on the user's level of experience?

My plan has therefore been to find out from heavy newsgroup users how they go about reading newsgroups (i.e. what the tasks involved are) and to test the assumption that multiple visualisations are better than a single one. I therefore plan to evaluate how effective the different types of visualisations are for these main tasks and suggest better representations for a certain type of task. The actual choice of visualisation will always be up to the user. In the spirit of user-centred interface design, users should always be involved in the different stages of design and development, including requirements gathering, informing design, testing and usage, where they will have the choice of what (if any) representation to use for carrying out their tasks.

Research

Newsgroup Tasks. To get an idea of what the user tasks to do with newsgroups are and how users go about reading newsgroups, I first carried out semi-structured interviews via instant messaging/email with eight users recruited opportunistically and through newsgroups. They were asked about the groups read, group membership, reading sessions (amount, length, distribution in time), the reading process, the interfaces used and their posting habits. The data gathered confirmed the problem of information overload and the mixed blessing of quoting, but also showed that successful heavy newsgroup users evolve sophisticated techniques to deal with these problems. Suggestions for newsgroup interfaces were also collected. These included flagging postings by known posters, replies to one's own postings and ignoring useless sub-threads (e.g. spam, "flames" and replies to these). Overall, the activity of newsgroup reading emerged as quite a complex one.

Pilot. As a first step towards tackling the questions posed by using multiple representations in newsgroups (above), I planned an experiment to compare the simplest case of single vs. multiple linked representations: the linear representation of a thread (reply underneath the previous message) vs. this linear representation (right) plus a representation of the discussion structure (left). The two representations may be also seen as comparing the "navigation off" (NAVON) and "navigation on"

(NAVOFF) conditions in the context of newsgroups. The actual ERs used in the experiment were borrowed from the widely-used Google™ Groups (http://groups.google.com) (see Fig 1).

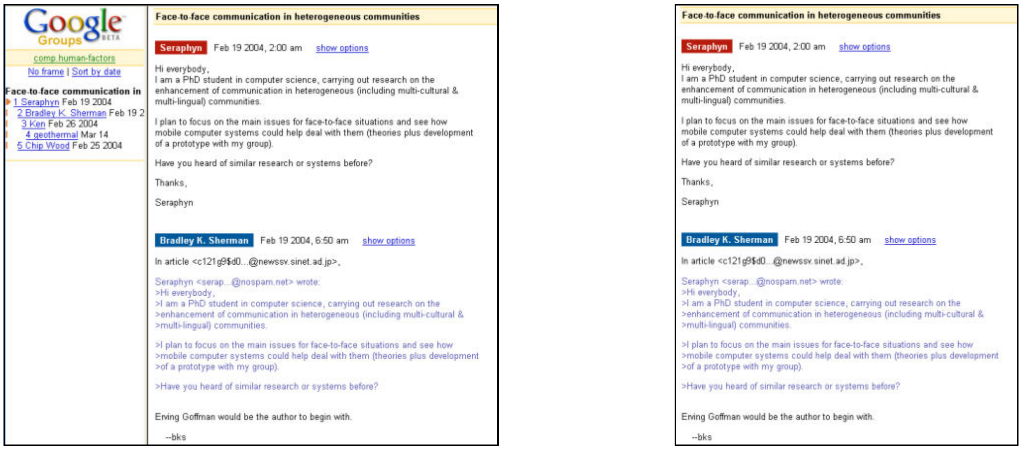


Fig. 1 – The Two Representations: Navigation On (left) and Linear/Navigation Off (right)

Design. Due to the conviction that accounting for experience would be sufficient to deal with individual variation and to the expected difficulty in devising matching tasks, the pilot used a between groups design, each participant being randomly assigned to one of the two ERs. The task required users to answer 16 questions. The measures taken were search times, accuracy measures and difficulty ratings for each question (plus video recordings). The experimental hypotheses were:

(1) There will be a significant difference in search times and difficulty ratings between the ERs;
(2) There will be a significant difference in search times across the four conditions created by the intersection of the two ERs and the two types of tasks (content and structure);
(3) Users will find it significantly easier to answer structure questions in the NAVON condition

Materials. Two threads from comp.human-factors were selected. 16 questions were produced addressing both message content and structure of the discussion: 8 questions were on a shorter thread (9 messages) and another 8 on a longer thread (27 messages). The questions were presented in a printed handout, one question per page, and presented in a random order.

