HUMAN CENTRED TECHNOLOGY WORKSHOP 2003

Square pegs in round holes? The relationship between empirical research and theoretical frameworks

PROCEEDINGS

7th Human Centred Technology Postgraduate Workshop

December 15th and 16th, 2003

Department of Informatics, University of Sussex, Falmer, Brighton, UK.

Organizers:

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Beate Grawemeyer
Tom Hamilton
Amanda Harris
Erika Martinez-Miron
Jonathan Matthews
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FOREWORD

This is the seventh in an annual series of workshops held in Sussex. They bring together PhD students from around the UK and mainland 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 at the forefront of this field. The theme of this seventh workshop is "Square pegs in round holes? The relationship between empirical research and theoretical frameworks".

Many people have been involved in the preparation for this seventh workshop. I particularly thank Jon Rimmer and Pablo Romero for chairing the workshop organizing committee, and the members of that committee:

Amanda Harris, Rowanne Fleck, Diane Brewster, Beate Grawemeyer, Tom Hamilton, Benjamin Zayas, Genaro Robolledo, Erika Martinez and Jonathan Matthews.

I would also like to thank the British Computer Society Human Computer Interaction Group for their sponsorship for a second year.

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 seventh in the series.

All the above are members of the Human-Centred Computing Technology group in the Department of Informatics at Sussex. This group comprises faculty, research fellows and graduate students from this and other schools, interested in research on the design, implementation, and use of human-centred technologies. The group is organized into three labs: the Interact lab, the IDEAs lab and the Representational Systems lab.

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

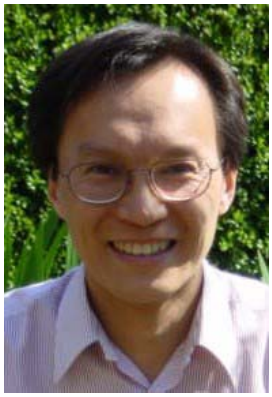
(i) to develop frameworks for understanding how people interact with and communicate through technology;
(ii) to apply this understanding to develop and support innovation.

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 two ESRC/EPSRC/DTI PACCIT Link grants.

Benedict du Boulay
Dean of The School of Science and Technology
Professor of Artificial Intelligence

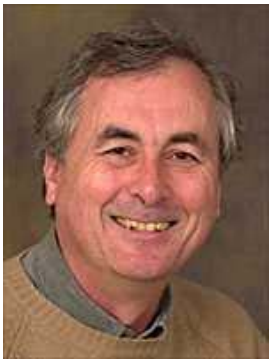
December 2003

INVITED SPEAKERS AND GUEST DISCUSSANTS



Peter Cheng's research concerns the fundamental nature of representational systems, both external in the world and internal to the mind, with a particular focus on the highest forms of human cognition, such as complex problem solving, discovery, and conceptual learning. The work also explores the design of technologies to exploit representations to support these forms of advanced cognition and the development of new methodologies and experimental environments to study the nature of such cognition. This area of interest grew out of his PhD in Artificial Intelligence, from the Open University, on computational models of experiments in scientific discovery. Following this he won a Postdoctoral Fellowship to work with Professor Herbert Simon at Carnegie Mellon University, Pittsburgh, where they collaborated on computational studies of the role of diagrams in scientific discovery. He then joined the School of Psychology at the University of Nottingham, becoming Deputy director of the ESRC Centre for Research in Development, Instruction and Training. Peter Cheng led projects on representational systems analysis and design, computational modelling of problem solving and learning with diagrammatic representations, the nature of drawing, graph-based reasoning and novel curricula for school science and mathematics. In July 2003, he joined the University of Sussex as Professor of Cognitive Science and now directs the Representational Systems Laboratory in the Department of Informatics.

Geraldine Fitzpatrick has a PhD in Computer Science and Electrical Engineering but her research and industry work have been more concerned with the 'people' side of the technology equation. This has meant working at the intersection of technical and social science disciplines to understand how to design technologies that fit in with the messy 'real world' of life and work. Her areas of particular expertise are around social interaction and collaboration, and she publishes in diverse areas such as groupware, computer supported cooperative work, user centred design, expertise sharing and health informatics. Currently she is the Director of the Interact Lab at the University of Sussex, where the group is engaged in a number of projects, including Equator, that are concerned with innovative interactions between people and technologies that move computing beyond the desktop. Prior to this, Geraldine worked in London as a Senior Manager of User Experience at a business and technology consultancy company called Sapient. Before coming to the UK, she was at the Distributed Systems Technology Centre in Australia where she established and led the Enterprise Work Practice group. Prior to all of this she used to be a nurse/midwife with work experience in a variety of settings, roles and countries.



Benedict du Boulay is Dean of the School of Science and Technology at The University of Sussex, a leading member of the Human Centred Technology Group in the School of Cognitive and Computing Sciences, and Editor of the International Journal of Artificial Intelligence in Education. Before becoming an academic he worked in industry and as a school teacher. His main research interest is in the applications of artificial intelligence in education and he has written or edited seven books and written more than 100 other publications in this general area. His particular interests include the role of representations in learning to program and in learning radiology, and modelling motivational teaching tactics in intelligent tutoring systems. Recently he has become interested in the interplay between Intelligent Learning Environments and educational TV.

Beate Grawemeyer has a Dipl. Inform. from the University of Applied Science in Trier and a Masters in Knowledge-Based Systems from the University of Sussex. She is a 3rd year part-time PhD student in the Department of Informatics at the University of Sussex, and a member of the Ideas lab. Her research interests include individual differences in preferences for external representations, user models, and automatic information visualization systems.
http://www.cogs.susx.ac.uk/users/beateg/

Jon Rimmer has a first degree in Psychology from the University of Manchester and a Masters in HCI from the University of Sussex. He has worked on several academic projects and a variety of commercial developments informing the design of interactive products and environments.
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Simon Li is a second-year PhD student at UCL. My research interests lies in Human-Computer Interaction and computational cognitive modelling. More specifically, like to understand the user from a cognitive psychology/cognitive science perspective.

Fatima Mansour has a Master of Philosophy (MPhil) in Multimedia industrial training and information management system from University of Wales. She is currently carrying on her PhD University of Wales. Her main research focuses are on knowledge representation and information visualization.

Mirja Lievonen has MSc and LicSc degrees in Architecture from Helsinki University of Technology.
She has worked since 1980's on several academic projects related to urban/rural environment and cultural landscape. Recently she has been working on issues related to work environment and technology mediation as a researcher on EU-funded SANE project (Sustainable Accommodation for the New Economy, IST-2000-25257).

Barbara Crossouard has a first degree in English and French from the University of Glasgow. She worked in English Language teaching abroad for some years before doing an MA in Linguistics (TESOL) at the University of Surrey. She is now a 2nd year DPhil student within the Sussex School of Education where she also works as a graduate assistant and research officer for an EU funded project focusing on Internet-Based Assessment.
http://www.sussex.ac.uk/education/profile140665.html

Shaleph O'Neill is studying Part-time for the degree of PhD entitled "An Exploration of a Semiotic Model of Interaction Through Mediated Environments" and is in his third year. He is also a research assistant and member of the Human Computer Interaction research group at Napier University.

Alice Good has a first degree in Computer Science from the University of Brighton and a Masters in HCI from the University of Sussex. She has worked on academic and professional projects relating to both usability and accessibility. She is currently in her 2nd year of Doctoral studies at the University of Portsmouth and is also unit co-ordinator for Computer Aided Presentation.

Erika Annabel Martinez-Miron obtained a BSc degree in Computer Science at Universidad Autonoma de Puebla (Mexico) in 1996. Then she moved to Mexico City to study at the Universidad Nacional Autonoma de Mexico where she obtained an MSc degree in Computer Science in 2001. Now she is in her third DPhil year at Sussex. Her interests include student modelling in Interactive Learning Environments and motivational and affective computing.

Tom Hamilton has a first degree in Medicine from the University of London and a Diploma in Fine Art from Suffolk College. His work experience includes psychiatry, web design and creative consultancy. He is currently a first year DPhil student at the University of Sussex. His research interest is how technology can be used to enhance individual and group creativity.

Jonathan Matthews has a first degree in Business Information Systems from Humberside Polytechnic and a Postgraduate Certificate in Education from the University of London. After teaching for 10 years, he did an MSc in Human-Centred Computer Systems at Sussex and is now in the fourth year of his PhD. His research is concerned with the collaborative creation and use of external representations in problem-solving.

Hanna Stelmaszewska has a first degree in Applied Computing from Middlesex University and a Master in Human Computer Interaction from Queen Mary. She is a first year PhD student and a tutor at MDX researching into evaluation of user experience. Her other research interests include: digital libraries, human computer interaction, user interaction, and usability.

Lene Nielsen has a master degree in Danish Literature and Language and Filmstudies. She has a pg.dip in Writing for the Screen. Lene Nielsen has worked commercial with HCI for several years especially within the area of medical information. For her PhD degree she works with the e-business group at the medical company AstraZeneca and a website aimed at asthma patients and medical practitioners.

Harry Brignull has an MSC in Human Centred Computer Systems and a first degree in Psychology from the University of Sussex. His research interests currently lie in user experience design for large interactive display systems in public places. Harry is currently in the final year of his PHD, and is also a research fellow on the Dynamo project.
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Amanda Harris has a BA in Applied Psychology from the University of Sussex. She is currently in the second year of her DPhil at Sussex and is working as part of the Riddles project in the Department of Informatics (www.riddles. sussex.ac.uk). Her research focuses on the influence of motivation on children's ability to engage effectively in peer collaboration.

Sallyann Bryant has a first degree in Information Systems and French and has worked in computing for 8 years mainly as an analyst, user interface designer and project manager. Sal is currently in the 1st year of her PhD at the University of Sussex, where she is interested in the psychology of systems design, particularly expertise and representations.

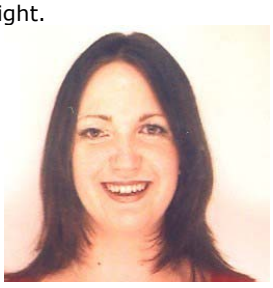
Diane Brewster spent 20 yrs teaching and studying in the humanities before being seduced by computer science, she now has a BSc from the OU and an MSc in Human Centred Computer Systems from Sussex. Diane is a member of the IDEAS lab at Sussex (Interactive Educational Applications) just completing the first year of her DPhil and is a course tutor on "Interactive Learning Environments".

Genaro Rebolledo has a first degree in Computer Sciences from Veracruz Mexico. He then did a MSc in Human Centred Computer Systems at Sussex University. He has worked on academic and professional work related to education and is currently doing his third year of Doctoral studies at Sussex University. His interests include educational technology, motivation and affective computing.

Thom Heslop has a first degree in Internet Computing from London South Bank University and has just started studying for a DPhil in Computer Science and Artificial Intelligence at the University Of Sussex, where he is part of the Nat-Hab group project looking into Natural Language Service Composition for persuasive networks. His research interests include intelligent user interfaces and the Semantic Web. www.cogs.sussex.ac.uk/users/tth20

Rowanne Fleck did her first degree in Artificial Intelligence and Psychology at the University of Edinburgh. She is presently working on her DPhil at Sussex where she is a member of the Interact Lab http://www.cogs.susx.ac.uk/interact/ and funded through the Equator project (www.equator.ac.uk). Her research is looking at ways interactive technologies can be used to support reflective learning.

Alison Elderfield has a first degree in Sociology from Cardiff University School of Social Sciences where she recently received her MSc in Social Science Research Methods. Using Max Weber as a theoretical backdrop for her PhD, she will now research the social realities of the 'enchanted' use of mobile devices and 'techno-mediated' interaction. She will use these sites to examine the technological 'promise' of a reintroduction of 'enchantment' into social life, via 'magic' and delight.



Julie Marshall BSc full time Research Student / Tutor at Middlesex University undertaking a PhD in HCI and a PGCHE. Interests in cognitive psychology and disabilities of people using the Internet. Studying the links between emotions experienced and the demand put on working memory when using assistive technology.

CONTENTS

Day one

Models and heuristics for science: examples from studies in representational epistemology

Professor Peter Cheng

The effects of knowledge of external representations upon representational preference patterns

Beate Grawemeyer

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Abstract
This paper reports on a study of individual differences in the external representation (ER) selection behavior of participants on a range of database query tasks like comparing, ranking and clustering. Participants were provided with a choice of information-equivalent data representations and selected one of these for use in answering an individual database query task, having previously been divided into two groups on the basis of a pre-experimental task (card sort) designed to assess knowledge of external ERs. The results show that the groups differ most in terms of representation selection on difficult tasks like clustering. Participants in the low group tended to change from more 'graphical' to less complex representations. In contrast, high ER knowledge group were able to successfully use a wider range of ER types.

Introduction
External representations (ERs) such as diagrams (graphs), text (notes, lists) and hybrid forms (tables, concept maps) are powerful aids to reasoning and problem solving. This has been established in various domains including analogical reasoning, vector arithmetic, algebra, word problems, and logical and analytical reasoning (e.g. Blackwell (2001), Cox & Brna (1995), Cox (1997), Glasgow *et al.* (1995), Larkin (1987), Stenning (2002)). Successful use of ERs depends upon skillful matching of a particular representation with the demands of the task. Day (1988) and Norman (1993) provide numerous examples of how a good fit between a task's demands and particular representations can facilitate search and read-off of information. Vessey (1991) provides a review of studies that show that tasks involve perceiving relationships in data or making associations are best supported by graphs whereas 'point value' read-off is better facilitated by tabular representations.

This paper is based on a study of participants' ability to select appropriate ERs, in the form of digital data displays, for use in answering database query tasks. The tasks were based on a database of information about cars including fuel efficiency, engine size, CO2 emissions, etc.. Participants were presented with a range of different task types, for example identify a single entity, spot clusters, compare entities on one or dimensions, etc., over 25 trials. Each trial consisted of one task type from the set associate, cluster, compare, correlate, distinguish, identify, locate, rank. On each trial, subjects were asked to choose the particular data display they felt would be most useful for answering the query. The options were presented as an array of display-type icons (table, scatter plot, bar chart, etc.). When a choice was made, an automated information visualization engine (AIVE) then instantiated the chosen representational form with the data needed to answer the task. Each query (task) could potentially be answered with any of the display options offered, but each task type had an 'optimal' display type. Figure 1 shows the different types of representations that AIVE generates.

Next, subjects answered the query using their chosen visualization. Following a completed response, the subject was presented with the next task and the sequence was repeated. The following data was recorded: the user's representation choices; time to read question and select representation (selection); time to answer question using chosen representation (answer); and participants' responses to questions. Further details about the experimental procedure are provided in Grawemeyer & Cox (2003).

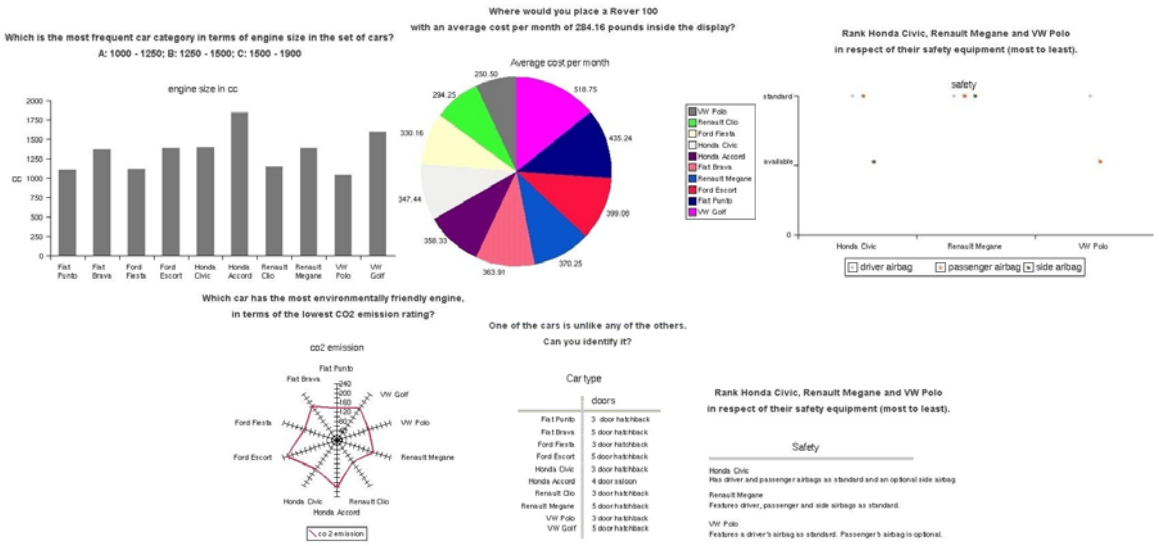

Figure 1: Representations generated from AIVE

Before the database query session, participants were administered a card-sort task Cox (1996), Cox & Grawemeyer (2003) in which participants sorted and labeled a large corpus of ER examples. The card-sort task was designed to assess participants' background knowledge of ERs. The aim was to study the relationship between subjects' prior knowledge (or 'repertoire' of ERs) and their reasoning accuracy and representation selection performance on the database query tasks.

