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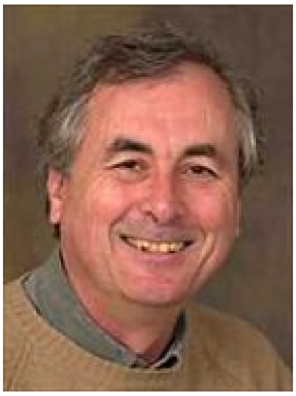
Organisers:
Genaro Rebolledo-Mendez, Edgar Acosta-Chaparro, Madeline Alsmeyer, Katerina Avramides, Sallyan Bryant, Amanda Harris, Joh Hunt, Zaliman Yusoff

Invited Speakers and Guest Discussants



Benedict du Boulay is Dean of the School of Science and Technology and former Dean of the School of Cognitive and Computing Sciences (COGS). He is a leading member of the IDEAs Lab and the Human Centred Technology Group. He is former Editor of the International Journal of Artificial Intelligence in Education (AIED) and is now a member of its Advisory Board. He is on the editorial boards of the Journal of Interactive Learning Environments and the Journal of Computational Intelligence, and was Programme Chair for AIED'97. Program committee member for numerous conferences.

Judith Good. My areas of interest are in contructivist learning environments, the use of games in education (particularly to foster the development of narrative skills in children), and visual programming languages. Judy Robertson (at Glasgow Caledonian University) and I are collaborating on the development of Adventure Author, a game-authoring tool design to support interactive storytelling skills in a 3D virtual reality environment. Much of the work leading up to the development of a prototype tool involved the use of a child-centred design methodology. I teach a course in Interactive Learning Environments, and, at the University of New Mexico, where I was previously, taught courses in Instructional Simulations, Adaptive Learning Systems, Instructional Multimedia, and Artificial Intelligence and Learning Systems.

Rose Luckin. I am Professor of Learner Centred Design at the London Knowledge Lab and a Visiting Professor at the ideas lab at University of Sussex. The aim of my research is to increase our understanding of the process of learning with technology and to use this to design technology effectively to stimulate curiosity, maintain engagement and foster creativity. I am particularly interested in the development of participatory methods to engage learners and teachers in the process of designing technology to fit their needs and to enable them to access all the resources within their environment that might effectively support learning.
You can find out about my current projects through these links
http://www.lkl.ac.uk/graphics/projectsheets/ar.pdf
http://www.lkl.ac.uk/graphics/projectsheets/homework.pdf
http://www.lkl.ac.uk/graphics/projectsheets/vesel.pdfsex

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She is joint author of a leading textbook on Interaction Design and has published over 50 peer-reviewed articles. She received a BSc in Mathematics and an MSc and PhD in Computer Science from University College London. She is an affiliate of the IEEE Computer Society, and a member of the British Computer Society, the Engineering Council and the ACM. She is also a chartered engineer.

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I'm currently a PhD Student of Computer Science and Artificial Intelligence at the Sussex University. My general research interest is the application of artificial intelligence in education. My particular interests are in investigating how intelligent learning environments can mediate and facilitate collaborative learning, particularly in learning to program.

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When Madeline isn't working she likes to tend to her allotment and perhaps drink the odd pint here and there.

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Katerina is currently a PhD student in the IDEAS lab at the University of Sussex. She is studying the role of people's beliefs about knowledge and knowing in the way they assess their knowledge of ill-structured problems. Her background is in Cognitive Science (University of Nottingham, Carnegie Mellon University).

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I am Niamh Caprani and I am a research student from Dublin. I am currently working on a Strand 1 Masters degree with IADT Dun Laoghaire, along with Dr. Nicola Porter and Dr. John Greaney, to design a technology mediated memory aid for cognitively impaired elderly individuals.
I graduated from IADT Dun Laoghaire in 2005 after completely a degree in Psychology Applied to Information Technology. This course involved applying psychological methods into the study of how people interact with technology and how technology affects humans cognitively, behaviourally and emotionally.

Amanda Harris

Amanda is currently writing her thesis for submission in September 2006. Her DPhil (Psychology) explores the role achievement motivation plays in the way children interact with each other in peer learning contexts. She is also a Research Fellow in the Department of Informatics and is currently working on a project exploring motivational approaches to learner modelling and the provision of scaffolding structures in order to support productive collaboration between children.