Procedure. A training session with the interface used in the experiment was run prior to the experiment, using the same procedure. In the experiment, each participant answered 8 questions on the shorter thread and another 8 on the longer thread. Participants read the questions from their paper handout and recorded their answer (and difficulty rating) on the same page as the question.

Participants. Two female postgraduates aged about 25 were recruited. One reads newsgroups daily, the other never reads newsgroups.

Results. (1) NAVOFF recorded shorter search times (16 mins vs. 23 mins overall). (2) No difference (3) Difficulty ratings of structure questions were lower for NAVON (avg: 1.675) than NAVOFF (avg: 1.875), but this was not the case with accuracy (NAVOFF: 100%; NAVON: 75%).

Discussion. We obviously cannot draw any conclusions from this small pilot and some of the effect observed would seem to be due to participant characteristics (e.g. experience, "spontaneous" think aloud protocol). For instance, experience and ER may have counteracted each other in (2).

The pilot study did confirm the absolute necessity for a within-group design, as cultural and other differences would not be accounted for by simply controlling for newsgroup experience. This design will also allow each participant to compare the two representations. The pilot also suggested the use of even more explicit (and numerous) questions. The full study will run with 20 participants.

Future Work

As well as running the full study, more work also needs to be done on better pinning down newsgroup tasks. Further, other types of visualisations will be tackled in an attempt to help fill the current evaluation gap in the research by comparative evaluations of contrasting visualisations (i.e.

sequential vs. tree-like diagram and static vs. dynamic representations) in different patterns of use (single vs. multiple ERs) for different tasks (such as making sense of a sub-thread vs. making sense of a whole thread) to find out which visualisations are most appropriate for what tasks.

The results of these evaluations will feed into a system giving suggestions to users depending on their current task. The choice of representation will be left to users: it will be interesting to see if high ER knowledge users, being more willing to switch representations and better able to make sense of them, will benefit the most from the suggestions and representational choices or if, instead, the recommendations will encourage learning of "more useful representations" in low ER knowledge users.

Conclusion

Current newsgroup clients and web interfaces to online discussions are based on the hypermail model and offer little (if any) customisation as regards selection of what to display and how, visualisation of quoting (turn taking) or even context preservation mechanisms. They are not effective in reducing the working memory load of the user.

Better ERs of online discussions are needed. So far, research efforts have focused on developing new visualisations of online discussions, often by composing several representations. However, little evaluation has been carried out. I therefore propose to carry out evaluation of different types of ERs (sequential vs. tree, static vs. dynamic) and their pattern of use (e.g. single vs. multiple ERs) for the main tasks of online discussion users. It will then be possible to present users with suggestions that they can follow if they wish. Unless the user is left in charge of choosing the representation, the communication and learning potential of online discussions will not materialise. We need to address this lack of user choice while supporting users in their online discussion tasks.

References

Abras, C., Maloney-Krichmar, D., and Preece, J. (2004) User-Centered Design. In Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications.

Erickson, T. and Kellogg W.A. (2000). Social Translucence: An Approach to Designing Systems that Support Social Processes. *ACM Trans on Computer-Human Interaction*, Vol. 7, No. 1, March 2000, 59–83.

Grawemeyer, B. (2003). The Effects of Knowledge of External Representations Upon Representational Preference Patterns. *HCT 2003, 7th HCT Postgraduate Workshop*, 15-16 Dec 2003.