Results and Discussion

Participants were divided into two groups on the basis of a post-hoc median-split on ER card-sort cluster scores. This yielded two groups – 'typical' card-sorters (high ER knowledge) and 'more idiosyncratic' card-sorters (low ER knowledge) (Grawemeyer & Cox (2003)). The 25 database task types were collapsed into 3 groups: 1. tasks requiring the precise read-off of values, 2. those involving qualitative comparison and 3. cluster tasks (involving associating entities, identifying groups of similar entities, etc.

Representation selection from early to late trials over the different task groups showed that the low group tended to change from more 'graphical' representations to less semantically complex representations (like bar charts or tables). In contrast, the high ER knowledge group used a wider range of ER types in early and late trials and selected more ERs that were predicted as to be 'good' ER to task matches by the literature.

The differences in selection changes from early to late trials between high and low ER group was most dramatic on more difficult query types such as cluster tasks. Subjects with high ER

knowledge tend to use scatter plots (appropriate) in cluster tasks, whereas low ER background knowledge subjects tend to revert to less semantically complex representations (and more ubiquitous ones) such as bar charts and tables. Low ER background knowledge subjects try at the first phase (early trails) to assign the 'best' representation, scatter plots, to cluster tasks, but abandon it when they have trouble with comprehending the display.
Scatter plots are more 'diagrammatic' or 'graphical' and require more specialized knowledge (of Cartesian coordinates, of what cluster patterns of high levels and lower levels of association look like, what the effect of isolated outlying values are upon association measures, such as correlation) to interpret, than with tables (which are ordered text) or bar charts (which have a simple 'longer = more' semantics). In the late cluster trials it can be seen that the low ER group scored higher (93.38% correct answer response) where tables were chosen 73.37% very efficiently with none incorrect answer, than the high ER group (88.2% correct answer response), which chose most often the 'best' representation, scatter plots (29.4 % correctly/ 5.88 % incorrectly).

Our research shows that there are differences in how low and high ER knowledge groups change their selection behaviour over time where difficult tasks are presented. The high ER knowledge group tends to match ERs to tasks which have been predicted from the literature to be 'good' matches. In contrast, the low ER group tend to change to less semantically complex representations which have not necessarily been predicted to be 'good' matches. If a 'good' match is present, there is a chance of getting an efficient result. However, our results show that matching an 'incorrect' representation to a task does not necessarily lead to a non efficient result. The next phase of this research will investigate the relation of subjects' difficulty with particular ERs, their skill on the card sort task, and classification and labelling performance.

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Investigating the language gap between the system and the user

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Thesis statement

This thesis highlights the interaction problems of a common mismatch between user and system languages. It exposes the lack of tools available for the HCI practitioner to investigate user language, and so provides a battery of techniques designed to elicit, capture and analyse this user language through a case study.

Introduction

> *Heuristic: Match between the system and the real world*
>
> The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

Above is one of the key heuristics as laid out by Nielsen (1994). The method of critiquing interactive products using a set of heuristics is the most popular usability inspection method. However, it is as much a mantra as "know your user", in that it does not make explicit techniques that enable you to do this. So, why should the language of the system match that of the user? What makes this heuristic significant? Indeed what are the problems of the language of the system not matching that of the user? And how can a usability practitioner go about capturing, analysing and using this 'user language'?

Problem space

1. Helpdesks

My research has focused on people's use of the Internet, the web and other networked technology. By carrying out long and short-term field studies of helpdesks around the UK, I found that many callers used mismatched language to describe their problems. Frequently, they did not seem comfortable using language that was composed of system-oriented terms. Often callers couched their language in non-technical terms, which needed to be clarified and translated by the expert. It was apparent that incompatible language contributes to user frustration, disappointing user-experiences and the necessity for helpdesks; a waste of time and resources for both user and service provider.

2. Error Messages

A variety of messages produced by popular web-sites were scrutinised by expert evaluation as well as interviews with network users. This revealed that standard error messages have a poor construction, which goes against most (if not all) of the guidelines for writing effective error messages. A critique of the different styles of

dealing with errors is presented and a checklist of design considerations for use by web designers and site managers that pay close attention to good customer service and experience is provided.

3. Network breakdowns
An experimental lab study was contrived which presented participants with a trail around the Internet that was sabotaged with typical network breakdown situations, thus hindering their tasks. The study explored user strategies for overcoming these obstacles and examined the language the participants used to explain these problems. Their descriptions were based on their own knowledge coupled with the language presented within the interface. There was indeed a problem, a mismatch between the knowledge and expectations of the user and the language of the system.

Having established the problem space of the thesis, in that whilst using the Internet a language mismatch can be detrimental to both user and service provider, the solution is to demonstrate techniques for the usability practitioner to investigate the user language. This can then be used to inform the language used within the system design. However, investigating user language can be problematic. There is very little research within the HCI literature regarding the investigation of this language. Therefore this thesis investigates methods to capture and analyse this language drawing, in particular, upon discourse analytical techniques.

The language expressed in the system can be seen in the labels used to assist the user's navigation, the content of the help files and in the system error messages. By making this language more accessible to the user, breakdown situations can be handled more intuitively and the user experience should be less frustrating.

Solution space
A battery of methodologies and techniques were employed to gather and elicit user language surrounding the use of networked technologies. My thesis presents this ‘battery’ approach illustrating the various ‘texts’ collated and their analysis, providing accounts of what this language is. In addition to this, the techniques are explored in terms of their practical use and where they may fit into the product development lifecycle, including a cost benefit analysis. Such methodologies include the following;

Eliciting user language

1. Flash Cards
This approach was a variation of the card sorting techniques used by researchers often to look at hierarchies and grouping of words from a consumer’s perspective. It is grounded on the idea that the organization of information on user interfaces should be based on the cognitive models of users rather than the intuition of designers. Single word flash cards were used to prompt explanations both in and out of a 'network' context. This empirical study investigated how far people understand central terms associated with networked technology. It demonstrates how people contextualise words, and when forced to define technological terms borrow from the semantics of the real world and this often leads to misconceptions.

2. Contemporary Legends (aka urban myths) & other authored accounts
Contemporary legends were collected as a method for gathering information about users' background knowledge and experience - the first step in conceptual design.

Contemporary legends are products of people's need to channel their insecurities and fears about the world around them into something concrete, and can therefore help us identify the issues that are important to a group of users. These were used to elicit users' existing knowledge of computer networks. They showed the misconceptions and fears, especially of computer viruses, which exist among Internet users. Addressing these fears and misconceptions in future network applications will ensure more confident users who are less likely to waste valuable resources.

3. Drawings and diagrams

Having shown that adults have a poor understanding of how the Internet works, how do we expect parents and teachers to impart the correct information to children? Longitudinal research was carried out that gathered children's drawings and explanations of how the Internet worked. Drawings proved to be a valuable resource when eliciting explanations from children which was perhaps less intimidating than an interview without 'props'.

4. Repertoires

This entailed analysing the texts gathered from interviews, think aloud protocols and authored accounts using the tools from discourse analysis. This can be used to capture these lexicons, and show how they vary according to the function of the text. Analysis showed a variety of repertoires used to describe typical network applications, such as Email and Web use. These repertoires are presented and a description of how they can be used in the design of the user interface is given.

My thesis discusses how elicitation and analysis of this user language can be carried out and the extent to which detailed analysis is necessary depending on purpose of the research. So, for example, top level content analysis may be useful for informing the navigational labels, thematic analysis for system messages and more detailed repertoire analysis for online help.

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Postcompletion error — what we know and what can we do to avoid them?

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Abstract

There are many different kinds of error humans could make when interacting with technologies. A postcompletion error occurs when a user has completed the goal but not the task itself. For example, one might successfully complete the goal of withdrawing cash from an ATM but forget to take the card back. Byrne & Bovair (1997) studied postcompletion error in a proceduralised task and found that subjects were more likely to make the error when working memory demands were high. A memory capacity theory was proposed and a computational cognitive model was developed to explain the phenomenon. This thesis is going to investigate postcompletion errors in problem-solving tasks and how visual feedback might, or might not, mitigate the occurrence of such errors. A computational cognitive modelling approach is adopted and empirical findings will be modelled within the ACT-R cognitive architecture.

Introduction

Human error is one of the most important research topics in the field of Human Computer Interaction (HCI). James Reason, a prominent researcher in the field, provided a comprehensive account of human error in his book Human Error (1990). However, Reason's and several researchers' theoretical accounts of human error have been criticised in terms of the strength of understanding of the nature/origin of the phenomenon. Researchers such as Byrne & Bovair (1997) and Gray (2000) adopted a cognitive science perspective in investigating human error, in which they developed computational cognitive models to explain the mechanisms that underlie the types of observed human errors. Such mechanistic approach allows researchers such as Byrne et. al. and Gray to provide a finer classification of human errors (in addition to taxonomies such as false alarms, mistakes, or slips) and also explanations of the causes of the phenomenon.

This thesis is an attempt to address the research question: "What are the factors that would mitigate postcompletion error?" Postcompletion error is a kind of systematic procedural error. Systems that are prone to this kind of error usually have a characteristic of having the last step of the task independent of the user's goal. When the user has achieved his/her goal

through the use of the system, the task remains incomplete because the user has forgotten the very last step of the interaction. An example would be forgetting to get the original documents back from a photocopier after photocopying.

Byrne & Boviar (1997) investigated under what condition postcompletion errors are more likely to occur in a highly proceduralised task. They found that subjects were more likely to make postcompletion error when they were under high working memory demand. A memory capacity account, based on the 3CAPS cognitive architecture (Just & Carpenter, 1992), was proposed to explain the phenonmenon. Byrne et al put forward a theory of postcompletion error which postulates that the occurrence of such error is due to goal loss caused by excessive loading on working memory. From the general theory of postcompletion error, which incorporates the cognitive system — working memory, Byrne et al. developed a computational model which operationalised the concept of limited capacity of working memory and was able to simulate postcompletion error. The most important concept of the model is that its goal-forgetting mechanism is load-based activation scaling. This allows one to make predictions of postcompletion error occurrence according to the load on working memory. My work will further investigate this phenomenon, studying other factors that provoke or mitigate it.

Proposed empirical studies

The objective of the empirical study is to investigate whether subjects are likely to make a postcompletion error when solving a text-based puzzle of high working memory demand. Instead of using a dual task paradigm, as in Byrne et al's study, with a well-practised proceduralised task and a secondary task to tax ones working memory load, problem-solving tasks with an embedded post-completion step will be used to explore the possibility of generating the error. The hypothesis is when subjects are required to do a mental problem-solving task that requires a high demand on working memory resources then, with all else being equal, there should be a higher probability of committing a postcompletion error.

Based on the findings of the first study, a second study will be carried out to investigate the effect of visual feedback on postcompletion error. Postcompletion-error puzzles will be implemented as games presented on a computer screen. The hypothesis is that when the information of the puzzle is offloaded to the external world this should free up working memory capacity. With all else being equal, it is predicted that subjects should be less likely to make the postcompletion error in this condition.

Research approach

Byrne et al's theoretical and formal approach to investigate human error has motivated this study. The approach to address the proposed research question in this thesis is largely empirical as well as formal. The formal approach involves modelling empirical behavioural data within a cognitive architecture, and in this thesis the ACT-R (Anderson & Lebiere, 1998) architecture is used as the modelling framework. Byrne et al's theory of postcompletion error will be used as a starting point to guide the modelling direction of this study.

Relation between ACT-R and human error in general

Byrne (2003) argues that taxonomic frameworks provided by conventional human error research lack predictive powers to allow researchers to make predictions of error behaviour. He suggests that a mechanistic approach using computational cognitive modelling can help overcome the shortcoming. Furthermore, Byrne suggests ACT-R as a suitable candidate as a mechanistic framework for error prediction. Although it is acknowledged that ACT-R is not the ultimate answer to human cognition, it nevertheless serves as a good starting point in explaining and predicting certain human behaviours in terms of its proposed cognitive mechanisms. ACT-R allows one to implement a running simulation of one's theory. It requires also a runnable external environment to accept and respond to ACT-R's actions. When running an ACT-R model, an output of timestamped sequence of the model's behaviour is produced. This output contains overt (e.g. mouse click) as well as covert (e.g. memory retrieval) behaviours which allow the researcher to trace the model and, ultimately, explain the observed behaviour.

Byrne also points out several mechanisms proposed in ACT-R that potentially has the capability in producing error behaviours. Due to space limit, a detailed description of ACT-R's mechanisms will not be presented. However, the general idea is that because there are noise components in ACT-R's computation, consequently, this stochasticity might lead a model to select an "incorrect" action despite the presence of "correct" knowledge.

The ACT-R model to be implemented in this study will be validated against empirical data for its cognitive validity. When the cognitive model has a close approximation to the human data, it will be used to predict human behaviour in a further experiment which will be designed to investigate how postcompletion error might/might not be mitigated through visual feedback.

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From City Walls to Digital Boundaries
- Studying Interaction in Hybrid Environment

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Work environment has undergone profound changes when Internet and mobile phone became part of everyday life: new electronic fora for interaction and collaboration became available, and new types of community such as online communities have emerged. When technology mediation enables communication and collaboration, it also breaks down natural interfaces by fragmenting them. This modal fragmentation has impact on everyday life and ways of working. Information that can be captured by human senses of sight and hearing can be remotely represented and multiplied in digital form. However, remote representation of the information captured by proximate senses of touch, and in particular, smell and taste, is not within reach of such representation or replication. We therefore must distinguish between information that will remain within the boundaries of physical interaction space and information that can be remotely represented in digital form.

In order to study communication and collaboration in a hybrid environment, it is necessary to capture the whole diversity of communicative situations. This paper addresses some theoretical and empirical research challenges of work communication and interaction in hybrid environment, in particular the concept of *situationality* which has gained little attention so far in CMC- or CSCW-related literature *(Pihlanto 2003)*, and will therefore be discussed here in order to contribute to the development of theoretical tools for studying interaction in hybrid environment.

'Hybrid' situationality

Spatial aspects play a crucial role in interaction and communication: the participants remain bodily beings in their geographical contexts, independent of what method of communication and interaction is used. Mutual orientation is necessary for any joint action. A joint action encompasses the current situation of each participant. Difficulties occur in understanding others' perspectives even when people are communicating face-to-face in the same room, but much more difficulties arise in mediated communication and interaction where participants try to establish mutual orientation remotely, eg. through their embodiments in virtual environments as has been described in literature *(Hindmarsh et al. 1998: 220-221).*

If we take a *human centred* perspective on technology mediated communication and interaction, we then have to view it as *human-human* communication and interaction, enabled and supported by technology mediation. Human-human interface is highly complex, because interaction and communication is a stratified process ranging across different spheres governed by different types of laws and regulating rules. The participants of interaction and communication are, depending on the focused level, physical bodies with spatial dimensions in the world, biological organisms with metabolic and physiological processes in their ecological context, human beings each having their unique personal history and background, members of social organisations in their socio-cultural environment, capable of learning and using specific languages. In the hybrid context of interaction and communication, even their representations are involved among contextual references. The human-human interface in the hybrid environment is therefore increasingly complex.

We may find the 'holistic individual image' by Lauri Rauhala helpful in order to understand what underlies the human-human interface. According to Rauhala, the three basic modes of human existence are corporeality *(kehollisuus),* which is existence as organic processes, consciousness *(tajunnallisuus),* existence as experiencing consciousness, and situationality *(situationaalisuus)* which is existence in relation to reality (personal situation) *(Rauhala 1993, Pihlanto 2003)*. Situationality as a concept referring to 'life situation' is ambiguous, because life circumstances consist of tangible and intangible (concrete and ideational *(Rauhala)*) elements.