Hina Keval

Hina is a currently studying for her PhD in Computer Science at the University College of London (UCL). Her PhD work examines the issues with modern control room technology and the effect it has on task performance within city centre CCTV control rooms. The interactions between different CCTV users and task performance were studied using a mixture of 'quick and dirty' ethnography and interviews with key stakeholders. Other empirical work she is involved with includes the use of an eye tracker and task performance measures to identify optimum task performance when digital CCTV video is degraded under several quality levels.

Sven Laqua

I'm Sven Laqua, since August 2005 a PhD student in the Human Centred Systems Group in the Department of Computer Science at University College London. My research focuses on intelligent user-centred interfaces for web-based environments.
After living in Berlin for 18 years and finishing my a-levels, I moved to Dresden (Germany) where I studied Computer Science and Multimedia at Technical University Dresden, receiving my BSc in 2003. After that I studied one year in Newcastle, where I received an MSc in IT Management with distinction from Northumbria University in 2004. More information about me on my website: www.sl-works.de

Julie Maitland

I am coming to the end of my first year as a research student at the University of Glasgow under the watchful eye of Dr Matthew Chalmers. My overall area of interest is Ubiquitous Computing and Social Interaction; particularly within the realms of health promotion and health care. I gained a BSc(Hons) in Software Engineering in June 2005 from the same university, and before that trained and worked as a Registered Nurse. Apart from the crazy world of ubicomp I love snowboarding, rock-climbing, my two terribly-behaved dogs, and of course my long-suffering husband.

Genaro Rebolledo-Mendez

Genaro Rebolledo Mendez has a Bachelor degree in Computing Sciences and an MSc degree in Human Centred Computer Systems. He is currently a DPhil student in the Informatics departments at the University of Sussex and is a member of its Human-Centred Technology Research group and IDEAS lab. His DPhil work combines his programming skills with his understanding of motivational factors in education through an investigation of the effect of motivational scaffolding in intelligent tutoring systems. He received the best young researcher's paper award at the Artificial Intelligence in Education conference in 2003. He has conducted empirical work in classrooms, collecting and analysing data to investigate the effects of motivating techniques in tutoring systems. He is familiar with both quantitative and qualitative data analysis methodologies.

Georgios Saslis-Lagoudakis

Georgios Saslis-Lagoudakis is a PhD student at the Computing Department in Lancaster University. He received his MEng in Computing from the Department of Computing, Imperial College London. His current research interests lie in the area of Human-Computer Interaction with a focus on the longitudinal deployment and evaluation of situated display systems in the home, as well as in public spaces.

Nilubon Tongchai

I graduated Bachelor degree in Computer Engineering (Khonkaen University, Thailand, 1997) and Master degree in Computing (Nothumbria University, UK, 2001).
At present I study as a 3rd year PhD student under the supervision of Prof Paul Brna at Glasgow University. I have worked as a lecture in Computing Department at Songkhla Rajabhat University (1998-2000) and Kanchanaburi Rajabhat University (2001-2003). My research interest is about collaborative learning and open learner model which I would like to combine both teaching and computing experience to innovate the way of teaching to suit learners as much as possible.

Phil Tuddenham

Phil Tuddenham is completing his second year as a PhD student in the Rainbow Research Group at the University of Cambridge Computer Laboratory, where he previously completed his undergraduate degree. He works in computer interaction with tabletop displays under the supervision of Professor Peter Robinson. His research is supported by Thales Research and Technology and the EPSRC.

Zaliman Yusoff

I'm a third year Dphil student at the University of Sussex. My research interest is to study the relationship between emotions and learning gain especially within an intelligent tutoring system environment. Although emotions have been strongly regarded as a key success factor in human intelligence, very little research has been done to study about the interactions between human emotions and learning outcomes within an intelligent learning environment. Therefore, my research is aimed to study and explore the insight of these interactions by developing an emotionally sound affectively framework that able to intelligently adapt and react to the changes of users' emotional state which is hypothesised would also improve their learning performance.

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Collaborative e-Health Systems

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It is well acknowledged that an individual's social environment can contribute to and influence both their health and their attitude towards health-related issues [7]. Despite this, many e-Health systems focus on the individual in isolation rather than the social networks that play a role in his or her everyday wellbeing. In the same way that CSCW is based on the premise that people generally work together and as such require collaborative working environments, it is suggested that collaborative systems are a potentially valuable and as yet relatively unexplored area of e-Health.