Larking, J. and Simon, H.A. (1987). Why a Diagram is (Sometimes) Worth Ten Thousand Words. *Cognitive Science*. 11 (1987), 65-99.

Neustaedter, C., Smith, M., and Venolia, G. (2003). Grand Central Usenet: The Design and Evaluation of a Thread-Based Usenet Browser. Microsoft Tech Report, MSR-TR-2003-89, 2003.

Newman, P. (2002). Exploring discussion lists: steps and directions. *Proc of the 2nd ACM/IEEE-CS Joint Conf on Digital libraries* (2002), Portland, Oregon, USA. Novel search environments session, 126-134.

Pimentel, M., Fuks, H. and Lucena, C.J.P. (2003). Co-text Loss in Textual Chat Tools, *Lecture Notes in Computer Science*, Volume 2680, Jan 2003, 483–490.

Popolov, D., Callaghan, M. and Luker, P. (2000). Conversation Space: Visualizing Multi-Threaded Conversation. *Proceedings of AVI 2000* (Palermo, Italy, May 2000), 246-249.

Severinson-Eklundh, K. and Macdonald, C. (1994). The Use of Quoting to Preserve Context in Electronic Mail Dialogues. *IEEE Trans on Professional Communication*, vol 37, no 4, 1994, 197-202.

Smith, M.A. and Fiore, T., A. (2001). Visualization Components for Persistent Conversations. *Proc of SIGCHI 2001 Conference on Human Factors in Computing Systems*.

Suwa, M. and Tversky, B. (2002). External Representations Contribute to the Dynamic Construction of Ideas. Diagrams 2002: *Int. Conf. on Theory and Application of Diagrams (Diagrams02)*, Callaway Gardens, Georgia, USA, 18-20 April 2002

Xiong, R. and Donath, J. (1999). "PeopleGarden: Creating Data Portraits for Users", in *Proc. of the 12th Annual ACM Symposium on User Interface Software and Technology*, New York: ACM, 37-44.

Yabe, J., Takahashi, S., and Shibayama, E., (2000). Automatic Animation of Discussions in USENET. *Proceedings of AVI 2000* (Palermo, Italy, May 2000), 84-91.

Yee, K.P. (2002), Zest: Automatic Outlining for E-Mail Discussions, *Vertex Innovators' Challenge*, University of California, Berkeley. Available online at: www.cs.berkeley.edu/~pingster/vertex/zest.html

Pair Programming: Matching Pairs in a Sequence of Learning Sessions

Aybala Yuksel, Pablo Romero, Geraldine Fitzpatrick
HCT Group, Department of Informatics, University of Sussex
Brighton, BN1 9QH, UK

1. Introduction

In collaborative learning, students are required to work together on a common goal. Many studies have shown the effectiveness of collaborative learning in many areas including computer science courses, it develops communication and higher level thinking skills (Paintz, 1997).

Pair programming, where two programmers code side by side on the same algorithm, is a form of collaborative learning and an effective approach to teaching programming. For instance, Williams (2003) applied pair programming to an introductory computer science course and reported that students who programmed in pairs got better results in assignments and were more satisfied from doing course projects. However, matching partners appropriately is an issue in pair programming. VanDeGrift (2004) showed that students complained about working with people with different personalities and skill levels.

Most studies on matching pairs have been concerned with matching in one single learning session only (Katira, 2004, Williams 2003). We will investigate the benefit of the partner changing in several learning sessions according to skill level. This paper outlines a study to address questions in this area. This paper is divided into 6 sections. The following section talks about collaborative learning and its practice in the computer science course. Section 3 briefly reviews pair programming as a dimension of eXtreme Programming. Effectiveness of pair programming in the computer science course will also be discussed in the same section. Group dynamics will be defined in Section 4. In addition, pair matching and user modeling as a possible solution for it will be discussed in the same section. In Section 5, we will describe our study including our research question. We will also talk about what further steps will be taken based on the aim we would like to achieve. Finally, in section 6, we will conclude the research proposal with useful suggestions for the user model.