Interlinking situationality and Common ground

Situationality is not detached from evolutionary aspects of life and culture. Life results from the biological evolution and reproduction, and the cultural components of human environment result from the cultural evolution and human capacity for learning. The sociologist Norbert Elias takes a longitudinal approach to culture in grand scale. In his symbol theory, Elias goes beyond the traditional boundaries of subject/object and nature/culture, taking the biological evolution and the social development into account as the background of symbols, language, and accumulation of human knowledge. Symbols are also tangible sound-patterns of human communication, made possible only by the precondition of the human vocal apparatus resulting from the biological evolution. Symbols are for Elias also the 'fifth dimension' *(Elias 1991).*

The ontology of Three Worlds by Karl Popper distinguishes the realms of nature, subjective experience and culture *(Niiniluoto 1990)*. According to Popper, "World 3 is the world of the products of the human mind" *(Popper et al. 1977: 449)*. Popper's categorisation is not sufficient enough for the study of communication and interaction, because it 'hides' the intermediary level of the biological 'world' underlying World 1/World 2, World 1/World 3, and World 2/World 3. That level is, however, crucial for understanding the relation between individual and interpersonal processes. The biological body is the necessary instrument for a subjective experience. Georg Henrik von Wright *(1994: 108-110, 1998)* addresses the relations between neural, mental and behavioural phenomena describing three priorities that govern their interfaces: epistemical priority of the mental to neural, causal priority of the neural to behavioural, and semantic priority of the behavioural to mental. This clarification helps us to see the human experience and action as a dynamic circle. The human body is the instrument and the centre of coordination of both experience and action, of internalisation and externalisation.

Donald W. Winnicott approaches culture and creativity introducing a concept *transitional phenomenon*. He speaks firstly of personal or psychic reality, secondly of external reality or actual world, and thirdly of potential space, the area of transitional phenomena. According to Winnicott, "the place where cultural experience is located is in the *potential space* between the individual and the environment (originally the object)". *(Winnicott 1971: 100-103).*

These approaches seem to capture overlaps not 'down-breakable' on the one and same level. The overlaps seem to be crucial for human interaction and communication, where language plays an important role. For studying the use of language, a Common Ground Approach was developed by Herbert Clark *(1996)*. However, it has a limited validity because it does not cover the whole range of extra-linguistic domain of communication, starting from the tones of intonation and facial expressions to the full range of body language of movements and actions, gestures and physiological expressions of nonverbal communication. Before learning to speak, the only way to communicate for the human being is the multi-modal, preverbal

communication. (Although the work of Gill & Borchers, 2003 on gestures and body language is complementary to Clark's work on language use)

We regard here languages, concepts, tools, intangible and tangible artefacts created by human intention through human action, as more or less dynamic components of situationality. Tangible products are embodied in material form. Technology is both created and used by the human being. Once applied, it becomes part of human environment and consequently, part of situationality. Digital communication does not practically exist without human intention and participation; it is, eventually, human –human communication mediated by technology.

Towards interrelated perspectives on human centred technology mediation

Several aspects need to be taken into consideration in the further development of a conceptual toolbox for the studies of interaction and communication and their modal fragmentation in the hybrid environment. In this paper, some human centred building blocks have been discussed. For its part, the paper aims at contributing to the clarification of spatial aspects of 'hybrid' situationality. The construction by G. H. von Wright, combined with the Common Ground approach, seems to give a solid theoretical base to pursue theoretical thinking further in order to reach an integrative approach to interaction and communication in the hybrid environment. Incorporating necessary elements and relations from complementary theories may help to avoid a theoretical fragmentation and to reach a set of interrelated research approaches.

The theoretical base needs to apply to a variety of combinations of interfaces between who-what-where, enabled or not, by technology mediation. In hybrid interaction, coordination levels and organisational nodes differ from those of natural interaction. Mapping and describing them, and clarifying their mutual relations and their role as part of situationality, are steps to articulate interfaces underlying hybrid interaction. Mapping the relations is expected also to lead to a better understanding of 'hybrid' situationality. That understanding again is needed in order to investigate the affordances and constraints offered by hybrid environment for work communication and interaction, and their multi-faceted implications in everyday life.

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Holistic Visualization of Distributed Knowledge

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Introduction

The goal of this research is to investigate how visualization tools may help the collaborative decision making process. Traditionally, experts, e.g. in the medical profession rely on empirical data and their own experience to advise patients with individual needs [1]. This knowledge is often independent and detached. The aim of this research is to define how individual therapist's knowledge may be represented and how collective knowledge may be represented holistically.

Background and significance of this research

Knowledge is the full utilization of information and data coupled with the potential of people's skills, competencies, ideas, intuitions, commitment and motivations [2]. A holistic view considers knowledge to be present in ideas, decision-making, relationships, perspectives and concepts. Clearly the knowledge that supports an organization's processes and decision-making capability is an absolutely vital resource, but it is a resource that suffers from lack of management. This has a profound effect on the decisions we make and actions we take. It is necessary to organize and understand the processes that affect our actions and decisions and take steps to improve the quality of these processes and in turn improve the quality of those actions and decisions for which we are responsible.

Knowledge management enhances the presentation and processing of knowledge by humans, machines, organizations and societies [3]. It ensures that the right knowledge is available in the right forms to the right entities at the right time. There are multiple techniques for managing and representing knowledge, such as concept mapping, semantic networking and frames [4].

Objectives of the research

The objective of this research is to provide an effective decision modeling and knowledge visualization tool that can be used to generate expert system knowledge, which will alternatively advise end users, e.g. the experts' clients.

The ultimate goal of the research is to improve decision–making processes by using visualization. Also the goal of this research is to measure the effectiveness of improved understanding and improved decision making by exploring how the visualization model changes the cognitive maps of individual decision makers.

Current Work

The starting point of this research was to explore visualization tools and using Mind Mapping as a graphical technique for representing and organizing ideas [5]. The important aspect of Mind Mapping is that information is categorized and structured. Mind Maps use this aspect in how elements are connected. Any main topic relating to the Mind Map subject is

connected to the central image with a line. Subtopics are connected to their respective higher-level topics with lines. The fact that Mind Maps provide an overview at the same time as very detailed information make them usable for giving brief overviews while immediately enabling detailed discussion.

Free Mind is a Mind Mapping tool, which allows editing and viewing tree-structured data [6]. An advantage of Free Mind software is that the data are structured with XML (eXtensible Markup Language). XML is created to structure [7], store and to manipulate data. It offers a structured and consistent way to describe data, which allow an easy access to information.

A Mind Map created in Free Mind is stored in XML format. Each node in Mind Map corresponds to an XML element. Additional information about these nodes is contained in attributes and can be accessed and modified easily. From this fact, one of the research focus is to generate several Mind Maps sharing the main idea and merge the XML source code of these Maps to produce one XML file. Opening this XML source code with Free Mind will display a merged Mind map. The next phase of the research is to consider how the merged map may be manipulated to represent clearly and truthfully the shared knowledge of individual experts' maps. Fig. 1 shows a very simple example illustrating the concept.

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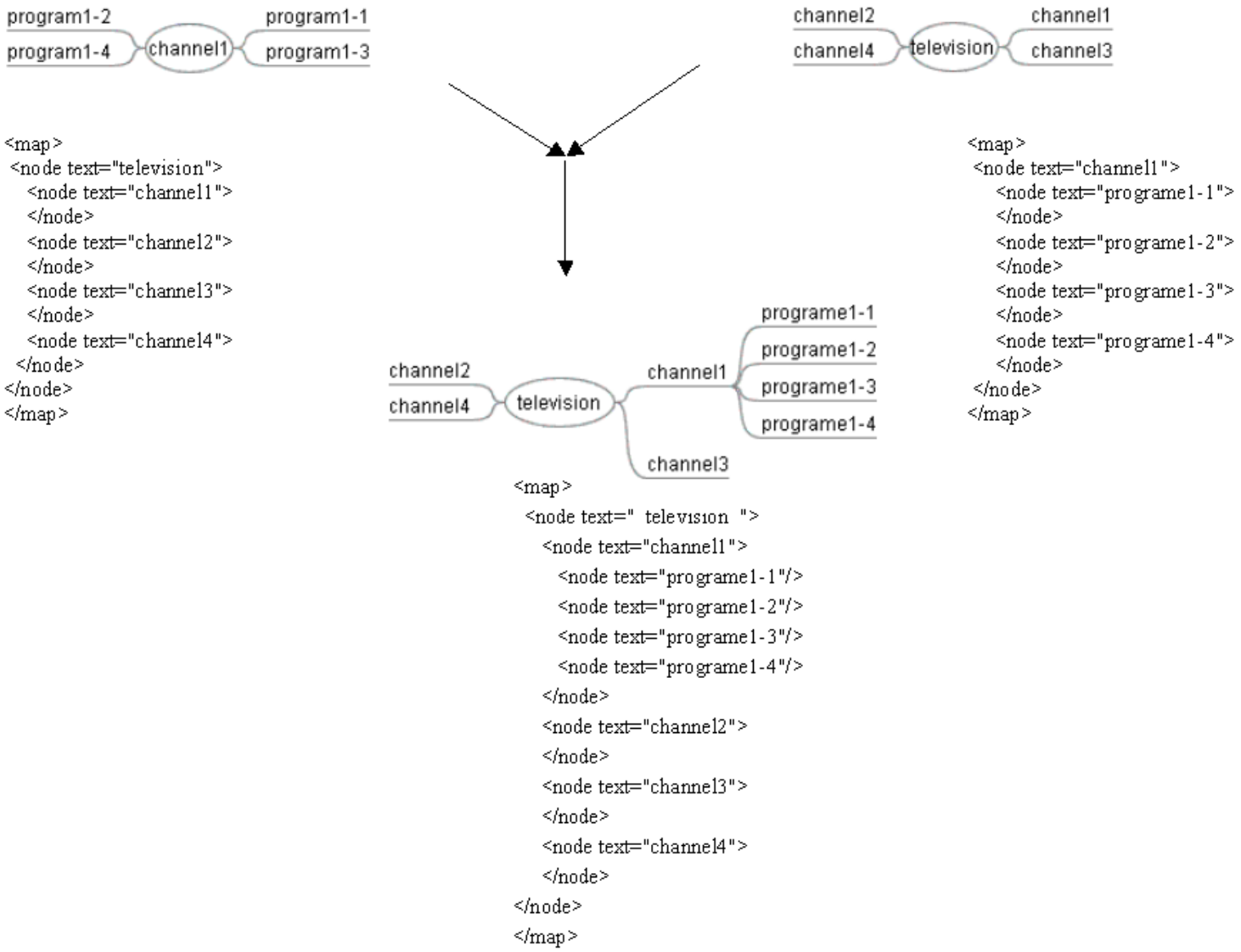

Fig. 1. A simple example of knowledge about TV programming.

The Development of Online Learning in the Context of a Part-Time Professional Doctorate Programme

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The growth in the use of the internet and development of the world wide web have been rapid and seemingly unrelenting. As noticeable as the spread of the internet has been the swell of bold predictions about its transformative powers, typically constructed as being for the better, so making questioning of these changes appear quite irrational (Woolgar, 2002). Education is no exception in this respect (see Clarke, 2003:2). As part of this transformation, e-assessment is also portrayed as a means to reform and diversify traditional testing methods increasingly seen as being unable to represent the range of skills of the 21st century citizen.

While all of this seems laudable and desirable, it does deserve examination. The pressures on higher education in many countries, including England, are undeniable. Fortuitously then the rapid development of internet technology and its uptake within broad sections of the population appear to open up the possibility of offering higher education on an any time, any place basis, allowing the delivery of course materials to large numbers of students in cost-effective ways, with e-assessment as an alluring mechanism to deliver large-scale testing. In addition, while much of the literature relates e-learning to constructivist learning paradigms, it would appear that older behaviourist paradigms lurk behind much current practice. Moreover, despite the promise of alternative assessment methods, in practice e-assessment can often take the shape of objective testing, where multiple choice questions are used to reinforce knowledge in fundamentally behavourist ways.

Great claims then have been made for the potential of the internet to transform higher education. While some of these claims relate to enhancements to student learning, equally there are other contradictory positions within this discourse, along with considerable financial pressures. It is important then to scrutinise the pedagogical implications and consequences of web-based learning. In the context of a project supported by the European Union (EU) the intention is to study the introduction of an element of online learning within the context of a part-time doctoral programme in School of Education within this university.

In this context I am conducting an instrumental case study of the cohort of Professional Doctorate students who joined in October 2003 with the aim of gaining insight into the development and use of online learning, and its potential for formative assessment. A case study approach is adopted as being particularly suitable for an in-situ exploration and representation of a complex situation, its special value being both its particularistic and holistic nature.

The Professional Doctorate in Education is a part time doctorate pursued by mid-career professionals from a range of educational settings. These students come to campus for two weekend workshops per term, so a dedicated web site (using the virtual learning environment software WebCT) has been developed to explore its potential to provide greater opportunities for interaction between seminars, and also to provide opportunities for formative assessment. Within this setting, the project can be seen in terms of action research, involving reconnaissance, planning, observation, evaluation in ongoing cyclical way, with the involvement of the students within the research context.

Formative assessment is conceptualised as lying at the heart of the learning process, where identification of an area of a student's understanding where new constructs could be developed can allow a tutor to teach in the zone of proximal development, as described in social constructivist learning theory (Vygotsky, 1986). Fine-grained analysis of classroom interaction by Torrance and Pryor (1998, 2001) has shown effective formative assessment to be a complex phenomenon the success of which cannot be assumed, but instead calls for a great deal of skill and awareness in the teacher both on the cognitive and the social/affective level. However more open questioning, exploring *what* learners knew or understood was found more useful to open up opportunities for formative assessment than question forms focusing on *if* learners knew or understood a predetermined thing. More open questioning was seen to allow the agenda of the learner to take priority, rather than the agenda of the assessor. The two different forms of assessment were conceptualised in their framework which opposes *convergent* and *divergent* assessment. (Torrance and Pryor, 1998; 2001). Within our project we are interested in the potential for online conversations to create a site for formative assessment of this kind.

The research questions which our project is examining are the following:

What are the teaching and learning practices that develop when participants within a professional doctorate programme are given access to web-based learning media?

- How useful do participants find these different practices?
- How do they inter-relate with other (face to face) teaching and learning practices.
- To what extent do the practices enhance formative assessment?
- How might these practices be incorporated sustainably into a blended learning environment?

Methodology

As a researcher I intend to follow an interpretative idiographic research paradigm which recognises the social construction of meaning (Berger and Luckman, 1966). Within this paradigm, the hermeneutic nature of an individual's subjective experience is seen as inevitable and indeed central in the production of the social world in which we live. From this standpoint I wish to elucidate the understandings of individuals in particular settings and the ways they make sense of their world.

Research Methods

An ideographic approach implies a primarily qualitative and interpretative paradigm, but where appropriate some quantitative data collection may also be carried out. The use of a variety of data collection methods will allow triangulation and increase the validity of the interpretations made, and respondent validation will also be used. Reflexivity in examining my representations of the study will be essential. Employed as a graduate assistant as research officer for the project, I am developing the web site for the students and am therefore part of the setting which I am researching; indeed part of my research focuses on the role which I am fulfilling as web site developer.

The documents relating to the project as well as the educational context in the UK will be analysed to contextualise the study, using critical discourse analysis (Fairclough, 2001).

To contextualise our study, a questionnaire has been used to develop some awareness of the current uses of the internet for teaching learning and assessment at Sussex, followed up by semi-structured interviews with respondents and key actors in e-learning at Sussex.

I have carried out semi-structured interviews with some students of the previous cohorts, in order to characterise the different learner experiences on the programme and I am now interviewing the new cohort (14 students), some by telephone, although most face to face. Another series of interviews will be carried out at the end of the first year of the programme where students will be asked to reflect on their use of the web site and its relationship with their learning. The interviews will be transcribed and coded around emerging themes in an interpretative, responsive way, with Nudist software used to facilitate analysis. Insights from Discursive Psychology (e.g. on what individuals *do* with their talk) may be used to analyse how learning and online learning are constructed. Some online questionnaires may be used to gain the students' evaluation of specific initiatives using the web site. By attending the weekend workshops, I can engage in participatory observation, interacting with the students and the tutors. Keeping a reflective diary involves me writing about the setting I am studying, but also on how I am learning about that setting. Finally electronic data (emails, use of discussion forums) can be analysed using both qualitative and quantitative methods, but primarily fine-grained qualitative analysis, combined with respondent validation of interpretations.

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An Investigation into Improving Accessibility to Web-based Information for Users With Impairments.

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Abstract
There are huge problems associated with the accessibility of web-based information for both disabled and elderly people. These problems relate to the non-effective process in which information is selected and presented in addition to the well documented issue of poorly designed web pages This *limited accessibility* not only decreases the effectiveness of the web as an investigative tool but impacts too upon social interaction. One possible solution would be to order web pages according to accessibility ratings, which would then eliminate poorly designed web pages in favour of quality content. To this extent, adaptive, navigational technologies that support specific user needs could then improve accessibility and thus increase the pedagogical value of the web.