Background

As mobile and pervasive technologies become a more integral part of everyday life, attention is now being paid to how these ubiquitous computing systems can be used to monitor and contribute to health and health care. Commodity technology such as mobile phones and desktop computers are ideally placed within the environment of much of the general public, such that they offer great potential for enhancing awareness of health issues with relatively little effort on the part of the user. At the same time, special purpose devices are being developed and deployed that allow remote monitoring of patient groups in the community [5].

Much e-Health research has focused on the individual: the development of electronic medical records and online patient diaries has converted a number of established paper-based practices into their digital counterparts. The support of collaboration within e-Health systems has mainly fallen on the side of the health professionals or carers rather than the patients/individuals themselves. *The Aware Project* aids collaboration between staff in a hospital environment by facilitating 'social awareness of the working context of fellow co-workers' [2]. Multi-disciplinary community-based collaboration is currently being investigated in the *Mobilising Advanced Technologies for Care at Home (MATCH) Project* [14], alongside the development of assistive ubiquitous technologies. The role of interaction between a patient and his or her social circle, and the role of that same social circle in times of well–being, are aspects of collaboration unsupported by many e-Health systems.

One well-established collaborative e-Health environment is that of the online patient community, where sociability is supported alongside information provision [8]. It is interesting to note that the drive behind the development and maintenance of these collaborative environments originated from the patient communities themselves rather than computing or health professionals. There is evidence that the role of peers is being acknowledged in some health-promotion applications. *Houston* [6] and *Shakra* [12] are mobile phone-based activity promotion systems that facilitate the sharing of activity-based information between friends, and show a positive influence on daily activity levels as a result of mutual awareness and friendly competition.

Interviews with women who stipulated a desire to become more physically active guided the design of *Houston*: a system comprising of a pedometer connected by USB to a mobile phone. A user can view the number of steps taken each day via a text interface on the phone, and annotate days by using the phone's keys when he or she wishes, e.g. on a day when he or she goes for a swim. The annotated information may then be shared between friends, and this sharing was proven to be a positive motivational factor when the system was trialled against a non-collaborative control application [6].

Shakra is a system that was developed by members of the Equator IRC based in Glasgow and Bristol [12]. It monitors the daily activity levels of users and shares this information between peers. A key design goal of the system was to provide an unobtrusive method of monitoring daily activity. This was achieved by avoiding the burden of additional technology, such as a pedometer, being carried by the user (assuming that the user normally carries a mobile phone). The application monitors the fluctuation in GSM signal strength and neighbouring cell information to infer the current activity of mobile phone carrier. Periods of detected moderate activity contribute to a daily total of minutes of activity per day, which can be viewed on the phone either in isolation or in comparison with peers (through hourly GPRS updates). The week long trial that took place with 9 people of varying levels of physical activity confirmed the application's positive potential for future use and development as an awareness- and motivation-increasing tool. It was expected that the sharing of information between peers would have a positive effect on motivation and awareness, but we were surprised by the amount of collaboration, competition, and game-play like behaviour that occurred.

Both of these systems afford only minimal peer-to-peer interaction, but this is enough for *Shakra* to foster friendly competition, and for *Houston* to improve on the motivational affect of a single-user equivalent. These and other findings are feeding into plans for future work, as the next section outlines.

Future Work

As part of work aiming to advance collaborative e-Health systems, there are three distinct yet related aspects of my work: existing practices, conceptual work and new system designs.

Ongoing review of existing e-Health systems will inform our future designs. It is important not to neglect traditional health systems, both effective and ineffective, because rich experience of their situated use and evaluation 'in the wild' has built up over many years.

Also, there is an existing body of conceptual work, namely activity promotion models such as the Transtheoretical Method (TTM) [11] and Social Cognitive Theory (SCT) [9]. Both acknowledge the social influences on health, but on the whole approach the individual in isolation within their theories rather than the individual as part of a social group. SCT has been shown to be ineffective over the long-term [1]; this is a criticism of many activity promotion models. A better understanding of the role of social groups with regards to health may influence the development of new conceptual models, enriching understanding and informing the design of effective collaborative systems.

These two lines of work will continue along with exploration of new ubicomp technologies for health-related purposes. As was mentioned earlier, these technologies encompass both commodity and special-purpose devices. Ubicomp games are another technology that has already proved to be both social and health–promoting: intentionally so in the case of *Games for Health* [13], and unintentionally in the case of my group's *Feeding Yoshi* [3]. *Feeding Yoshi* demonstrated the use of mobile ad hoc networks to support both direct and indirect communication among a user community, and we are exploring ways that such an adaptable and cheap communication medium may be exploited within e-Health applications to share and disseminate information on use and activity. This might also draw on heterogeneous co-visiting systems, which have already been shown to facilitate enriched interaction in cultural institutions. For example, in [4], on-site visitors used mobile devices to interact with online visitors via web sites and VRs.