2. Collaborative Learning

Dillenbourg (1999) defines collaborative learning as the "*situation in which two or more people learn or attempt to learn something together*." According to him, the three dimensions of collaborative learning are group size, form of interaction and time span. In this paper we will focus our attention on pairs of students learning a programming language using pair programming in a computer science course employing a computer mediated environment.

Collaborative Learning has been employed in Computer Science courses for decades with reported success (Yerion and Rinehart 1995). Well-designed collaborative learning exercises develop higher level thinking skills, stimulate critical thinking and help students clarify ideas through discussion. It also develops oral communication skills and fosters metacognition in students (Paintz, 1997).

LeJeune (2003) discusses key components that may affect the success of collaborative learning in a Computer Science course. According to him well-designed collaborative learning exercises should comprise key components such as a common task, small-group interactions, collaborative behavior, positive interdependence and individual and group accountability and responsibility.

Collaborative learning requires working in groups in which students are actively working on problems (Yerion and Rinehart 1995). Group size is one of the issues that may influence the effectiveness of collaboration. LeJeune (2003) suggests a group of five to seven people is an optimal size. Moreover, Trowbridge 1987 showed that pairs are more effective than larger groups. This paper focuses on paired collaboration rather than larger groups.

3. Pair Programming

Pair programming has recently been introduced to academia. Pair programming is a technique in which two programmers work collaboratively on the same code at one computer. One of the programmers is the driver who has control of the mouse and keyboard. The other is the navigator who actively observes the work of the driver, offers advice and corrects mistakes in both code and design. Partners should change frequently (Wake, 2002).

Studies from academia highlight the effectiveness of pair programming. Williams and Upchurch (2001) reported that by applying this method to computer science students they completed programming assignments faster and the assignments were of a higher quality. McDowell et al. (2002) showed that students who work in pairs produce significantly better programs than students who work individually.

4. Pair Formation

Differences between group members are an issue that may influence the effectiveness of collaboration. Skill level as an individual difference is probably the most studied variable. Katira et al. (2004) examined the influence of different skill levels on the compatibility of pair programmers. The study showed a strong link between skill level and compatibility of graduate object-oriented programming students. Many other studies report that students perform better with partners of the same skill level (Thomas et al. 2003).

In general, the smaller the skill gap the better the match. However weak students can benefit from the interaction with stronger ones. There will probably be periods when weak students will benefit from bigger gaps. Vygotsky (1978) identifies it as Zone of Proximal Development, in which a student can perform a task in collaboration with more able partner. Additionally, Davies (1993) reported that '…the transition from lower to higher levels of skill in programming does not follow a continuous developmental path…' Therefore it seems sensible that matching strategies should look beyond a single session and plan for a sequence of sessions.

In programming courses, pairs can either be self-selected or chosen by the instructor. Group formation can be done either manually or by the system in which a detailed model of the users is added to match the optimal group members. User modeling may be more efficient in complex situations. There has been some research into pair matching performed by a software system (Greer et al. 2001). This system (I-Help) works based on the user model applied when a learner requests help. However, different from the user model in I-Help, our research will use a model that supports matching in a sequence of learning sessions. The proposed user model would decide which students are compatible with each one based on the model applied. Our research will apply this user model to pair programming in order to find out how to optimally match pairs. The challenge is to model students with the aim of matching pairs in a sequence of learning sessions

5. Research Proposal

The research questions are:

a) *Is a systematic sequence of pairing effective?*
b) *How to do sequence matching and what are the criteria to take into account?*
c) *How can the user model support sequential pairing?*

To address these questions, I will conduct a pilot study, which will be used to enrich our understanding of the affects of sequential pairing in pair programming. In order to categorize the participants by skill level, a pre-study questionnaire will be completed by each participant. Participants will be matched randomly according to their skill level for each of the learning sessions. They will be required to work in pairs on a given task. The effectiveness of the pairing sequence will be evaluated via student interviews, questionnaires and the analyses of the audio or video recordings of some of these sessions. Subsequently, suitable pairing sequences will be inferred empirically. The final phase will be user modeling to find out which were the optimum pairing sequences. This will be done based on the data analyzed. The main contribution expected from this research is to provide a new approach for matching pairs based on their user model.