Background
Accessibility to information is increasingly focussing upon an extended range of user groups, including those with special needs, a process which could go some way to compensate for their difficulties and subsequently improve their lives. (Kobsa & Stephandis,1998) Social isolation is often experienced by both the disabled and the elderly due to families moving away and friends dying. (Katz, J.E. and Aspden, P, 1997). Furthermore, these people are often subjected to digital isolation as a result of the problems experienced in accessing information. (NTIA, 1999) This then impacts upon the extent to which these people are able to participate in the information world that is representative of today's society. The World Wide Web can provide access to a huge range of information in terms of learning support and specific interest needs for both the elderly and the disabled. However, the unsystematic way in which vast quantities of information is selected means that these users are unable to easily access specifically required content. In addition, much of this information remains of little use because the way in which it is presented pays little regard to the nature of users' disabilities. Ultimately, this user group requires access to information that has been selected to support not only the user's goal but also their individual needs.

Aim of Research
The aim of this research is to improve universal access to information for a wider range of users. This will involve the adaptation and subsequent extension of the Computer Aided Information Navigation project (CAIN) (Lamas et al, 2000) to support the specific needs of both disabled and elderly people. The CAIN project demonstrates how providing adaptive navigational support can effectively increase the web's value as a pedagogical tool. (Lamas et al, 2000) The system is intended to support the user by presenting them with context specific ranked information that has been selected and ordered according to their individual needs. These needs are stored

as heuristics in the user's model and currently focus on level of expertise and the user's goal. (Lamas et al, 2000).

To enable universal access, the user's model must be extended to consider both physical and cognitive disabilities. These are likely to include; problems with vision, hearing, motor control and working memory, as well as other less well known ones. (White, Jerrams-Smith & Heathcote, 2001). Furthermore, a means of developing new attributes of web pages, to be stored in the web model, will be explored. The web model will enable the process of automating the ratings of web pages, according to the specified attributes contained within the user model. For example, the *suitability* of web pages may be categorically rated as: very suitable, medium or unsuitable. Potential benefits include supporting users in various learning, recreational and social activities and therefore reducing the extent of experienced social isolation.

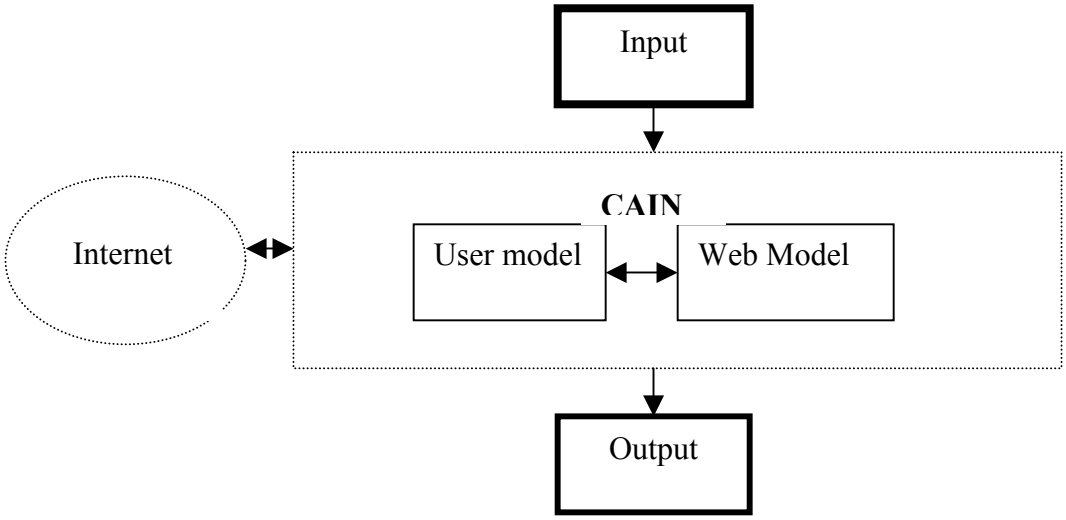

Figure 1: *A model of how CAIN works.*

Overview of Studies

The research will focus on identifying the requirements of this user group and identifying what adaptivity is needed for the current system to support specific needs. This will involve identifying recognized disabilities in addition to other less known handicaps, which will subsequently be categorised. Certain aspects of web pages that make them particularly suitable to users with disabilities will be looked at to help understand how information can best be selected and ranked. Using this information, the CAIN system will be adapted to meet these specifically identified requirements. Adaptation will involve the modification of Cain's user model to include certain physical and cognitive attributes. The system will then be evaluated with real end users to measure the extent to which accessibility has been improved. Indicators of measurement are likely to focus on usability and user experience goals. (Preece et al, 2001) A participatory approach to design will then be necessary to ensure that the extended range of user requirements has been encompassed and to guarantee the development of both a usable and fully utilised system

Aims – a sequential approach

- To identify taxonomy of determinants that affect navigational performance.

- To catalogue the range of effects that result from each determinant.
- To create a means of describing new attributes, that directly relate to the extent to which certain components of web pages can be said to be accessible to the disabled user.
- To find a means of enabling the web modeller to identify these attributes.
- To catalogue web pages based upon these attributes.
- To find a means of automating the rating of suitability of web pages according to the users' requirements.
- To evaluate the effectiveness of the system in improving accessibility.

Contribution to knowledge

The main contribution to knowledge, that this thesis endeavours to demonstrate are:

- To identify the additional requirements to enable CAIN to be adapted for users with disabilities.
- To create a means of storing attributes of web pages that relate directly to the accessibility of content.
- To automate rated content based upon user requirements.
- To improve accessibility for users with disabilities.

Summary

Adaptive navigational techniques that supported specific needs could improve accessibility to web-based information. Selecting information according to user-defined ratings of elements, which affect accessibility, could help to reduce the amount of non-accessible information presented. This very process of improving accessibility not only increases the usefulness of the Internet as a learning tool but also goes some way to improve the lives of people with impairments. Not least by providing the means for empowering these individuals and reducing the risk of social isolation.

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Theory and Data: The Problems of Using Semiotic Theory in HCI Research

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Abstract
This PhD is concerned with developing a semiotic model of interaction that focuses on interactive systems. An important factor in the development of this model is the relationship between semiotic theory and empirical work. Semiotic theory grounds the basis of the model while empirical evidence to support the model is based on detailed video talk-aloud protocol analysis. It is now at a stage where the empirical data gathering is nearing completion and the relationship between theory and data in paramount. This paper attempts to explore this relationship.

Semiotics and HCI
Semiotics has been used in many different domains to explore the meanings and meaning making process that occur when people interpret signs. For the most part it is used from a first person perspective to analyse 'texts'. Texts here are considered not just in the literary sense but also from the notion that any group of signs can come together to make up a readable, or interpretable, entity e.g. a news paper article with pictures, an advertising bill board, or a film. Largely it has made its mark in cultural and media studies as a form of critical analysis performed by semiotic experts who analyse these texts to find the different levels of meanings that can be attributed to them. An interesting central theme of semiotics is the notion of the relationship between the authors and the readers of these texts. Semiotic theory has called this relationship into question; undermining notions that meaning resides in texts in themselves and supporting the notion that the reader makes meaning when the text is interpreted. In relation to HCI research this is an interesting perspective for two reasons. Firstly it treats software interfaces as texts that can be analysed in search of the meanings that can be attributed to the signs in an interface. This idea can contribute to the notions of communicability and usability of user interfaces (Prates, deSouza et al. 2000; Prates, deSouza et al. 2000). Secondly it treats the whole process of interaction as a semiotic process, where signs are transformed, exchanged and interpreted between the user and the computer (O'Neill, Benyon et al. forthcoming).
One major aspect of the application of semiotic theory in relation to HCI research is that it offers an alternative to psychology based, or phenomenology driven approaches to HCI that largely focus on the cognitive aspects of human interaction. However, in this respect it's strength becomes it's weakness. The first person perspective of text analysis that is fundamental to most semiotic approaches enters into a discourse with HCI that is laden with third person empirical data gathering driven approaches. Empirical data gathering is something that semiotic theory is not designed to do and as such it suffers from criticism from other disciplines in not being able to defend it's claims. In relation to HCI then, semiotic theory finds itself in a unique position in a cross disciplinary field where the claims of any semiotic driven research have to address the questions levelled at it from these other

disciplines. The work that I have undertaken as a PhD student deals directly with these problems.

The model

The focus of this work with semiotics has been the development of a semiotic model of interaction. The basis for the model is developed form a broad understanding of the ongoing debates in semiotic theory itself and the place of such theories in the HCI /Semiotics community as a whole (O'Neill, Benyon et al. forthcoming). The model is derived from this theoretical background that is then explored in relation to case studies where users interact with various real and computer supported environments.

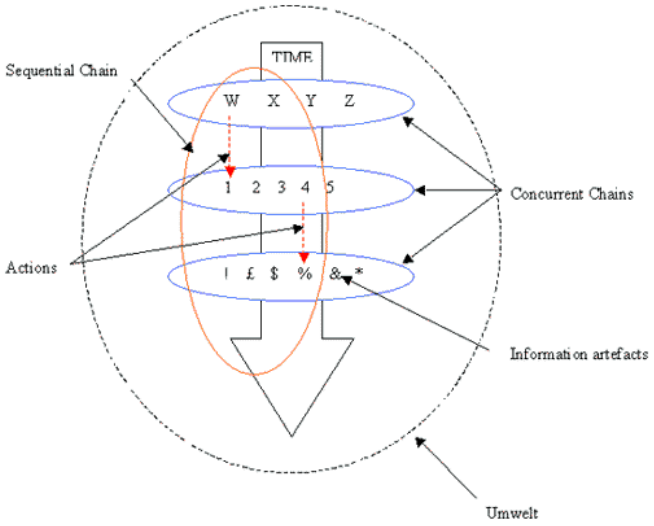

Figure 1 A semiotic model of interaction from theory

Significant aspects of the model (Figure 1) include the information artefacts (Benyon 2000; Benyon 2001) or signs in the interface; The relationships these signs have with one another, the concurrent chains of signs (Andersen 1990) that constitute the layout of the interface; The actions of the user on these signs, i.e. interpreting and using them; The background of knowledge and experience of sign systems that allows a user to interpret these signs, the Umwelt (Sebeok 1979; Allot 1992; Allot 1994; Kull 1998; Deely 2001); The sequential chains of signification that arises over time as users interpret and use the system (Andersen 1990).

Empirical work

The studies so far have been aimed at gathering empirical data that might support the theoretical model in some way. They have also been an attempt to develop a suitable method that will allow the gathering of empirical data from a semiotic perspective. The method is informed by semiotics, psychology, and phenomenological theory. As HCI is a cross disciplinary field where semiotic theory has a place amongst others, it seems appropriate to assess that place in relation to aspects of those other theories. Data is gathered using talk-aloud/video protocols that have been used in HCI research for some time now (Prates, deSouza et al. 2000; deSouza, Barbosa et al. 2001) The aim of this method is to gain an insight into how different users make sense of the signs in the environments that they operate in whether they be computer supported or other wise. The videotapes are analysed from a phenomenological perspective in the first instance, looking at the activities of the users and how they interact with the signs. The talk-aloud transcripts are then analysed using a

semiotically informed grounded theory approach to assess what kinds of meanings users are making as they interact with their environments.

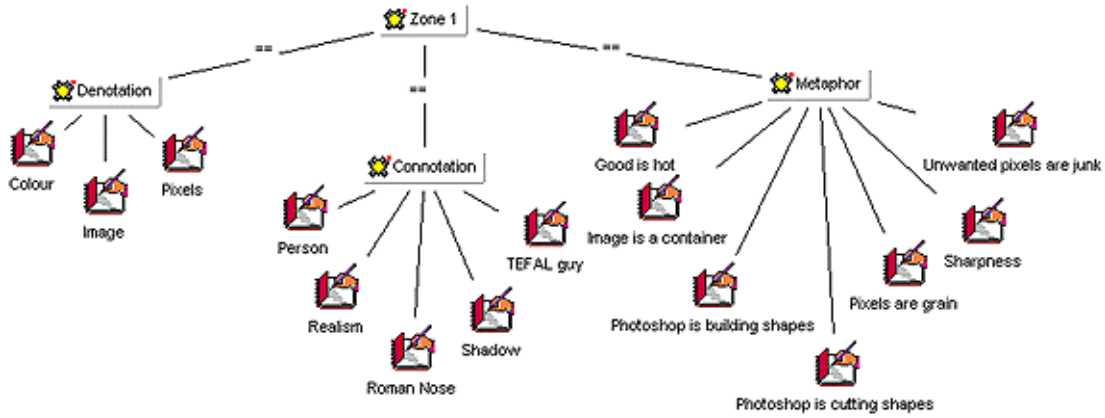

Figure 2 An example of coded data from a semiotically informed analysis

Support for the theoretical model is evident in the data produced so far (figure 2) but further development of the model has been prompted by other findings in the data. To this end the work so far, including the theoretical semiotic foundations, tracks the evolution of a semiotic theory of interaction. With no room here to explore the actual data it is sufficient to say that the project is still evolving. The relationship between theory and empirical data is a close one where theory informs method, method gathers and analyses data, and data in turn informs the further development of semiotic theory in relation to HCI.

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‘Creative Extelligence: The role of technology in enhanced creativity’

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Research context:
Our principal fascination with human creativity lies in its power to surprise and delight, but we are also intrigued by its elusive, ephemeral nature, and the difficulty we experience when trying to define and quantify it. However, two things appear certain, creativity is:

- ***Valuable:*** Creativity helps individuals and communities to survive and succeed in complex environments by enabling the development of new behaviours in response to changing conditions.
- ***Innate:*** Creativity is an intrinsic human characteristic. Man’s current dominance is testimony to our ability to influence and manipulate our physical, aesthetic and politico-social environments through the creation of a variety of technologies - linguistic, mechanical, philosophical etc.

Historically, new technologies result from creative innovation. However, the emerging information technologies such as the PC, multimedia and the Internet, appear to return the favour, providing new opportunities for creative expression.

The resultant positive feedback cycle raises some interesting questions:

- How does creativity work and how can the new technologies be used to stimulate and enhance human creativity?
- What is the value of creativity and how can we evaluate the worth of enhanced creative ability?
- What is the likely impact of increased creative activity on the rate of technological and social change? Although powerful, creativity is value-neutral and can be a destabilising force within societies as it seeks new realities.

Although prized throughout history, scientific research into creativity is relatively new and there is much work still to be done on what exactly constitutes creativity, how the creative process works, its evolutionary basis etc.

Recently, much of this research has concentrated on using computer models to simulate human creativity. This reflects a wider trend in cognitive sciences where the focus of investigative attention is how technology can reproduce aspects of human cognition such

as intelligence, creativity etc. Less work has been done on how people are using the new technologies to support and enhance their own creative practice

Proposed research:
I am interested in how individuals, groups and communities can utilise the emerging technologies to enhance their individual and collective creativity and the social impact that might result.

Taking my definition of creativity to be '*that ability or process whereby individuals or groups are able to transcend current perceptions of, and beliefs around, reality in order to imagine new, alternative solutions'*, I believe that the key to answering the questions raised above lies in a deeper understanding of the interaction between unconscious and conscious thought in the construction and deconstruction of our models of reality.

My investigation into the role of technology in supporting traffic between the conscious and unconscious thought will draw upon established theories of psychology, psychoanalysis, pedagogy and neuroscience.

I will investigate how technology might be used to support each stage of the basic 4-stage model of creativity as proposed by Hadamard, amongst others:

Stage 1 - Conscious research
I believe that the associative mechanism shared by learning and creativity makes it likely that analogous phenomena exist within creativity, mirroring processes, such as 'learning styles', already known to pedagogy.

I propose that there is a natural overlap between creativity and learning – people learn by playing with ideas and create by playing with their learning – and intend to further investigate this relationship by testing the applicability of Vygotsky's zone of proximal development to creativity.

I intend to investigate how technology and software might be used to support and enhance goal setting, action learning and research, and knowledge management during the initial conscious stage of the creative process.

This will involve the application of established learning on the use of:

- Narrative to enhance motivation and focus attention on the desired area of creative investigation
- Pedagogical methodology to support individual creativity through reflection
- Pedagogical techniques to scaffold collaborative creativity
- Psychoanalytical techniques to support the traduction of unconscious thoughts into the conscious realm for further investigation and consideration

Stage2 - Unconscious 'incubation'
Despite our best attempts, humans often find it difficult to 'think outside the box'. We are designed to recognise and follow familiar patterns of thought and associations. I believe that the unbiased nature of computer processing affords enormous potential in generating previously unimagined combinations and permutations which can then be evaluated for possible significance by human users.

I intend to develop intelligent software systems that will support individuals to identify and translate themes and motifs into universal 'meme' agents that can interact with and learn from the agents of other individuals. Over time the system learns to recognise potentially valuable agent combinations, which it would then present to the agent owner.