Although ‘the user’ has so far only been involved in the evaluation of our first e-Health system, their use and appropriation of the system has highlighted the strength of even the simplest collaborative functionality. Our system evaluations serve in ongoing design work, as the outcome will inevitably inform and guide our future systems and experiences. In order to gain a fuller understanding of the individual and social aspects of the user experience of our systems, subjective reflection and interpretation is considered alongside qualitative evaluation data. Other members of the group are working on a tool that augments qualitative and quantitative data to facilitate such holistic analysis [10].

Conclusion

This paper has summarised the findings of my first 6 months of postgraduate study, and the intended direction in which I hope to continue. My involvement in the design, development, and evaluation of *Shakra* has served as an ideal introduction into the design of collaborative e-Health systems. The wider aim is a rich collaborative environment, built on a solid foundation of health theory, which is part of a new generation of e-Health systems that supports individuals and their surrounding social networks.

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Collaborative Decision Making in Complex Safety Critical Systems: A Common Information Space Approach

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1.1 Introduction

Complex organizations encompass multiple distributed, interdependent workgroups that function autonomously yet are influenced by actions of others, thereby requiring cooperation and coordination of activities between these groups. In distributed work settings, information is distributed across operators and tools. The co-ordination necessary for the successful accomplishment of tasks is mediated through the construction and use of shared representational artefacts. The way in which information is represented and propagated across individuals shapes the interaction essential to achieve the required coordination (Marti 2000). Much research in the area of Computer Supported Cooperative Work (CSCW) has focussed on providing shared workspace systems (groupware, collaborative virtual environments, etc.) that support facilities for cooperative work by integrating information and representing activity. Research in this area has been mostly concerned with cooperation taking place within an organization. Apart from a few exceptions not much deliberation has been given towards inter-organizational cooperation, although other research fields such as Business Administration has been investigating this for a long time (Steven & Wulf 2002).

1.2 Research Focus

My research is concerned with understanding how people work in networked communities, and exploring the role of Common Information Space (CIS) in facilitating decision making taking place in such a collaborative setting. Also, the research is interested in how such a stance could be taken into account in the design of technology for work environments where information managed from various sources influences the coordination and cooperation between individuals involved and is vital for successful accomplishment of tasks. This work investigates how the notion of CIS can assist decision making in a time constrained safety critical environment, such as that of Air Traffic Control, by providing an information space within which people can collaborate, especially across work communities. Safety critical systems involve multiple agents and work groups who are distributed in time and space and are actively interacting with each other because of the interdependent nature of their tasks. The domain is complex because the system is dynamic, unstable, can vary in terms of the number of processes to be controlled simultaneously and the relationship between them, and requires cooperation between people, machinery and technology. The complexity is also due to the tight coupling between multiple processes, and the need to operate under time and various resource constraints. Also, the consequence of actions can result in catastrophic situations affecting human safety, economics, environment, and the like. This complexity places enormous demands on the individuals involved and has important implications for the design of systems intended to support collaborative decision making.

In such an environment, apart from the geographical distribution of work, there is also a cultural distribution. Therefore to coordinate activities across organizations not only is there a need for shared access to information but also common interpretation. Existing approaches such as Activity Theory (Bodker 1991), Distributed Cognition (Hutchins 1990) and distributed information resources (Wright et al. 2000) has helped to understand collaborate work and the factors affecting it such as context, environment, organization and social factors. However, it does not take the above mentioned factors into account while analyzing collaborative activity. This drawback could be resolved through the notion of Common Information Space **(**CIS**)** which is considered to be more suitable for analyzing distributed heterogeneous work communities (Fields et al. 2004). This notion concentrates on both representation of information and meaning attributed to it by the concerned individuals.

The most influential work in this area has been that of Schmidt & Bannon (cf. Bannon 2000) on how people in a distributed setting can work cooperatively using a common information space. Bossen (2002) attributes the value of this notion to its focus on the *interrelationship between information, actors, artefacts and cooperative work*. Work by other researchers such as Bertelsen & Bodker (2001), Bossen (2002) has contributed in sculpting this notion but literature provides a picture of how inadequate and fragmented this work is currently and also how sceptical the researchers are about the use of the notion because of its loose conceptual definition. The use of this notion raises various issues such as how and who will constitute the space, how will the interpretation of information be held in common especially across different professional communities, articulation work required to coordinate interpretation, etc. Apart from this, the safety critical nature of the environment creates additional constraints.