6. Conclusion

Understanding how student pair programmers can be best supported remains a critical line of educational research. Many issues arise between pairs because of badly chosen partners. Every individual has their own differences (Individual differences make all learners unique). The challenge is matching them with an optimal partner.

User modeling is one technique to do matching. Knowledge about how pairs of students communicate and the extent to which they are compatible with their partner in pair programming should be included in a user model. Furthermore, individual differences between partners should carefully be adapted in to this user model. This research also refers to the necessity of an intelligent matching system, in which the user model could be used.

References

Davies, SP (1993) Knowledge restructuring and the acquisition of programming expertise. International Journal of Human-Computer Studies, 40, p703-726

Dillenbourg, P. (1999). What do you mean by 'collaborative learning'? *Collaborative Learning: Cognitive and Computational Approaches.* Oxford, Elsevier**:** 1-19.

Greer, J., G. McCalla, et al. (2001). Lessons Learned in Deploying a Multi-Agent Learning Support System: The I-Help Experience. AIED, San Antonio.

Katira, N., L. Williams, et al. (2004). On Understanding Compatibility of Student Pair Programmers. SIGCSE'04, Norfolk,Virgina, USA.

LeJeune, N. (2003). Critical Components for Successful Collaborative Learning in CS1. JCSC 19.

McDowell, C., L. Werner, et al. (2002). The Effects of Pair-programming on Performance in an Introductory Programming Course. SIGCSE, ACM.

Panitz, T. (1997). T*he Case for Student Centered Instruction Via Collaborative Learning Paradigms.* Available: http://home.capecod.net/~tpanitz/tedsarticles/coopbenefits.htm [Retrieved 2005, January 17].

Thomas, L., M. Ratcliffe, et al. (2003). Code Warriors and Code-a-Phobes: A study in Attitude and Pair Programming. SIGCSE, Nevada, USA, ACM.

Trowbridge, D. (1987). An investigation of groups working at the computer. Applications of cognitive psycology: Problem solving, Education and Computing. K. Berge, K. P. & and W. Banks. Hillside, NJ, Lawrence Erlbaum Associates.

VanDeGrift, T., *Coupling pair programming and writing: learning about students' perceptions and processes*, in *Proceedings of the 35th SIGCSE technical symposium on Computer science education*. 2004, ACM Press: Norfolk, Virginia, USA.

Vygotsky, L.S. (1978). *Mind and society: The development of higher mental processes*. Cambridge, MA: Harvard University Press.

Wake, W. (2002). Extreme Programming Explored. Portland, Addison -Wesley Professional.

Williams, L. a. and R. L. Upchurch (2001). In Support of Student Pair-Programming. SIGCSE, Charlotta, USA, ACM.

Williams, L., et al., *In Support of Pair Programming in the Introductory Computer Science courses.* 2003.

Yerion, K. A. a. and J. A. Rinehart (1995). Guidelines for Collaborative Learning in Computer Science. SIGCSE.

Wake, W., *Extreme Programming Explored*. XP series. 2002, Portland: Addison-Wesley Professional. 144.

Qualitative Analysis of User Preference with UML Interaction Diagrams

Jennifer Swan[1], Trevor Barker[1], Carol Britton[1], Maria Kutar[2]

University of Hertfordshire[1], University of Salford[2]

Abstract

It is of key importance that all representations used in the software development process can be clearly understood by all who must use them. User preference is one area that may influence the effectiveness of the representations presented. Described in this paper is a study that was carried out to explore the relationship between user preference for UML sequence and collaboration diagrams. Analysis suggests sequence diagrams as being easier to follow and understand. It is hoped a further more formal study will provide more detail on reasons for preference for one of the diagram types.