Stage 3 - Inspiration
More vividly known as the 'Eureka!' moment, this stage reflects the emergence of relevant unconscious associations into the conscious mind.

Here, I will investigate how technology can be used to predispose individuals and groups to a more creative state.

Specifically, this will involve investigation into:

- Whether it is possible to influence brainwave activity by external stimuli. Creative activity has been shown to be associated with decreased overall arousal and increased theta wave patterns in the frontal cortex. Can theta activity be triggered by visual pulses of corresponding frequencies within onscreen animations? Would this have an appreciable impact on creative ability?
- Whether it is possible to induce meditative state within individuals or groups through use of onscreen content and whether this would have any measurable impact on creative output?
- Whether it is possible to support individuals to induce a state of autohypnosis through the use of appropriate psychoanalytical tools within onscreen content and whether this would enhance creative associations?

Stage 4 - Conscious verification – as this is an essentially iterative process, stage 4 forms the first stage of the next cycle and is therefore supported by the same technologies as stage 1.

Stages 2 and 3 will involve considerable research into how technology can be used to influence conscious and unconscious creativity and how technology may replicate the behaviour of unconscious thought.

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Analyzing the role of students' goal orientation during their interaction with an ILE

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Abstract

Goal theory considers the individual differences that exist among students to approach, tackle and classifies new learning tasks. According with this theory, students with mastery goals are more keen to develop new skills and competencies, whereas students with performance goals try to demonstrate competence or to achieve at high levels of normative ability. These observations have been extracted from a classroom context, but no attention has been given to this aspect in the design of ILEs. In this paper we described the results of a study whose main goal was to analyze how students with different goal orientations behave when they interact with an ILE.

1 Theoretical background

On one hand, motivational theories point out that it is important, among other things, to provide instruction responsive to learner motives and values (Lepper & Malone, 1987; Keller, 1987). On the other hand, goal theory classifies students, considering their goals, into two main groups: mastery students and performance students; each of them with different attitudes towards learning tasks (Ames, 1992; Dweck & Elliot, 1988).

It is suggested that more effort is expended by mastery- than performance-oriented students because the former think that by attempting more, they have more possibilities to achieve their goals; whereas the latter think that by spending more effort they show lack of ability (Dweck & Elliot, 1988). Taking this into account, (Ames, 1992) suggests that we must develop classroom styles that are specifically designed to foster mastery goals. However, other authors suggest that we need to research more about multiple goal perspectives before concluding that a mastery goal perspective is best (Harackiewicz & Barron, 1998; Elliot & Harackiewicz, 1996).

As part of the research into multiple perspectives, this paper describes a study carried out to analyze whether students' goal orientation has an impact in their behaviour pattern during the interaction with an ILE.

2 Experimental study

The Ecolab software has a domain in Ecology concepts such as food chains and food webs (Luckin & du Boulay, 1999). The elements of the interface offer the opportunity to build up representations of the feeding relationships which exist in a particular community.

As theory suggests, students with different goal orientations are concerned about different aspects during the learning process. We included new elements to the Ecolab's interface (see Figure 1) that provide either personal information (personal progress), normative information (classmates' scores), or tools (to edit notes or learn more about an ecosystem).

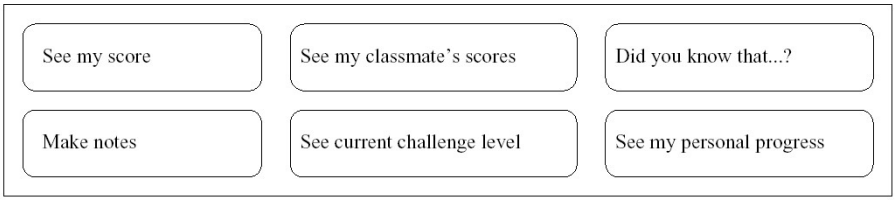

Figure 1: Panel of the Ecolab's interface concerned with student's progress

2.1 Research aims

The question which guided the investigation within this study was: Is there any correlation between students' goal orientation and their interaction with the elements of the Ecolab's interface, particularly those in a panel concerned with the student's progress?, i.e. do students with different orientations have particular preferences for using those elements in this panel?

Our hypothesis was that the interaction between student and the panel would depend upon the student's goal orientation. Frequency, order, and use of the panel's buttons would present a different pattern for each type of goal orientation.

Claim 1
Mastery-oriented students will be mainly concerned about their own performance and, for this reason in first place, they will be interested in making use of those elements of the interface which provide self-progress information or an opportunity to learn ("See my personal progress", "Make notes", or "Did you know that...?" buttons), whereas performance-oriented students will be more concerned about their own progress in comparison with that of their classmates. So, they will make more use of those interface's elements which provide self vs others' performance information ("See my classmates' scores", "See my score", or "See current challenge level" buttons).

Claim 2
When task instructions highlight the value of either a performance or a learning goal, differences in students' interaction with the Ecolab will be observed. For instance, mastery-oriented students receiving instructions highlighting a performance value will make more use of the elements that provide self vs others'performance information, than mastery-oriented students receiving instructions highlighting a mastery value; similar behavior is expected for performance-oriented students.

2.2 Methodology

An adapted PALS questionnaire (Midgley, M.L. Maehr, & Anderman, 2000) was applied to the students before their interaction with the Ecolab software, as shown in the Figure 2.

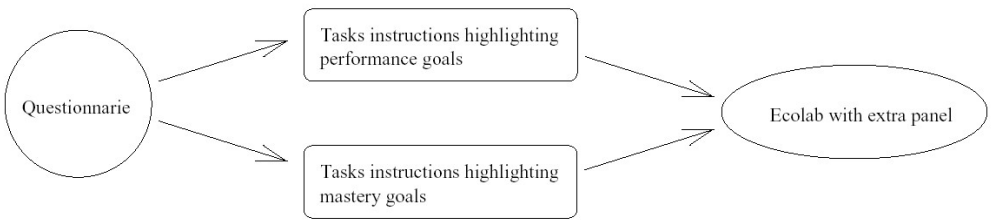

Figure 2: Study structure

The students were between 9 and 11 years old with some knowledge about food chains and food webs. So far 5 students have taken part in the experiment but more are expected. They were classified, according to their answers to the PALS questionnaire, into mastery-oriented or performance-oriented students.

Task instructions highlighting a particular goal orientation were given. So, some students received mastery instructions and other received performance instructions. Finally, a session with the system was carried out in order to obtain interaction data to be analyzed.

2.3 Preliminary results

So far the participants have all been classified as students with mastery orientations, according to the PALS scale. For this reason, the variable that we can discuss here is related to the differences observed because of the instructions.

The results shown that for some of the buttons, "Personal progress", "Did you know that?", and "See current challenge level", our expectations have been fulfilled. This is, students who received performance task instructions seemed less keen to look at their personal progress than students under mastery task instructions.

The button "My score" was used by all of the students, although the students who received performance instructions made more use of it. For the button "Classmates' scores", the opposite result was observed: students who received mastery instructions made more used of it.

Finally, the "Make notes" button was not used at all for any of the students. They preferred to make their notes on a piece of paper. It is very likely that their limited keyboard skills influenced this behavior.

3 Conclusions

As the number of participants is not big enough, it is difficult to draw firm conclusions. In addition, students with performance orientation need to take part in this experiment in order to have both groups considered. So, the final results will be shown during the presentation of this paper.

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Grounded theory, grounded practice

Geraldine Fitzpatrick

Three potential research themes in system design

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Introduction

My research interests take place against a background of commercial systems development, rather than laboratory experiments where 'expertise' could have a different meaning (e.g. Curtis, 1986). The focus is the analysis and design phases, particularly expert problem representation and solving. Programming will not be considered as it is already the subject of studies (e.g. Brooks (1977), Davies (1993), Romero (2001)), many of which are on-going.

My areas of interest tend to crystallize into three main subjects. The first of these has been considered in some depth, the others are future areas for expansion:

1. Representations

System design is a complex task in an often ill-defined problem domain, however progress has been made towards understanding methodology use. Mental representations and their semi-formal translations (with pre-defined components and rules) seem to play an important role. Purchase et al (2001) show that representations are more diligently used by those less at ease with the notation, Petre (2002, 2003) discusses the relevance of informal representations and Adelson (1984) notes that experts tend to work with more abstract representations. There is a need for a number of further studies:

To confirm the effect of formal and informal representations on memory, subjects of varying expertise could write a précis, or produce a formal or informal representation of a scenario. Level of detail, understanding and recall of the scenario could then be assessed.

To confirm whether structured and unstructured representations are more useful for those with a particular pre-disposition ('visual thinkers') a group of novices assessed for pre-disposition could be given additional training in the production of formal/informal representations or neither. and then given a task to test the effect on their understanding of the problem. A group of commercial experts could be given the same task to assess their use of representation.

To consider the impact of representation type three groups could be given two types of problem (one function- and one data-focused) and a representation to produce (function, data or object focused). The resultant designs could be checked for completeness to verify whether Gilmore and Green's (1984) match-mismatch theory can be successfully recreated.

Petre (2002) considered the use of informal 'focal images'. Studies could look at how these are transformed into standard representation. The use of informal representation as a precursor to formal representation could be explored, with 'same-expertise' groups asked to create a formal representation with and without a preceding informal representation.

As a by-product, it would be interesting to consider how groups found themselves unable to stick to the constraints (e.g. Created a formal representation when asked for an informal one).

2. Expertise in design

Studies considering expert behaviour have often come up with seemingly contradictory results. For example Davies (1993) and Romero (2001) report conflicting results for code recognition times in novices and experts; Detienne (1997) found experts mostly use an object-centred, declarative approach but Rist (1989) the opposite. These discrepancies often seem due to the classification of 'expertise'. What makes an expert? One observation is that experts seem to 'jump' to a solution. Whilst they can retrospectively justify the decisions they have made according to learned behaviour or best practice, they do not always appear to be using this to form the solution. Schmidt (1993) states that expert theoretical knowledge is encapsulated and only used when other methods fail. In some cases this does not confer with the concept of implicit learning, as the expert is able to discuss their knowledge (in implicit learning the learner is unaware of their knowledge and tends to think they have 'guessed'), however, Adelson (1984) remarks that they 'know, but don't know that they know'.

Further research could focus on the transition to 'expert' by attempting to find individuals whose behaviour puts them just pre- or post- expert and investigating their behaviour. One theory is that experts have re-organised their knowledge into very large and efficient chunks so that retrieval at a very high level is sufficient to find a solution. This fits Kintschs view (1998) that experts' mental representations are hierarchical, with higher levels easier to access.

3. Inheritance

Inheritance seems the least successful and 'trickiest' aspect of object-orientation. Detienne (1997) shows that novices do not spontaneously re-use (but copy and paste instead) and that re-usable classes are often abstract and harder to understand. Developers incorporate inheritance into their designs with forethought, but the identification and design of abstract classes seems notoriously hard and whilst the identification of re-usable code takes place (finding the piece to 'copy') inheritance mechanisms are hard to apply (it's easier to just 'paste').

Studies of expert commercial OO designers could look at the mental processes involved and help define strategies for identifying, designing and representing abstract classes. Progress could then be made on providing a means of encouraging their production and use.

Conclusion

The second and third areas require further research of current literature and related studies.

Using commercial projects brings organizational overheads and implies a qualitative approach, hindering statistically significant results. Study design therefore requires particular forethought.

The outcomes may impact a number of areas: Easing categorization of analysis and design; Knowledge and facilitation of the transition to 'expert'; Insight into inheritance in OO, including easing the use of abstract classes; Information about more and less formal representations in system design and methods encouraging their appropriate use.

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A Model for Personas and Scenarios Creation

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Personas and scenarios are becoming established tools in the design process. They help designers to focus on the users' need and the context in which the system will be used. A persona is a description of a fictitious user based on field data. A scenario is a story about a persona using a system that has not yet been created. Using personas and scenarios in the design process provides the designer with a tool to see the situation from the user's perspective engaging more easily in the user. But the construction of personas and scenarios involves several obstacles. The writing tends to end in a description of stereotypes (Nielsen 2003), and the scenario does not appear convincing. Some obstacles seem to be connected to the writing process, others to the distinction between the persona and the scenario. In this paper, I will take a look at the persona and the scenario from a narrative point of view. The aim is to provide a model that can guide the field studies on which the personas are based in addition to the scenarios and the creative process.

Elements of Understanding the Construction of Personas

Most writings on personas seem to focus on goals as part of what distinguishes one persona from another (Cooper 1999; Pruitt and Grudin 2003). But with a narrative point of view, goals are part of what makes the persona act in a given situation. As in real life, it is the persona's personal traits (age, background, psyche, etc.) that differentiate personas.

The Construction of Personas

The persona as a rounded character (Nielsen 2002) can be characterised by the following elements:

- Body – the body constitutes a human being. Sex, age and looks help the designer characterise the persona
- Psyche – to understand the motivations for actions, we need to understand the personality behind the motivation.
- Background – job position, family, education, social and cultural positions explain motivations for actions.
- Emotional state – to know the emotional state furthers the engagement in the persona (Smith 1995). Inner needs, goals, ambitions and wishes create a foundation for the emotional state.
- Cacophony – two oppositional character traits (Horton 1999). The oppositional traits are exactly what constitute the difference between a stereotype and a rounded character.

The persona is static, but the figure becomes dynamic when it is inserted into the actions of the scenario. In the scenario, the persona will be in a context, in a specific situation and have a specific goal.

Elements of Understanding the Construction of a Scenario

A scenario is a story that moves forward by the principle of causality.

Fabula
The creation of the fabula is an intersubjective process constructed by the reader from the actual information in the written text and from the reader's presumptions and inference. (Bordwell 1997).

Content
The fabula contains a narrative logic and includes elements that seem to be present in most stories. These elements vary and the media influences the elements. A scenario is a special kind of media, and some elements are crucial to the kind of drama that a scenario is, i.e. there is always an interaction with some sort of system, and the goal sets the story in motion.

Events and Plot
The events in the causation are essential to the narrative. A narrative is made up of constituent events that are necessary for the story and supplementary events that might not be essential, but enrich and add flavour to the story (Abbott 2002). The plot links the events and keeps the story moving (Cobley 2001).

Goals and Obstacles
Goals function as a starting point for the scenario and constitute the main driving force in the story. Obstacles may also be part of the story and drive it forward.

In the scenario, the persona has needs that in turn create goals. Carroll believes that it is important to look for obstacles during the field studies (Carroll 2000).

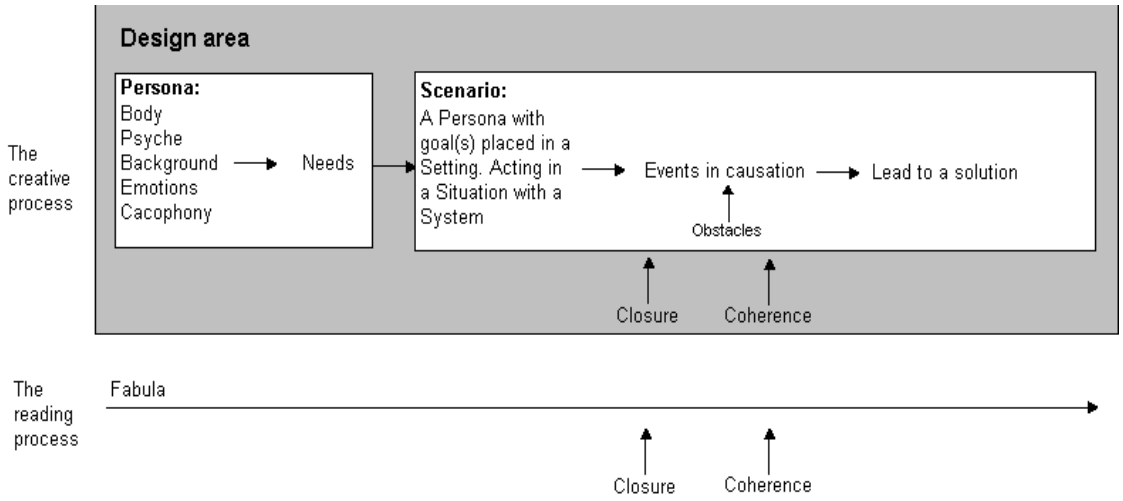
Solution
The solution is part of the story elements and the dramaturgy. A story includes character(s), setting(s), goal(s), plot and solution (Fields 1984).

Setting
In a scenario, the setting is inevitable. It is the setting that pinpoints where the use takes place, and the surroundings, the time of day and other contextual elements might influence the use.

Closure, Resolution
When a narrative resolves a conflict, it achieves closure (Abbott 2002). The closure may refer to a single event or the whole story. Resolution is one way of obtaining closure. When we read a story, we want to come to the closure, get answers to our questions and see the end. (Brooks 1984).