1.3 Research Contribution

Decision making has been perceived as an individual cognitive activity. In recent years however, it is considered to be a device for collaboration because people use decisions as devices to share and organise social interaction. Through this work I contribute to a more refined depiction of the notion of CIS to aid decision making activity. This research would address some of the issues mentioned in the previous section by articulating the meaning, dimensions and implications of the notion of CIS on decision making as a collaborative device and also on the design of technology to aid collaborative decision making.

Ethnographic methods of observational studies supplemented by field notes and semi-structured interviews with individuals working in different work groups is currently being undertaken at a medium-sized single runway airport**.** Apart from this, analysis of scenarios and case studies involving accidents, misuse of resources and miscommunications will be undertaken to facilitate the research. A conceptual model of the existing work environment is currently being developed from the ongoing ethnographic studies. Based on this model and analysis of the data collected through further studies, a generic conceptual model of how people collaborate and co-ordinate the activities involved in the decision making process of safety critical systems by maintaining a common information space would be developed. This would result in the generation of guidelines to help designers in developing technology that would aid efficient collaborative decision making.

This work is a contribution in the field of Human Computer Interaction (HCI), with particular concerns in designing technology in the context of complex safety critical systems. Also, it demonstrates how this requires a multidisciplinary approach involving disciplines such as Computer Supported Cooperative Work (CSCW), Sociology, Cognitive Psychology, Human Factors, etc. The novelty of this research lies in exploring how a CIS based approach to cooperate and coordinate decision making activities enhance collaborative decision making taking place across different interdependent professional communities in a safety critical environment. Also, it investigates to what extent the notion can be applied to design technology to make events more predictable.

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The Impact of a Group Open Learner Model on Learning in a Computer-Based Collaborative Learning Environment

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1. Introduction

Collaborative Learning is often seen as a good way to encourage peers to learn and teach each other while Open Learner Modelling is seen as helping learners improve their knowledge by representing the state of their learning[1]. This research seeks to apply both concepts of Collaborative Learning and Open Learner Modelling in a computer-based learning environment in order to see whether there is any difference between seeing and not seeing the group model.

We consider Collaborative Learning in terms of Vygotsky's Zone of Proximal Development which is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" [2, p.86].

When someone learns something, whether on their own or with a friend, they may need to know how well they performed on that particular task. In the classroom, the teacher may give some information such as a score or some suggestion about their performance on the task. An Open Learner Model is considered to be an aid to reflection. Bull defines an Open Learner Model (OLM) as a student model which is designed to help learners understand what they have learned more effectively [3]. This kind of model allows the learner to inspect, and sometimes challenge, beliefs recorded in the user model in order to change them[4].

Less has been done with Group Open Learner Models (GOLMs) though there is some work with them. Zapata-Rivera and Greer [5] found that students could be very confused when seeking to understand their GOLM. However, this GOLM was developed by a group of students working together with a single instance of ViSMod. The issue of the GOLM is taken up again later.

2. Research Problems

Collaborative Learning is interpreted here in two distinct ways - the way that learners help each other in a group and the way that a teacher or a learning system helps the student to gain a better understanding. Teaching collaboratively helps learners to learn skills and ideas initially in their ZPD which is why "collaborative teaching" is important.

There are many systems that are used for Collaborative Learning, some of which refer to the concept of communicative interaction, some reflect back the learner model to an individual

[1] The author is a PhD student under the supervision of Prof Paul Brna.

student and a very few use a GOLM – but how many of them contain both the notion of reflecting back group knowledge and a concern for what learners say to each other? Five systems have been selected and compared as representative of the state of the art.

Table 1: The comparison of systems to represent communicative interaction, individual and group leaner model concepts

System's name	References	Did the system examine the content of learners' conversation?	Did the system reflect back the Learner Model to the learner?	Did the system reflect back the Group Learner Model?
ViSMod[2]	[5]	No	Yes	No
ICLS	[6]	Yes	Yes	Yes
PairSM	[7]	Yes	Yes	No
STyLE-OLM	[8]	No	Yes	No
Mr.Collins	[9]	No	Yes	No

According to Table 1, all of these five systems reflect back information to individual learners, and two of them are concerned with what learners say to each other. However apart from these two systems, only ICLS is concerned with what learners talk about and reflect on – both in relation to an individual and group model. Nevertheless the concentration of ICLS on the communicative interaction module is quite different to the system I am designing which will focus on updating the model from the knowledge exchanged rather than classify groups of sentence openers, to help the group know how well they cooperate. In order to do this, a dialogue game[10, 11] has been designed as a first approach to defining the communicative interaction possible in the system.