Introduction

The UML (Booch, 1999) is a general purpose visual modelling language that is used to specify, visualize, construct, and document the artifacts of a software system.' [1]. Diagrams are widely used as a tool to aid software development and the selection of appropriate tools can influence the success of the development process. The choice of diagram for particular projects often reflects the experience or preferences of the development team more than objective consideration of possible alternatives [2].

The UML provides two diagrams for representation of scenarios during the software development process, known collectively as interaction diagrams. Interaction diagrams, which are isomorphic, consist of sequence and collaboration diagrams. The sequence diagram emphasises time sequences whilst the collaboration diagram emphasises object relationships.

One factor that may have a strong influence on the success of the use of diagrams during the requirements process is the users' preference for a particular type of technique. Intuitively, it would be expected that any tools and techniques users prefer will help them to perform their job better. As Petre [3] points out "The importance of sheer likeability should not be underestimated; it can be a compelling motivator." This intuition is, generally, supported by research, which has shown that overall, if users prefer one way of solving a problem to another, they will perform better with the technique that they prefer [4].

The Diagrams Research Group (DRG) is based at the University of Hertfordshire and the University of Salford. The DRG's main focus is to conduct research into software engineering diagrams. The most recent study makes comparisons between the two types of interaction diagram to try to improve the ease with which people can understand them. As a first stage to this work an empirical study was developed which investigated factors identified as being important in the related literature, previous research and feedback. These factors are diagram type, preference and performance, cognitive style, text direction, scenario and question type. Our findings on the effect of cognitive style on interpreting diagrams are beyond the scope of this paper. The work is currently in press and will be presented elsewhere [6]. The findings for diagram type, text direction and scenario are also beyond the scope of this paper. The work is currently submitted elsewhere.

Previous studies by the DRG into the relationship between user preference for UML sequence and collaboration diagrams and objective performance with the diagrams have shown mixed findings.

The current study shows that participants who preferred sequence diagrams showed improved performance when using sequence diagrams. However, participants who did not prefer sequence diagrams showed an overall improved performance for both types of diagram over the group that preferred sequence diagrams. These results were from the quantitative analysis of the study. Some qualitative data was collected in the study which will be discussed in this paper. It was expected that the results from the qualitative analysis would deepen the understanding of earlier results from the quantitative analysis.

Design of the study

This study was carried out using bespoke software developed specifically for this investigation. The aim was to time participant's responses when answering questions on the information contained within various interaction diagrams. The software was designed to gather data on both the time taken to respond and the accuracy of responses, with participants asked to answer questions relating to information contained in sequence and collaboration diagrams. This software was subjected to pilot testing using heuristic evaluation with five experts answering questions relating to each screen and the overall study.

Experimental Setting

The study took place in the same room for all participants although only one person participated in the study at any one time. This was to ensure that all conditions for the study were the same for everyone. All participants were asked to adjust their environment to make themselves comfortable and then read the same sheet of information. The 40 participants were a mixture of students and staff from the department of Computer Science at the University of Hertfordshire. All participants had some previous experience with UML diagrams during their studies or work. Each participant was introduced to the task and given an explanation of what was expected. Personal data was gathered and participants were given the option of not disclosing their contact details.

Experimental Task

A whole range of variables were looked at as part of this study including diagram type, preference and performance, learning styles, scenario, text direction and question type. These were analysed using time and accuracy as measures of performance and are reported elsewhere [7]. This paper reports on the qualitative preference information gathered in the study.