Coherence
Coherence and continuity persuade us that the story is true. If it hangs together, it is true (Abbott 2002). Coherence is extremely important to scenarios. It is very difficult to assess whether a scenario is true or not, but coherence is the means by which we can judge. Coherence is not only valid for the story, but also for the character, the setting and the actions.

A Model for Thoughts



The five characteristic aspects of the persona should be considered before writing. The characteristics will reveal one or more needs when they are considered in light of the design area. The needs undergo a transformation into goals when they are viewed in light of the specific systems design. Each goal is the point of departure for the story and as such the beginning of the scenario. The setting, the persona, the goals, and the situation are the motor that spins the story into a succession of events. Obstacles may disturb the events and turn the story into a new direction. At the end, the story will reach a solution, either with a happy or an unhappy outcome. Closure and coherence should be considered in the creative process. A lack of coherence and closure will disturb the story. It will make the reader infer actions that stem more from the reader's own imagination and area of knowledge than from a reference to the field data.

Conclusion

Through this model, I hope to provide a guideline for the creative process of writing. But it may also be seen as a guide indicating what to look for in field studies and what information is necessary to obtain about the users. In this model, the users are much more than a vehicle to a system.

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Supporting group interaction using large situated display appliances in community nexuses.

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INTRODUCTION

The shortcomings of the 'traditional deskwork' model supported by desktop computers are all too familiar among CSCW and Ubiquitous Computing researchers. In short, the desktop computer exists in only one small corner of our social environments, and thus cannot not provide support to us as we move around in the world and interact with other people doing our day-to-day activities. The desktop computer is also best suited to remote interaction, for example the web, email and newsgroups, while there is a huge amount of evidence showing that face-to-face interaction has a massive value in engendering understanding, trust and rapport (Seely Brown & Duguid, 2000). The continued existence of workshops and conferences is a testament to the value of face to face interaction– since there are high costs of organizing and attending such events, while desktop conferencing and dissemination media is a readily available & cheap alternative.

With the advent of mobile technologies, a great deal of hope formed around the vision of supporting people in their interactions as they move around in the environment- opening new domains for computer support, such as outdoor activities, shopping, recreation and of course mobile work. Mobile telephony, text messaging and other recent developments have brought about some big changes in our day-to-day activities. However, a shortcoming of these technologies, by virtue of their mobility, is the small size of their screens. This makes them into inherently *personal* devices – i.e. only one person can comfortably see and interact with the UI of a mobile device. As such they are not well suited to supporting face-to-face group interactions.

Large Interactive Situated Display Appliances (LIDSAs), such as electronic whiteboards provide this support much better, owing primarily to the large, publicly visible size of their screens (e.g. Tivoli: Rønby, Pedersen, McCall, Moran & Halasz 1993; and Flatland: Mynatt, E., Igarashi, T., Edwards, W.K. and LaMarca, 1999) . However, to date, research is only beginning to look at LIDSAs outside the context of the office or classroom (e.g. FxPal's Plasma Poster, XRCE's CWall, and IBM's Blueboard). As a result, there is still little understanding of what the primitive functions such a system should do, and in particular the interaction models most suited to support them. For example, there is some confusion and conflicting messages about various issues – e.g. Single Display Groupware proponents (eg Bederson et al, 1999; Greenberg et al, 1999), suggest that it is important to provide multi-user access to a shared display, where people can interact simultaneously, while many recent efforts use touch-screens and therefore require turn-taking to allow group interaction (e.g. Plasma Poster, CWall & Blueboard). Also, many of the cited systems in this genre only have low resolution displays (e.g. 1024 x 768 pixels), effectively being like normal computer monitors but stretched to a larger size - which has the effect of increasing the public visibility, but does not increase the amount of information that can be displayed. This means that little information can be shown side-by-side, limiting the potential for displaying multiple items concurrently (e.g. documents, images or web pages).

Our approach to bettering our understanding of this area this was to look at the places where nomadic/mobile people interact, and investigate the current practices of group interaction. From this we have derived a better understanding of how personal devices and LIDSAs can be designed to interconnect and provide a platform for supporting group interactions in such places.

THE COMMUNITY NEXUS

As a core focus of our research we have studied three places where nomadic and mobile people come together, cross paths and interact in groups: (1) the central store room used by an audio-visual technical support team at a conference (as detailed in Rogers & Brignull, 2002), (2) a party venue where a postgraduate welcoming event was held (as detailed in Brignull & Rogers, 2003), and (3) the common room of a college, where 6th formers (17-19 year old students) relax, socialize and work (pending publication). We have characterized these places as 'community nexuses'- places where people come together and cross paths, interacting with each other in groups. We found these group interactions were very diverse – ranging between planned and spontaneous, synchronous and asynchronous, and in size, level of trust and quality. To summarize the findings, we found that in studies (1) and (3), people often used wall surfaces such as noticeboards as a place to disseminate information to the community, even though they often had mobile devices such as cell phones, and access to the web from other devices elsewhere. The situatedness of the wall surfaces not only provided this publicly visible surface for dissemination, but also provided a place for face-to-face interaction. This means that serendipity could occur – unplanned 'lucky accidents' by which people meet at the location, and can have discussions and solve problems, using the information on the wall to mediate the interaction. Also situatedness allows for 'overseeing' (Heath & Luff 1992) to occur – as people pass by they can see what their colleagues are doing, and can choose to participate if they feel they have something to offer.

Also, we found that people often brought physical information artefacts to gatherings at the nexus and discussed them with others, co-viewing the material by passing or crowding around. This physicality made the artefacts into a shared visual point of reference for group interactions, providing conversational support. Also the physicality affords movement, giving and taking of the artefacts, (i.e. 'micromobility', Luff & Heath, 1998) while it makes the creation of copies difficult, unlike digital media.

DERIVING REQUIREMENTS SPECIFICATIONS FOR A COMMUNITY NEXUS LISDA

Based on findings from ethnographic studies summarized above, we derived a set of requirement specifications, stated below:

- Support for public dissemination of media (i.e. noticeboard style uses)
- Support for group viewing, sharing and exchange activities.
- Support for intermittency in synchronous interactions – i.e. people leaving and later revisiting an interaction and it's related media.
- Support for bringing media to, and taking it away from the communal space.
- Support for the achievement of privacy within the communal space.
- Provide means for managing and cleaning up 'clutter' as it develops over time.
- Provide a low cost of entry – in terms of time, effort, and finance.
- Provide a visual interface to allow for vicarious learning

A more detailed account of the basis of these specifications is available in Rogers & Brignull, 2002, Brignull & Rogers, 2003, and Izadi, Brignull, Rodden, Rogers & Underwood, 2003.

FROM REQUIREMENTS TO DESIGN – THE DYNAMO SYSTEM

From these specifications, we designed and built Dynamo: a LIDSA which provides *a public interactive surface for the cooperative sharing and exchange of media* . A detailed account of its interaction models and architecture is available in Izadi et al, 2003, and a demo video & screenshots are available online (www.cogs.susx.ac.uk/interact/projects/dynamo.htm). The key points of the interaction models are summarized as follows:

- Users can bring media on removable USB devices (pen drives, mp3 players, and digital cameras), and view and share it by drag-and-dropping it onto and off of the communal surface.

- The system is multi-user, allowing multiple people to interact on the surface at the same time, with their own mouse and keyboard. Users can bring their own laptops and run a telepointer application, or they can use the wireless mice & keyboards provided.
- The interaction model for the connection between a personal device and the dynamo surface involves a 'personal palette'. This is similar to the Windows taskbar or Mac OSX dock, except that each user has their own on the surface, primarily providing them access to the file-store on their personal device. Users can exchange files by simply dropping them onto each other's palettes.
- Registration with the system is beneficial to the users but not required, making dynamo open access to all community members.
- A novel screen management technique called 'carving' allows users to define areas of screen estate as their own, and they give and revoke access control to others using a simple drag-and-drop GUI. This is intended to provide a way to allow users to post media as notices, and a way to support intermittency – i.e. allowing users to leave their interaction and media on the surface and return to it later, safe in the knowledge that others have not been able to modify anything within their space.

CONCLUSIONS & FUTURE WORK

To conclude, this paper has defined the community nexus as a problem space for the support of various kinds of group interaction. Our grounding ethnographic findings have been summarized, as well as our requirements specifications and the key aspects of the Dynamo interaction model. Our next step of our research is to run an ethnographic field study of dynamo deployed in a community nexus. Specifically, we are deploying in the 6th form common room of a Brighton college for a period of two weeks. Our research interests include the role Dynamo will play in community life, patterns of adoption and practices which evolve over time, the achievement of privacy and communal management of space; and the role of situatedness in serendipity, overseeing, peripheral participation.

ACKNOWLEDGMENTS

This paper summarizes work done by the Dynamo team: G. Fitzpatrick, S. Izadi, Y. Rogers, M. Underwood, & T. Rodden. (EPSRC grant number: GR/N01125).

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Achievement Goals within the Context of a Collaborative Learning Environment.

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The research outlined in this paper contributes to a larger project concerned with raising children's linguistic awareness through a method which uses joking riddles to draw attention to language ambiguity. The aim of the project is to design software which employs this technique for use in the classroom in order to improve children's reading comprehension skills. A key feature of the design will be the use of computer-mediated peer discussion; the software will encourage and support collaborative interaction between children working in pairs. Collaboration is a widely exploited method of learning. However, while some children engage very effectively in group work others consistently fail to work together productively. Therefore, the individual differences children bring to the collaborative group play an important role in the effectiveness of the learning experience. These differences have been largely overlooked and many of the psychological processes and mechanisms underpinning collaborative interaction remain unclear. To ensure that a system scaffolds collaboration appropriately the role of individual differences needs further consideration. My research seeks to examine the different types of achievement goals that individual children adopt when engaged in a collaborative task and to explore how these might influence the effectiveness of their collaborative interactions.

Linguistic Awareness and Reading Comprehension – The Riddles Software

10 -15% of children between the ages of 7-11 years can be classified as poor comprehenders, that is, their reading comprehension skills are well below their level of reading accuracy in relation to their chronological age (Yuill and Oakhill, 1991). This relatively high proportion of children challenges educators to address this issue as a serious concern. As children progress through their school careers the support present in the early stages of learning to read is reduced, and there is an increasing demand for using skills such as reading comprehension independently. Deficits in this domain which are not addressed early on can have negative effects on subsequent academic achievement.

Yuill and Oakhill (1991) identify linguistic awareness as being particularly problematic for poor comprehenders. Linguistic awareness is the ability to treat language as an external object and to reflect on its structural features. Appreciating the humour inherent in a joke requires an understanding of the use of ambiguity in language. Yuill (1998) found that linguistic awareness could be developed by drawing children's attention to the use of ambiguity in joking riddles and encouraging discussion on different interpretations of the language. Significant improvements in children's reading comprehension skills was evident after exposure to the riddle training.

The current project will continue to explore the link between linguistic awareness and text comprehension and to develop this training method using a computer interface which employs multiple external representations of meaning, software scaffolding and peer collaboration as features of its design. My research will address how best to

exploit the use of collaborative learning within this context. Although the software provides an ideal collaborative environment - two children working together towards a common goal - pilot data of children interacting with the software have revealed that interactions within this context are not always collaborative. A clearer notion of the qualities that make these interactions so different is required in order to identify the circumstances that contribute to a successful collaborative experience. Firstly, it is important to address what is meant by collaborative learning.

Collaborative Learning

Improvements in children's problem solving skills after collaboration with either an adult or peer have been widely documented (Roschell & Teasley, 1995, Howe et al 1995, Underwood & Underwood, 1999, Azmitia, 1988). The processes underlying collaborative learning have been most commonly understood within either a Piagetian or Vygotskian framework, emphasising either socio-cognitive conflict or intersubjectivity, respectively.

Learning theories such as these underpin the vast body of research on the benefits of learning through peer interaction and more recently computer supported collaborative learning (Crook, 1994). However, there is still a degree of contention regarding the actual mechanisms and processes involved in collaboration. Furthermore, defining the term has proved a difficult task as it is used very differently within and across different disciplines (Dillenbourg, 1999). In differentiating collaborative from cooperative learning Teasley and Roschelle (1995) provide a definition frequently adopted in the CSCL literature: *'Collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a common problem.'* (p. 70). Underpinning their emphasis on 'coordinated, synchronous activity' is the assumption that all members of the collaborative group participate equally in the task. This implies that all members of the group are both equally *willing* and equally *able* to participate in the collaborative process (Burton, Brna and Treasure- Jones, 1997). However, I would argue that this is not necessarily the case as children's responses to and levels of engagement in collaborative learning environments differ considerably.

As Tudge (1992) points out, initial differences in understanding may not necessarily lead to appropriate discussion and subsequent cognitive gain if one child simply agrees without attempting to understand the other's point of view. Equally, he argues that one child may have the ability to persuade the other even if they do not fully understand the concept themselves. In these contexts collaboration may not affect or positively influence learning.

It is crucial, therefore, to understand more about the contribution that individual children make to the collaborative experience in order to design ways of supporting this process so as to exploit the collaborative potential of participants in the best possible way. In doing this I suggest that it would be appropriate to begin by exploring the goals children adopt when engaged in a collaborative learning task.

Achievement Goals

A cognitive theory of motivation emphasises a goal as providing an insight into the *purpose* behind behaviour, and as such is a complex cognitive structure constructed within the person-environment interaction (Lemos, 1996). Achievement goals are

those that provide a cognitive focus, or purpose to behaviour, in situations where competence is of specific relevance. Traditionally, goal theory has emphasised two types of achievement goals; mastery goals which focus on the development of competence through task mastery and performance goals which focus on the demonstration of competence in relation to others (Dweck and Elliot, 1988). More recently this distinction has been revised and has incorporated approach and avoidance elements to the mastery – performance dichotomy (Elliot and McGregor, 2001). Four distinct types of achievement goals have emerged; mastery approach and avoidance and performance approach and avoidance, each associated with distinct behavioural patterns evident in achievement situations.

The types of behaviours associated with different achievement goals impact on the way in which individuals engage in different tasks and influence learning outcomes; approach goals often being associated with more adaptive patterns of learning (Dweck and Elliot, 1988). Achievement goals have been examined in a variety of classroom settings. However, no studies have explored goal related behaviour within a collaborative context. I would argue this a valuable area of exploration given the popularisation of collaborative learning activities within the UK primary classroom and, in particular, the use of this type of learning in educational software design. Studies currently being conducted are assessing, firstly, whether children adopt different types of goals in a collaborative context as opposed to individual and whole class learning contexts and, secondly, relating specific goal adoption to the effectiveness of the collaborative interaction. Exploring this relationship will provide an insight into some of the individual differences children bring to the collaborative group and, therefore, may contribute to the development of the learner model and the effective scaffolding of collaborative interaction.

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Intelligent Interfaces and User Feedback Dialog Systems for Service Composition

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Introduction

Recent advances in wireless networking and web-based technologies have brought closer the possibility of a pervasive computing environment, within which a wide range of *services* will be available to the user. As Fensel and Bussler point out [1] Web Services, self-contained, self-describing applications that can be remotely located and invoked, will transform the web from a "collection of information into a distributed computational device." This powerful tool potentially gives individuals the ability to control this computing environment by aggregating or *composing* these services into *policies* that meet their needs. I intend to research ways for non-programming users to compose services in an intuitive way in collaboration with the system – an *intelligent* feedback dialog interface.

Background: Web Services and Semantic Web Technologies

At present, most information on the web can only be read and understood by humans.
The Semantic Web initiative aims to make all information on the web machine-processable – information that computers will be able to understand and make use of. This is a similar aim to the Web Service model described above. Indeed, Preece and Decker [2] state "Web Services are an essential ingredient of the Semantic Web and benefit from Semantic Web technology". This technology makes use of a unifying data model (Resource Definition Framework or RDF), languages with defined semantics built on this model (DAML+OIL) and Ontologies of standardised terminologies for Web resource mark-up. As use of Ontologies can make service descriptions richer, it may be possible to use this semantic data to enable intelligent interfaces where system can collaborate with the user in the service composition process. The work of Kim and Gil [3] investigating the use of constraint reasoning in analysing semantic service descriptions in order to provide user assistance for task requirements definition illustrates one approach to this. However the main focus of research in this area is still very much on getting the basic technology to work and so treats service composition primarily as a programming problem. Enabling service composition for non-technical users is a largely neglected research area.