In our research we focus on a Group Open Learner Model in Collaborative Learning. The group model borrows ideas from both Paiva's work [12] and PairSM [7] to generate the group model while a dialogue game and a set of sentence opener will be used for communication interaction. Each role and move of the game has been defined and applied in the domain of 'Number-based conversion'. To confirm my belief that this domain is suitable, I produced a multiple choice test and asked experts to do the test. The result from 10 experts who graduated and work in the area of computing reveals that some of them still make mistakes even though they have previously learned this particular topic.

3. Evaluation

It is currently envisaged that two conditions for learning with a peer will be compared: can see the group model and cannot see the group model using a bar-chart to represent the group model. The main hypothesis is that learning with a peer and seeing the group model will help the learner get a higher score than not seeing the group model.

There are two types of group models: GLM (Group Learner Model) and IdealGLM (Ideal Group Learner Model) – see Figure1.

[2] Another version of ViSMod [5] describes some works with a group model but not the kind that we are interested in.

- *GLM*: the group model that reflects what happens when learner1 (L1) and learner2 (L2) work collaboratively to solve the group task.
- *IdealGLM*: the group model which is generated from merging the performance of each learner (ILM1 and ILM2).

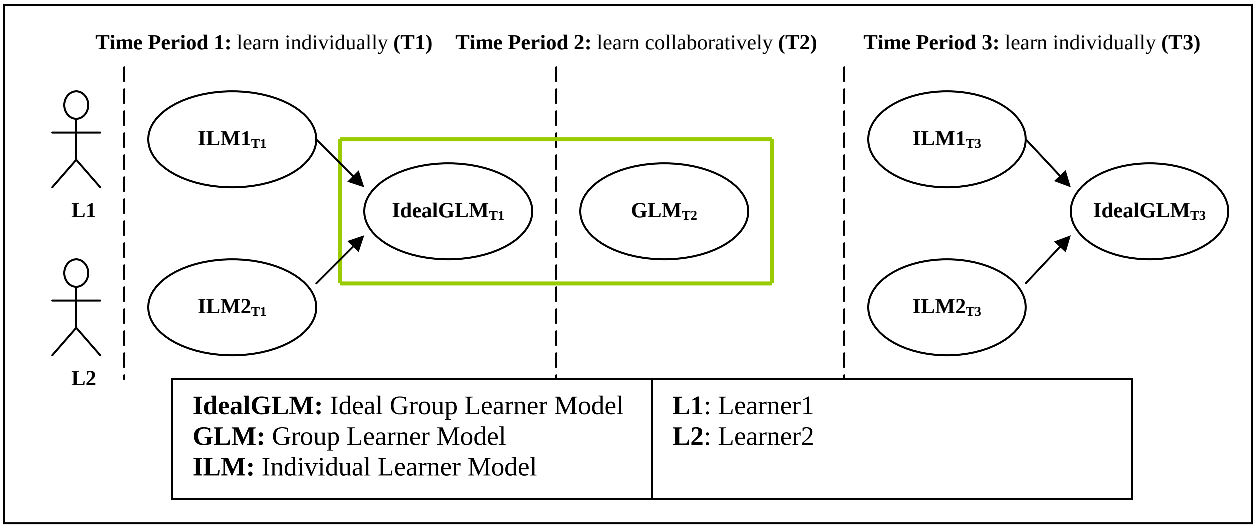

Figure 1: A Group Model diagram

In the system, both individual and group models are calculated over three periods of time (time period1 (T1), time period2 (T2), and time period3 (T3))

T1: learners perform the provided task and submit their answers to the system. The information of how well learners perform is kept in individual learner models (ILM_{T1}). The system will estimate the model of $IdealGLM_{T1}$ which will be used as the expected performance of both learners when they perform the group task in T2.