A series of four diagrams were displayed to each participant, two of which were sequence diagrams (fig. 3.) and two of which were collaboration diagrams (fig . 4.). The order in which the diagrams were displayed was randomised to ensure there was no learning effect. The diagrams were comprised of approximately thirty interactions each and were of similar complexity. Two different scenarios were modelled in the diagrams – an ATM scenario and a lift scenario.

Each diagram had six questions associated with it relating to the information contained in it and the diagram was visible throughout the time the participants were answering questions. The questions asked related to either ordering information or activity information. To ensure that the information in the diagrams was read carefully, the questions asked about information that was specific to the particular scenario represented in the diagram, rather than the general case of using a lift or ATM machine. The answers were usually a numeric value as opposed to a simple yes, no or don't know i.e. Which floor did the lift start at? Participants could only continue once they had input a correct answer to a question, an additional measure to try to ensure the information was read carefully. The participants were not told that their answers were timed as it was felt that this may change any strategy they adopt to answer the questions. All participants were asked to work quickly and accurately.

Pre-test and Post-test preferences

An example of a sequence diagram and corresponding scenario was displayed and participants were asked to read and try to understand. The same scenario shown as a collaboration diagram followed this; again the participant was asked to read and try to understand. For the purpose of this study the diagrams were called Type A and Type B respectively fig. 1. (a) and fig. 1. (b).

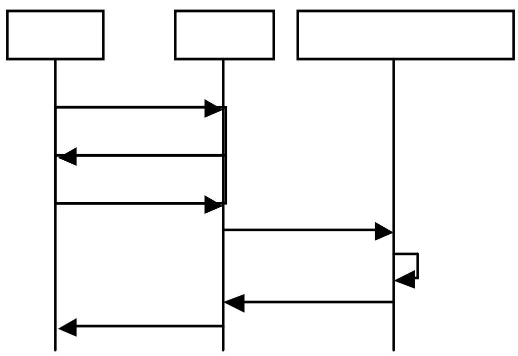


Fig. 1. (a) An example of diagram Type A

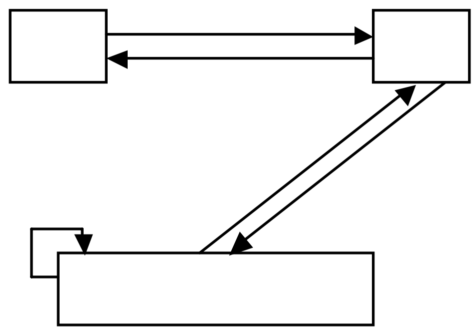


Fig. 1. (b) An example of diagram Type B

Each of the participants was asked to select their preference for a diagram, both before and after the experimental task. There were three possible options: Type A (sequence), Type B (collaboration) or no preference.

When participants were asked to input their preference, two thumbnail diagrams were always visible. These outlined the diagrammatic structure of a sequence diagram and of a collaboration diagram. This was to ensure the participants were confident the option selected corresponded with their preference. When choosing their preference for a particular diagram type, participants were asked to state the reason for their decision, although this question was optional. It is these qualitative answers this paper is concerned with.

Results

Table 1:No. of Preferences for Diagram Type Pre-test/ Post-test

	No. of Participants Pre-test	No. of Participants Post-test
Sequence Diagram	26	27
Collaboration Diagram	7	4
No Preference	7	9

Table 1 shows the number of responses to each of the preference options.

Initially twenty-six participants selected sequence diagrams as their pre-test preference. Of those twenty-six participants twenty-four gave a reason for their preference. In the pre-test answers given, sixteen participants state the diagram was ‘easier to follow / understand’ whilst the remaining eight refer to the order and logic of the diagram. For participants who chose the sequence diagram as their pre-test preference as well as their post-test preference, ten gave a reason for their post-test preference. In the post-test answers eight of the ten participants stated the diagram was ‘easier to follow / understand’, one mentioned the order, and one just preferred it.