As part of University Of Sussex Department of Informatics' Nat-Hab group research project focusing on Natural Language Service Composition [4] I am developing a prototype system for testing different interaction models. This system will act as a test-bed for the evaluation of different approaches to generating intelligent user feedback for use in composing services. It will use a test case scenario of three printers with different capabilities, available over a network, in order to allow a range of different interaction models to be tested. Initially, for system testing purposes, the user will only be given a limited number of options for service composition through the use of developer-defined "drop-down" menu fields in a Web Page. However, once the system is up and running, it will be used to test different modes and of

interaction, such as speech, gestural and textual, and their possible combinations through multi-modal interfaces. This will allow discourse modelling: identifying, representing and developing methods of incorporating dialog properties into a user feedback system.

Modes will include (but not necessarily be limited to):

Natural Language, Simulation, Direct manipulation, Gestural, Textual.

An area of particular interest to this investigation is the problem of ambiguity in intuitive user-machine dialog. Kim and Gil point to the challenges to composing services posed by interactive service composition, such as user mistakes, incomplete input and input that is inconsistent with existing service descriptions. Different combinations of modes may give indications as to how to meet these challenges in order to facilitate better user-machine collaboration in service composition.

Related areas of Research

The use of Semantic Data in a user – machine dialog throws up other areas of research that would be relevant to this investigation:

- *Does the use of semantic data in a dialog require new approaches to interface design?* Of the few studies into interfaces for the manipulation of semantically defined data that have been done use is made of a pre-existing paradigm such as a dynamically generated Web Page [5] or a Windows Explorer-like browsable tree-based UI [6]. But are these approaches flexible enough or do we need new modes and representations for new types of data? An example of the possible use of the Semantic web that may not be possible with existing approaches is given by work being developed by Benjamin Jang and Lyndon JB Nixon at Trinity College, Dublin [7] on "user-oriented valuable-information". In the Semantic Web URIs (Uniform Resource Identifier) are used to address and name all information objects (much like the URL addressing scheme for web-pages) and so can be accessed remotely regardless of their physical storage location or binary representation. This means that any information objects can be recombined in many different contexts. Jang and Nixon point to the role that XML and, more specifically the Xlink part of the XML specification can play in the seamless integration of multimedia components into a Semantic web as Xlink "allows link sources and targets to be defined in any granularity, e.g. ranging from a single line to the grouping of objects (graphics), from a single note to a set of measures (audio) and from a single frame to an entire scene (video)". This opens up endless possibilities in the use, reuse and rejuxtaposition of elements of multimedia components according to user queries.

- *Generation of dynamic graphical simulations from semantically defined information.* It may be possible to generate graphical simulations of objects that carry information about their state, properties, behaviour and relationships to other objects from their semantic definitions. Users could then manipulate these simulations for intuitive service composition.

  An example of the graphical manipulation of information objects on the Semantic Web is given by the "Haystack" information management program [5]. This application dynamically generates interactive web pages about an information object from its relevant URI. The data for this object comes from a variety of sources including the local machine and remote information services. All UI elements on the page are *bound* to information objects. This means that a UI element can serve as a proxy through which the user can manipulate the underlying object. This approach

could give clues as to how to set out the basis for the development of a framework for the dynamic generation of graphically simulated objects

Issues relating to the use of different hardware platforms such as mobile devices will no doubt also come into play during this research. These will be addressed as they arise.

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Supporting Reflection and Learning with New Technology

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Introduction

Reflection is considered to be an important part of the learning process and there are many theories about what reflection is and why it is so important especially for learning from experience, developing the skills of professional practice and for the development of meta-cognitive skills which are said to enhance learning. Recently there has been increased exploration into the ways technology can be used to support reflection in these areas (Loh, Radinsky et al. 1997; Seale 1998). There has also been exploration into how technology can be used to support reflection in other ways for other purposes, for example some pieces of interactive art claim to provoke reflection in a contemplative way, where the viewer is not asked to learn anything, just consider and enjoy this process (Gaver, Beaver et al. 2003; Höök, Sengers et al. 2003). I am interested in attempting to put some of these latter theories into practice and investigate whether they can be used to inform the design of technology to support reflection and learning in a way that has been little explored in the literature so far. Where it has been touched on, there is scant explanation and understanding of why or what the reflection being supported is, and how that in turn is supporting learning.

What is Reflection?

Reflection, in the sense defined by the Oxford English Dictionary as 'to think deeply or carefully about', is a term used frequently in everyday language. We usually think it will involve looking back over ideas or experiences, and consider ourselves 'reflecting' rather than just 'thinking' in situations where the material is complicated and we don't really know what the outcome will be. Dewey, one of the earliest people to consider the nature of reflection regards it as an active thought process which is provoked by situations of uncertainty, doubt or difficulty and involves "an act of searching, hunting, inquiring, to find material that will resolve the doubt, settle and dispose of the perplexity" (1933, p12).

In the field of reflective practice, reflection is described as a type of thinking about which enables a kind of problem solving involving the construction of an understanding and reframing of the situation to allow professionals to apply and develop the knowledge and skills of their profession. Reflection is also considered to play an integral role in learning from experience and a number of researchers have developed learning cycles where the learners have a 'learning experience' and then reflect on this. Kolb (1984) for example suggests that the reflection allows the learners to form abstract concepts from their experience in order to guide active experimentation and further learning experiences. In this field reflection has been defined as 'to think for an extended time about a set of recent experiences looking for commonalities, differences, and interrelations beyond their superficial elements' (Gustafson and Bennett), and as 'a term for intellectual and affective activities of explaining experiences to get new understandings from' (Boud, Keogh et al. 1985).

Art work is often said to 'provoke' or 'invite' reflection. By looking at or interacting with the art work, artists claim that you are drawn to consider what they are presenting, saying, suggesting or asking. In interactive art especially the work can even surprise or confuse (Hindmarsh, Heath et al. 2002; Sengers, Liesendahl et al. 2002; Gaver, Beaver et al. 2003). This use of the term reflection seems similar to Dewey's use (1933); thought provoked by

uncertainty and perplexity to resolve doubt: Though perhaps in the case of art, more an attempt to order thought or even enjoy the discord. Reflection is used loosely to describe 'thought about' or 'contemplation' of an issue raised.

How can reflection be supported?

Going through the literature there are a myriad of techniques and theories about how reflection should be supported and I suggest a number of general themes emerge which to some extent imply a definition of reflection. The first of these emphasises the restructuring and integration of knowledge. The second is the idea of the need to raise awareness; of incomplete knowledge, of inconsistencies in knowledge, of assumptions and of what is known. Raising awareness in this way makes it possible to restructure disjointed knowledge to form a whole, but restructuring or reframing knowledge can also be a way to raise awareness. The third is the importance of seeing from multiple perspectives which again can raise awareness in the ways discussed above.

The techniques suggested to support reflection can also be grouped. For example:

- **Guidance Techniques:** e.g. the use of reflective questions in journals, portfolios or face to face, setting challenges, supporting the restructuring/reframing of knowledge and experiences and help in linking goals to feedback.
- **Discussion:** e.g. peer face-to-face or web/email forums
- **Recording Techniques:** including speech capture tools, journaling, portfolios, videoing or email/web discussion forums
- **Presentation/re-representation of knowledge and thinking:** e.g. by writing, talking or mind-mapping
- **Self-explanation:** there are now a number of software programs which have been developed to support this particular approach to reflective learning (REFS).
- **Looking back over and remembering techniques:** e.g. old photographs or trigger images
- **Causing confusion or surprise:** e.g. use of ill-structured material, techniques used in interactive art work and novel physical-digital coupling.

This final section is the area I am most interested in, in terms of my thesis. Gaver et al. (2003) present a framework for using ambiguity in interaction design. They suggest that ambiguous situations require people to take part in making meaning, that this is inherently pleasurable and leads to a deep appropriation of the article. Three types of ambiguity are suggested along with techniques for creating and using them in design; ambiguity of information, ambiguity of context and ambiguity of relationship. Sengers et al. (2002) created an interactive art work called Influencing Machine and experimented with providing different amounts of feedback to the users to try and find the balance between an intriguing ambiguity and a frustrating experience. I would like use these ideas to try and get the technology to raise the questions that spur reflection in a less explicit or verbal way than many of the techniques listed above.

Evaluation

This still needs a lot of thought – reflection by any definition is essentially an internal process and evaluating when it is happening will require me to firstly define precisely what I mean by reflection and the reflection I'm looking for and then to find external pointers which show this kind of thought is taking place. Asking participants to work in pairs is one technique I

plan to use so I can analyse their natural conversation for evidence of reflection. Other indicators may include periods of silence or any outputs from the exercise. I will be comparing the effects of a number of situations on levels of reflection as I have defined it. The data I collect is likely to be largely qualitative although it may be possible to identify a number of quantitative measures which could be relevant. Initially I hope to carry out a number of small exploratory investigations.

Putting theory into Practice

I am presently looking at an existing piece of educational software, 'Belvedere', which is designed to support critical inquiry by providing a framework for building evidence and concept maps of ideas based on information collected from various sources. I am hoping to use it to investigate the effects of structure and detail of material on triggering reflective thought. Trying to find ways to use some of the abstract ideas discussed, for example those in the ambiguity paper, in real situations has proved quite tricky and I'm hoping this approach will provide a way into exploring some of these concepts.

I have tried to base my research on theory, but am finding it hard to expand upon and use. I think this is partly because the area of reflection is more confused than I initially anticipated. It is not a simple case of lifting a theory from one place (e.g. the ambiguity in interactive art ideas) and applying to another (supporting reflective learning) because the first theory is too vague and there is a very muddled definition of what reflective learning is.

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Whose File is it Anyway? Investigating the Ownership Relationship between students and their digital resources.

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Abstract

There are serious questions being asked about how we can successfully support student learning, with technology, in the Higher Education sector. This empirical research is located within the theoretical literature on student learning. It seeks to extend that literature by investigating the ownership relationship of students to their digital resources. My key research questions are "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?" In this paper I discuss the theoretical framework in which the research is embedded, before outlining the quantitative and qualitative methodologies which will be used.

Introduction

> *E-learning has the potential to revolutionise the way we teach and how we learn. A great deal of progress has been made so far, but there is much more to do. E-learning can take us a further step forward. This is about embedding and exploiting technologies in everything we do, and getting ICT embedded across the curriculum for all subjects and in all pedagogues (sic). E-learning has the power to transform the way we learn, and to bring high quality, accessible learning to everyone – so that every learner can achieve his or her full potential. (Charles Clarke, Introduction to* Towards a Unified e-Learning Strategy*, DFES consultation document July 2003)*

There appears to be an assumption that if we can just get people to use new technology there will be measurable and clear educational benefits. The language of "transformation" and "achievement of full potential" seems particularly popular, with the concept of e-learning becoming education's new Holy Grail. As HCT practitioners we are concerned with the usability of technology and, in particular, matching system development to actual user requirements. My research, then, first addresses the question of what do we already know about how students, within Higher Education, learn?

The issues of different "learning styles", and individual differences in learning strategy, have been areas of research within education for decades (Marton and SäIjö, 1976; Entwistle, 1981). While this is closely tied to theories of what constitutes good *pedagogy*[1], to ask "how

[1] The study of the activities of educating or teaching, theories of how to impart knowledge from teacher to student.

do students learn?" as a research question, centres on the activities of the *student* rather than those of the teacher. This is a subtle but significantly different perspective as it assumes some activity on the part of the student in the learning process. While there is a body of literature on the "ownership of change", particularly within management theory, and some on the "ownership of knowledge" (Paechter), there is little to none on the issue of student ownership of their own learning resources. My research questions, then, are as follows; "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?"

Student Learning Theories

One of the most influential contemporary theories of learning must be *Constructivism* – the notion that students, via their interactions with the world, *construct* their own knowledge of it. In essence it is about the active interpretations of perceiving subjects. This is quite distinct from the "filling station" model of students as empty vessels who can be successfully filled with knowledge by a skilled teacher (or programme) – although it is not difficult to see traces of the latter model at times, peeking through the rhetoric of eLearning. Constructivism and its variants *tend* to be discussed in the context of pre-university education. When we get to the higher education literature there seems to be a subtle shift into talking about learning *styles*, perhaps because there is an assumption that reaching university level demonstrates that someone *can* successfully learn.

In the 1970's Marton and SäIjö (1976) distinguished between surface and deep approaches to learning, the former essentially being learning for "assessment" or examination purposes while the latter represented a full engagement with the subject. Marton developed his research further into what has become known as the phenomenographic approach (Marton and Booth 1997). This seeks to do empirical research into the different ways in which people perceive, understand and relate to the phenomena they encounter in the world. This encounter with phenomena can best be understood not in terms of the subject's perception or the object's reality – but of the internal relationship between the subject and object. Within the field of educational technology this approach influenced that of Diana Laurillard (2002, p30) who extended this pheomenographic framework by utilising the work of Pask (1988) on "Conversational theory". Here learning is seen to take place through a series of conversations in which knowledge is made explicit and articulated. Laurillard then extends the notion of learning conversations by showing how various forms of technology might facilitate this dialogical process.

One of Laurillard's main arguments is that the kind of knowledge we seek to transmit within a higher academic context is *of a different order* to the kind of knowledge being transmitted to schoolchildren. While a constructivist approach might make perfect sense teaching primary school children about gravity, much of the "material" that higher education is concerned with is text based – words, diagrams and formulae to describe reality, and words about the words, diagrams and formulae – meta issues. My research is concerned with the relationship between the student and this "stuff" – the data (words, diagrams, formulae) that allows the student to both learn about, and express these meta issues.

Research Methodology: Three main studies: Establish, in all studies, by means of a questionnaire, how students relate to, and use, both non digital and digital data. What

resources do they consider they "own" and how do they store and handle these? The main body of the questionnaire is drawn from the ESRC funded ETL "Learning and Studying" questionnaire (http://www.ed.ac.uk/etl/project.html).

(1) This will generate quantitative data drawn from two large (first year undergraduate) student populations, the current plan is one group of 100+ students from Informatics and one arts-based. It will go some way towards addressing the first part of my research question; "Do students perceive their ownership of digital data differently from their ownership of physical data such as books and lecture notes?"

(2) An in-depth investigation of "ownership" issues among students on an "Interactive Learning Environments" course in Informatics. This consists of 3rd yr undergraduates and Masters student. This will involve investigating how students use and personalise devices for data storage and manipulation (i.e. flash-pen drives and PDAs). Research data will be gathered via data logging on the devices, student's own logs, questionnaire, interview and observation. By focusing on the use of digital "stuff" for learning this study will address the issues of how this impacts upon "ownership of the learning process".

(3) A qualitative study with DPhil Students, data from in depth interviews and a further questionnaire on data storage and retention. At this point in the investigation it should be possible to begin to draw some conclusions about how this "ownership" issue has an impact upon how we support student learning with technology. (possible follow-up qualitative study, of students from the first study in their third year. How do more experienced students now perceive their own ownership of the learning process?)

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Enchanted Mobility?
The Impact of New Mobile Technologies on Social Interaction

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It is argued that mobile technologies offer a hitherto unprecedented means of connectivity to information and interaction with others (e.g. Katz & Aakhus, 2002). The emergence of innovative devices represent a new breed of technological innovation such as new 3G mobile phones, the Blackberry and other personal digital assistants (PDAs), as well as the use of bluetooth wireless and internet technologies. These offer, in theory, a 'promise' of a 'magical' and seamless capability to co-ordinate actions and communication 'anytime, anywhere' (Castells 1996). Such network enabled information and communication are leading to temporal and spatial redefinitions of social life.

Modernisation brought about the introduction of standardisation and automation which led to what Weber calls 'disenchantment', in contrast to magic and intense feeling prior to modernity (Weber, 1968); a time when social actors facilitated tradition, magical thought and emotion in their daily interaction and fulfilment. However, recent theories of technological forms of life (Lash, 2002) and mobility (Urry, 2002) indicate new mobile technologies to be seen as a means through which 'magic' of an 'enchanted' existence may be reintroduced. The social realities of the 'enchanted' use of such mobile devices is therefore a fertile site through which to examine 'techno-mediated' wireless interaction due to the technological 'promise' of magic and delight of contemporary mobility.

Situating Social Science Research

Whilst we know much about the technical and ergonomic aspects of mobile technologies, we know little about their use in day-to-day life. The social science research in this field is somewhat fragmented and lacks cohesion between the findings of individual studies (for example, Plant, 2000; Nafus and Tracey, 2002; Sussex Technology Group, 2001). We know very little regarding the synthesis of technological innovation, communicative and networked capacities with social reality; e.g. the ways people interact, as well as the ways in which society creates and maintains networks both with and without the use of mobile technology. Hence, there is the need to examine how, why and for whom mobile technologies impact on social life; in particularly, the possibility of re-enchantmant in out co-present and at-a-distance social relationships. This social science research of contemporary mobile artefacts will assess and affiliate innovation, communicative capabilities and social realities with the 'promise' of re-enchantment.