T2: the system keeps and updates information about group learning in GLM_{T2}. At this point, learners are allowed to talk with their peer using the provided communicative interaction area which combines a dialogue game together with fuzzy logic techniques to update the group model. At the end of this period, information about GLM_{T2} and $IdealGLM_{T1}$ are compared by the system to ask 'Is there any improvement of knowledge in this group learning?'

T3: the process of this period is to confirm that individual learners can benefit from collaborative learning using a Group Open Learner Model by comparing information about ILM_{T1} with ILM_{T3}.

Whenever learners communicate with their peer, either about the task or through the communication interface, the system will evaluate each move that learners make and update each relevant parameter of ILM and GLM. At the particular time that the system allows learners to see their own performance, it will provide information about GLM and IdealGLM in the form of a bar chart with textual descriptions to explain how well their group performs. The values in GLM and IdealGLM are compared to see the difference between seeing and not seeing the group model which may help us evaluate to extent to which a group model is effective for collaborative learning.

4. Conclusion

This work aims to encourage students to obtain an advantage from both collaborative learning and the use of an Open Learner Model in a computer-based learning environment in order to see if the result of collaborative learning with the ability to inspect a group model allows the learner to get a higher score than when unable to inspect the group model.

Learning improvements which have been demonstrated for many collaborative learning systems [6, 7, 9] and for Open Learner Models [1, 5, 8, 9] gives us reason to belief that our system, which combines these two approaches, will show similar improvements.

After this hypothesis is tested, further questions for this work include ‘is there any significant correlation between patterns of dialogue moves and the improvement of knowledge for each group?’ and ‘how general is this approach?’ We could also look at the difference between learners to see and not to see ILM_{T2} together with GLM_{T2} in order to see whether we need an ILM_{T2} in this system or if only a GLM_{T2} is adequate and ‘what theoretical reasons might there be for a GLM to be more effective than an ILM for individual learning?’

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Exploring collaborative profiles based on achievement goal orientations

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Introduction

The way in which children engage in collaborative activity with peers differs considerably. Several factors have been identified which are thought to influence the nature of collaborative interactions. These include gender, ability, friendship, type of task and group size (Slavin, 1996). However, even when these factors are used to create 'ideal' conditions, some interactions are consistently more productive than others.

Motivation, as an individual difference, has generally been overlooked in the collaborative learning literature. This paper discusses a study which relates different behavioural patterns, evident during collaborative interaction, to children's achievement goal orientation. It explores the possibility of profiling collaborative behaviour based on achievement goals in order that a system might a) provide appropriate support structures for collaboration and b) provide a 'motivated' context which encourages more effective collaborative behaviour.

Achievement Goal Theory

Achievement goal theory states that the goals an individuals holds represent a complex system of inter-related beliefs about and attitudes towards learning. This meaning system guides an individual's cognitive, affective and behavioural engagement in achievement related contexts (Dweck & Leggett, 1988). Two distinct orientations or patterns of achievement goals have been identified. *Mastery goals* orient learners towards developing competencies by mastering new skills and understanding new concepts. They are associated with high levels of task engagement, the use of self-regulated learning strategies, effort and persistence. *Performance goals*, on the hand, concern the desire to demonstrate ability in comparison to others. These goals are associated with more surface-level learning strategies, the avoidance of challenging tasks and a concern with comparative evaluations of ability (Ames, 1992; Dweck, 2000). Learning is therefore valued very differently within each of these goal orientations. For a mastery-oriented individual a learning context provides the opportunity for development which is self – referenced whereas for the performance - oriented individual a learning context provides the opportunity to demonstrate ability and, therefore, involves social comparison.

Collaborative Learning and Achievement Goals

Achievement goal theory helps us understand differences in how individuals approach learning in a general sense. The question for the current paper is how these differences might impact on the way individuals engage with collaborative learning specifically?

Using Rochelle and Teasley's (1995) definition of collaboration as '*a co-ordinated, synchronous activity, that is the continued attempt to construct and maintain a shared conception of a common problem'* (p. 70) it is not difficult to imagine the different meanings and consequences this might have for performance and mastery - oriented learners.

For a learner oriented towards performance goals, coordinated activity may prove difficult as inevitably individual markers of achievement are minimised. In relation to the more competitive nature of a performance orientation the collaborative context may either be a forum for public display of ability or a threatening environment to be avoided. In addition, the notion of a 'shared conception of a common problem' contradicts a fundamental element of a performance orientation in the sense that social partners are not resources for comparison but rather for the sharing of knowledge. These points illustrate potential conflicts for performance- oriented individuals between the demands of a collaborative task and individual perceptions of what might constitute success on that task.