Some participants chose the sequence diagram as their pre-test preference and then changed their preference for the post-test selection. Only five participants fell into this category and three of them gave a reason. The one person whose post-test preference changed from sequence to collaboration thought the collaboration diagram was clearly instructed. Of the remaining two participants who changed their preference from sequence to no preference one thought different diagrams were useful for different questions, whilst the remaining participant thought both diagrams were similar in terms of difficulty.

Of the seven participants who chose the collaboration diagram as their pre-test preference, four stated a reason for their preference. Two participants described the diagram as easier to understand whilst the others referred to the numbers being helpful. Three participants chose the sequence diagram as their pre-test preference as well as their post-test preference. Of these, only one gave a reason for their post-test preference which was that they thought it was easier to read. There were four participants who chose the collaboration diagram as their pre-test preference and then changed their preference for the post-test selection. Of these, only one gave a reason for their post-test preference which was that they thought it was easier to read. One participant selected ‘no preference’ both pre-test and post-test and stated that they read the scenario instead of using the diagrams to answer the questions.

Three participants changed their preference from no preference to sequence. These participants thought the sequence diagram was clearer because of the sequence of actions, easier to follow and quicker to extract information from. There were several comments referring to collaboration diagrams as being complex and confusing as well as descriptions such as 'jumps all over the place' and 'difficult to follow'.

Discussion

Each of the forty participants was given two opportunities to give reasons about their preferences. Out of a potential eighty answers only fifty were given as this part of the study was optional. It can be seen from the results the majority of missing answers occurred when participants' pre-test preference and post-test preference remained the same. An explanation for this could be that participants felt their post-test reason would be repeating their pre-test reason and would therefore be superfluous. With such a large proportion of participants who prefer sequence diagrams in both pre-test and post-test analysis, it is difficult to extract any meaningful data as to why users might prefer collaboration diagrams. The results show sequence diagrams as being easier to follow and understand. It is possible that collaboration diagrams are therefore difficult to follow and understand, although there is not enough evidence in these results to support this.

Future work

A further qualitative analysis is necessary to understand reasons for preference for one of the diagram types. It will be important to develop and use more formal methods of collection of qualitative data such as interviews, questionnaires and focus groups. Analysis of this data will also need to be more formal and content analysis will be one of the evaluation methods used in future studies. It is envisaged that a study based on the results of the next qualitative analysis will attempt to find possible solutions to solve some of the problems highlighted. Greater emphasis will be placed on individual differences and, depending on the results of the next qualitative analysis, possibly some new factors introduced into future investigations.

References

[1]Rumbaugh, J. Jacobson, I. and Booch, G. (1999) *The Unified Modeling Language Reference Manual,* Addison-Wesley.

[2] McCluskey, T., Porteous, J., Naik, Y., Taylor, C. & Jones, S. (1995). A requirements capture method and its use in an air traffic control application. *Software Practice and Experience, 25(1)*

[3] Petre, M. (1995) *Why looking isn't always seeing,* Communications of the ACM, Vol 38, No. 6.

[4] Nielsen, J. and Levy, J. (1994) Measuring usability, preference vs. performance, Communications of the ACM, Vol. 37, No. 4, April 1994.

[5] Britton, C., Kutar, M., Anthony, S., Barker, T., Beecham, S. and Wilkinson, V. An Empirical Study of User Preference and Performance with UML Diagrams In, Proceedings of IEEE 2002 Symposia on Human Centric Computing Languages and Environments (HCC02), Arlington, Virginia, September 02, IEEE Press.

[6]Kutar, M., Britton, C., Barker, T. and Swan, J. (2003) Investigating the Influence of Structure on User Performance with UML Interaction Diagrams. Proceedings of EASE and PPIG 03, Keele University April 03.

[7]Swan, J., Kutar, M., Barker, T., Britton, C. User Preference and Performance with UML Interaction Diagrams. Proceedings of IEEE 2004 Symposium on Visual Languages and Human-Centric Computing (VL/HCC 04), Rome, Italy September 04, IEEE Press