Questions

- *How*, *why* and for *whom* do mobile features and hand-held platforms impact on this enchantment?
- What are the social impacts of technological experiences?
- What are the implicit and explicit promises implicated within an enchanted realm of communication in relation to these devices?

In converting these theoretical questions into a manageable basis for social science research, I have devised these empirical questions:

1. How are mobile devices used or not used?

2. Which aspects of interaction have been socially created/enhanced and which aspects have been replaced/removed across groups as a result of using this technology?

3. Why are many social relationships facilitated by these contemporary mobile technologies, yet many are not?
   - issues of consumption, such as cost and inhibited access will impact on enchantment.

4. Is there really a 'magical' and 'socially enchanting' element to these technologies? Do mobile technologies successfully transmit enchanting and delightful qualities of co-present interaction at-a-distance and on the move (using PDAs, 3G, and Bluetooth)?
   - relating to theories of aesthetics, identity, embodiment and surveillance.

Research Methods

An ethnographic approach will be employed to ascertain the '(non) magical' aspects of 3G mobile phones, palm-pilots and PDAs as experienced by the users within each group; and *how* and *why* artefacts are (not) enchanting to our sociality. Participant observation will allow interaction to be captured in its raw form by researcher-subject reflexive interaction, using mobile mediums facilitating their social lives. In-depth interviewing will also be used to acquire factual, biographical and rich accounts of use from the perspective of subjects observed; capturing meaning, emotion and enchanted investment in mobile technology, which may be invisible at the time of observation. This will involve asking 'why' the artefact is (not) 'cherished' or for respondents to demonstrate what they are inferring to. Visual ethnography in the settings will be employed to record interaction with technology, as this will also be powerful in the analysis of enchantment.

Sample Groups: a working idea

The sample will contain a distribution of those who have access to mobile technologies in order to answer the research questions. I will enter settings where the sample of research groups (below) can be located to identify definitive groups. I will attain social immersion into one from each exemplar group to gain the 'feel' of the technology, as a novice to using the technology to socially communicate, and to understand uses for each group. From these settings I will select respondents for in-depth interviewing. To achieve a range of social groups, a sample of five exemplar social strands from which definitive groups will be accessed for research.

Access to groups 2, 3, 4 and a definitive sub-sample of group 1 will be gained via snowball sampling, by facilitating relationships with whom a rapport has previously been established in order to be introduced to definitive groups.

Group 1: Professional, administrators, officials, managers, high-grade technicians → observed setting of mobility: a first class train carriage.
Group 2: Routine non-manual employees (administration, commerce, sales and services), lower-grade technicians, supervisors → observed: pharmaceutical reps.
Group 3: Manual workers → observed setting: building sites, plumbers
Group 4: Those of low or no economic income → observed settings: amusement arcades and inner-city seating areas.
Group 5: Older adults (aged 60 years and over) → observed setting: interest clubs
Group 6: Young people (aged between 18-25) → observed setting: youth centres and night-time social venues.

Theoretically, such typologies cover a cross-section of society, group constitution and selection of observed settings are presently under review. After further review of literature, it is possible that only three exemplar groups will be selected in order to obtain definitive groups to be researched in alternative settings.

Potential Problems in the field

- 'Magic' and 'delight' may be compromised by researcher-subject effects.
- Enchantment is part of the private sphere of social life for many people – it may not be possible to capture this.
- Reliant on honesty of social actors.

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‘SnapShots’ – A Household Visualisation and Planning Tool

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1.0 Introduction

The act of ‘getting married’ is treated as a very important life event and milestone by many cultures across the world. Weddings are a time of huge celebration for all involved including bride and groom as well as friends and relatives. However, getting married takes a substantial amount of time and effort in the organisational process. When planning a wedding, there are a number of details to be worked out and everyone from ‘in-laws’ to friends and more distant relatives will have opinions as to how the day should look and progress. There are also many ‘hazy’ areas where members of the family need advice from suppliers or are at odds with each other as to how to resolve their problems. At this time, inter-personal relationships can dominate causing tension and conflict situations may arise that must be resolved through negotiation and careful management. In summary, planning a wedding can be a complex, stressful and time-consuming process. I propose that one way of reducing some of this stress and complexity is by providing a more open system that encourages collaboration and communication amongst all parties involved by giving them access to and a record of the planning process as it progresses over time and space.

2.0 Complex Planning

Much of the literature (e.g., Stone and Veloso, 1994) regarding complex planning has been A.I.-based and involves machine learning to solve problems automatically such as scheduling for university timetables. However, the type of complex planning necessary when organising a wedding is distributed across people, space and time. Currently, this is supported using a range of technologies, software applications and other artefacts that people create in order to help them solve particular problems encountered during the planning process. Also, many of the commercial applications available are temporally based in that they offer suggestions and checklists as to what tasks should be undertaken and when. They are also designed to be used individually and therefore, restrict who is privy to such information. The A.I. approach to complex problems and the commercially offered planning software does not offer solutions to a distributed task such as planning a wedding because communication is fragmented and not everyone has access to all information or is aware of the latest developments.

3.0 Collaborative Planning of Complex Events

The process of planning for a wedding was analysed in detail by undertaking a longitudinal study with four engaged couples, which monitored the wedding process over a number of weeks via structured interviews, and diary studies. Three other couples, recently married, were also interviewed to discuss their experiences of the planning and organisation process. In terms of planning a wedding, the engaged couple often prefer a bespoke approach that reflects their individuality and personality. A number of conflict situations may also arise over the course of the wedding that all have to be dealt with and resolved. From the interviews undertaken with couples who were just married, many of them found that planning the seating arrangement a difficult and time-consuming process. It was suggested that this problem is exacerbated by the complex inter-personal relationships that are so important during this time. Negotiation seems to be the key to the planning process and a lot of time and patience is necessary when discussing different options, requirements, budgets, problem

solving and other tasks. The study has highlighted that any difficulties when planning a complex distributed task are problem-based as opposed to time-based. Therefore, it is important to develop a system that helps solve this distributed problem and facilitate communication.

4.0 Wedding Organisation and Planning - A Normative Model

A normative model of wedding organisation and planning was developed based on the longitudinal study. The purpose of this model is to emphasise the proto-typical processes and tasks necessary to plan for getting married as well as to highlight the particular nuances of this special time and family activity.

At the hub of the whole process are the bride and groom and the moment they announce their engagement and decide to set a date for their subsequent wedding. Once an appropriate date has been chosen, it is necessary to make a number of arrangements with regard to catering, florists, decoration and venues. At this point, the process is too complicated and beyond the scope and expertise of the engaged couple to undertake by themselves, so it is then necessary for them to invite 'others' to partake in the planning at various times, taking on different roles. Thus, a small but temporary group of people is formed around the nucleus of the bride and groom in order to achieve the objective of planning and organising their wedding. Other entities are invited to join the group, depending on what service, product, help or advice they can offer and at the discretion of the bride and groom. The products and services provided by various entities can vary enormously from tangible goods and services such as flowers, the wedding dress, catering etc., to support from friends or financial help from close relatives. Weddings generally offer opportunities for family and friends to reinforce their emotional ties with the engaged couple. It is suggested that the bride and groom are at the hub of the planning process and, therefore, the majority of interactions will involve them on some level.

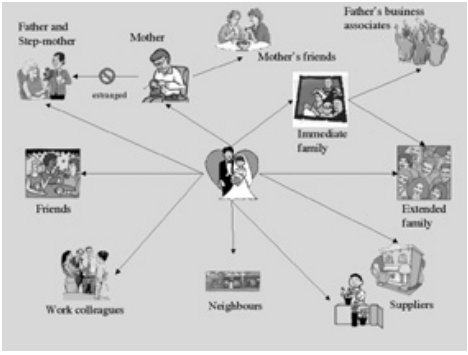

Figure 1: Wedding web: potential people involved in the wedding process

In considering this normative model, it is possible to identify the potential people involved in the wedding process (see Figure 1) and, therefore, some of the more complicated inter-personal relationships and problems that can arise.

5.0 'SnapShots' – A Visualisation and Planning Tool for Distributed Groups

'SnapShots' is a prototype broadband service designed to support a distributed group problem-solving task as well as enhance and support communication among group members. It has been designed to enable users to organise major family events including weddings, family reunions, birthdays and festive celebrations. It incorporates functions to aid the planning and organisation of such events including 'to-do' lists, guest lists and various prompts based on particular timescales. However, due to the higher bandwidth associated with broadband, it also allows users to create specific visualizations of the event. This could then be shared amongst family and friends for comments and suggestions but also acts as a starting point to complement and aid the complex planning and decision-making process. It is

envisaged that the new "SnapShots' broadband service will be used collaboratively amongst family members as well as potential suppliers. Although, 'SnapShots' will be used as a collaborative tool, it will be left to the discretion of the principal players (mainly, the bride and groom) to determine to what extent they wish to use these capabilities in terms of access rights and other privileges.

The collaborative visualisation capabilities of the 'SnapShots' tool serves three purposes but is also an integral part of the planning and organisational process. Firstly, is suggested that the process of being able to create, modify and edit collaborative representations will facilitate and support a distributed group problem-solving task, as well as aid the resolution and management of intra-group conflict and, enhance and support communication amongst distributed group members. Secondly, it could be used to develop and create a visualisation of the proposed wedding, which could then be shared amongst family, friends and other interested parties for comments and/or suggestions. More importantly, "SnapShots" would then offer the opportunity to work collaboratively and in conjunction with any potential supplier in order to design and develop the perfect day as well as automatically calculate any budgetary requirements (see Figures 2 and 3).

Figure 2: Wedding ceremony venue

Figure 3: Completed Visualization

From the interviews with couples who had just married, it was noticeable that organizing and determining the seating plan can be a very difficult and stressful process as personal relationships can dominate. It is recognized that many engaged couples planning their wedding already use some form of representation to aid them with this task. This will then be provided by the "SnapShots" service in order to aid with a solution to this difficult decision-making process. The schematic visualization, of say, the reception venue is included to help aid the organization of the seating plan but also in order to create a database of guest information.

Obviously, the bride and groom are central to the planning/decision making process and the majority of communication interactions will involve them on some level thus, creating a highly centralized network. Shaw (1981) analysed a variety of different communication networks in order to determine which was best suited for small group efficiency and productivity. He concluded that centralized networks were more efficient for routine tasks whilst decentralized networks were more efficient for tasks that require creativity and collaborative problem solving. In terms of the wedding planning process, this suggests some sort of contradiction in that the highly centralized network placing the bride and groom at the hub is unfortunately not the most productive or conducive to a collaborative task. Developing 'SnapShots' as an Internet based service allows distributed access for the collaborative creation and editing of the various visualisations.

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An Evolving Prototype to Inform the Design of a Motivational Module for an ITS.

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Abstract. The aim of this paper is to describe a series of participatory design studies that led to the creation of two prototypes for the reactive module of an intelligent tutoring system. These studies were useful as they informed the creation of a final prototype that has yet to be tested on end users.

1. Introduction

The Ecolab[7] is an ITS built within a Vygotskyan framework for children aged 10 –11 in the domain of food webs and chains. This system provides different levels of help for different learners offering scaffolding within the child's ZPD[10]. The creation of a new 'motivational module' for the Ecolab is being developed in order to investigate the influence of motivating instruction, specifically the ARCS model [6], in a computerized Vygotskyan framework. The research question governing this research is: What kind of relationship exists between Vygotsky's ZPD and theories of motivation? In order to gain an insight into these issues the 'motivational module' will be responsible for assessing and reacting to different motivational states in learners. There are two aspects related to this proposal: one is the detection of different motivational states and the other is the reaction to these states. Readers can find some information about the detection process in [8] and [3]. The aim of this paper however, is to describe an evolving prototype that will inform the final design of the reactions of the motivational module. Relevant work in this area includes the use of a socially intelligent tutoring system [5] and affective agents [4].

2. Designing the motivational reactive module

The approach taken to create the evolving prototype is that of 'prototypes for rapid visualisation' [1]. In this context different prototypes are created at different stages of the design using participatory design techniques gradually leading to the final prototype (see Fig. 1).

2.1 An initial prototype.

The framework used for the creation of the first prototype was that of the ARCS model [6]. Within this framework, motivation is achieved by gradually engaging learners in the teaching domain. The chief tasks of the tutor are to avoid boredom by the use of different strategies to obtain attention and to improve both the relevance of the material being taught and the student's confidence and satisfaction. With these objectives in mind an initial approach was to develop 'fun' activities for the Ecolab in the form of a quiz with questions created from the domain of the Ecolab. The quiz encompassed all the domains of the Ecolab curriculum and its format was like that of the TV program

"Who wants to be a millionaire". A crossword puzzle with words formed from the same domain was also developed.

Both the quiz and the crossword were modelled using low tech materials. An initial expert evaluation was carried out to identify usability problems via established human factors principles. The evaluation was carried out by six usability experts from the IDEAS lab. The format for this experiment was a presentation of the material followed by comments by the evaluators who also filled out a questionnaire. The results revealed problems with the design, the most serious being the wording and level of difficulty of the questions for both the quiz and the crossword puzzle.

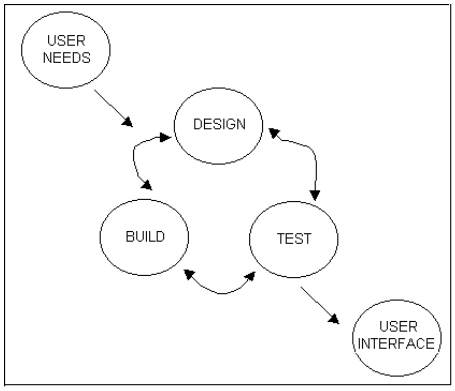

Fig. 1 A model of the process of design for rapid interface visualization

Based on the results of the evaluation, a new prototype was built using low tech materials. This prototype included a new set of questions for the quiz and the puzzle and a new format for the quiz. An evaluation with end users was then carried out. The format of this evaluation was an adaptation of the 'wizard of Oz' technique [2]. The aims of this experiment were to provide a framework for end users to interact with the design in order to identify interaction problems, to gather data that might be used for future designs and more importantly to determine whether the new wording was effective. This experiment created a scenario in which subjects needed to complete specific tasks involving the Ecolab and the prototype. The materials used for this experiment were a video camera, a computer with the Ecolab and the low tech prototype. Three subjects, 2 males and 1 female, aged between 9 and 11 agreed to participate. The procedure for individual subjects was as follows:

1. The subject was informed of the aims of the experiment and the fact that it was going to be videotaped.
2. The subject was instructed on how to interact with the Ecolab and was allowed to use it for five minutes before the actual experiment.
3. The subject was told that a new game for the Ecolab was going to be created and it would be based on a quiz and/or a puzzle. The prototype consisting of a set of sheets simulating a quiz and a puzzle were also shown to the subject.
4. At this point the camera was switched on and the subject was asked to interact with the prototype. The researcher was responsible for providing appropriate feedback to all of the subject's actions.
5. At the end of the experiment the subject was asked to give his points of view about the prototype and also propose some improvements to it.

The results of the experiment showed that the users understood the questions and were able to look for the answers using the Ecolab. It was also evident that users did not spend much time reading the feedback and that they preferred to continue exploring the software. The major problem with the prototype was that it was somewhat detached from the Ecolab and it did not reflect what was being taught.

2.2 A new framework for the design.

Based on the results of the experiments, it was decided to change the approach of the design as there is a need to integrate not only the quiz and the puzzle into the Ecolab but also to give efficient feedback while engaging the user in the interaction with the ITS. The ARCS model [6] provided an initial approach to integrate the different elements, however it constrains the design to certain types of motivational variables such as relevance or satisfaction. A broader framework is needed: one which engages users with some sort of motivating reactions and also allows them to interact with the existing ITS without being intrusive.

3. Conclusions and work for the future

The use of the 'prototypes for rapid visualisation' [1] allowed the creation of an evolving prototype from scratch. Two initial prototypes were designed within the ARCS model framework and were tested among experts and end users. The results of the experiments were used to build newer versions of the prototype. The next stage of the design of the motivational module for the Ecolab however, should consider a broader framework. The use of narratives [11] promises the inclusion not only of traditional motivating elements such as the quiz and the puzzle, but also seems to pave the way for engaging the users in the context of a plot by having characters willing to establish relationships with end users. The last point is of special relevance for this work as it is desirable for a motivational module to produce different types of affective help for different end users and the use of characters is a particularly suitable medium to do so. Future work in this direction should produce a new prototype which considers aspects of narrative theory including a plot and characters for the Ecolab. Other aspects of interest include the effect of individual differences such as the user's goals [9].

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