For the mastery – oriented learner their ability to focus on the task itself may enable them to use collaborative learning activities more appropriately. The willingness to expend effort and persistence, without concern for public performance, may equip the mastery – oriented learner with the skills necessary for successful interaction. In addition, the use of metacognitive strategies associated with mastery goals are vital for monitoring the extent to which activity is coordinated and the degree to which knowledge is shared.

The Current Study

The current study seeks to examine the extent to which mastery and performance orientations are related to the types of language used during a collaborative learning task. It is expected that mastery – oriented students will adopt a style of interaction which is more likely to promote the type of collaborative activity outlined in Rochelle and Teasley's (1995) definition. On the other hand, it is expected that performance – oriented students will be more likely to adopt an individual, more competitive style of interaction.

Method

The study used a matched pairs design and consisted of 48 participants matched according to similar goal orientation, gender and age. The mean age of participants was 9 yrs 4 months. There were 12 mastery pairs (male and female) and 12 performance pairs (male and female). The study used a novel method of measuring achievement goals which involves presenting participants with 6 scenarios each representing a different learning context. Each scenario presents the child with a dilemma or problem and 2 possible responses to the problem (a mastery and a performance response). The participant then has to select the response they feel would be closest to the way in which they would solve the problem .

Pairs were then observed playing Zoombinis; a computerised game requiring the use of logical reasoning skills to solve puzzles. The game was specifically selected due to its relative difficultly and was expected to generate large amounts of discussion between collaborating partners. All sessions were videotaped and transcriptions coded using a coding scheme specifically designed for the study. While the coding scheme was exhaustive, this paper will discuss only the categories which relate to the following areas of language; *metacognition* (specifically ‘I know’ and ‘I think’ statements), *togetherness* (I and we statements), *pair independence* (use of adult help), *puzzling solving* (using simple or complex strategies). Five percent of the transcriptions were double coded by a trained rater. This revealed an 89% agreement between raters with a kappa coefficient .88.

Results

Frequencies of individual participants’ use of each language category were calculated. Due to the length of sessions differing between pairs the absolute frequencies were converted to percentage of time each language code was used and thus results represent relative frequencies. A MANOVA was conducted on the data with goal orientation and gender entered as independent variables. This test revealed main effects of goal orientation for ‘puzzle solving’ and ‘independence as a pair’ categories. Children holding mastery goals used significantly more complex strategies in regard to puzzle solving ($f(1) = 5.81$, $p = 0.02$). Children holding performance goals requested adult help significantly more than mastery children ($f(1) = 5.34$, $p = 0.03$), thus displaying less independence as a pair. In the ‘togetherness’ category differences in the use of I or We statements were compared and a significant interaction between achievement goal orientation and gender was observed ($f(1) = 9.56$, $p = 0.003$) with mastery girls using significantly more ‘we’ statements. No significant differences were observed in the metacognitive category.

Discussion

The above results suggest that mastery and performance oriented children display different patterns of interaction when engaged in collaboration with a peer. Mastery children were more likely to use complex strategies for solving puzzles and seemed more engaged and independent as a pair. In contrast, the performance children needed more adult support and thus were less independent. In addition, they used simpler strategies in relation to puzzling solving.

This suggests that addressing motivational factors, particularly achievement goals, is important for understanding more about the individual differences observed in children’s collaborative behaviour. Creating profiles of these behaviours would provide a basis for developing appropriate scaffolding structures which take into account motivational orientations. In addition, an important feature of any learning system is to provide an environment which encourages appropriate attitudes and approaches to learning. Understanding more about the impact of achievement goals on collaborative behaviour allows the possibility of developing contexts which promote adaptive motivational orientations.

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Social Construction of Personalised Content Interfaces

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Introduction

We currently live in a society dominated by information and communication. At its centre, the Internet represents the ultimate information space allowing us to retrieve or contribute anytime and anywhere (when using the right tools). More than one billion people are already connected, searching information, communicating with each other, contributing thoughts and knowledge. But with the increasing universality of the medium, combined with growing information overload and a spoiling for choice of available tools and services, mastering the Web can quickly become a burden.
A personalised window to this messy world, tailed by and for the individual is what this project hypothesizes. By developing "large scale" prototype environments, restricted to specific informational domains we aim to create a controlable setting, that can be tested, developed and improved together with users of these systems.

Project Summary

The nature of my research interests is interdisciplinary with a strong focus on user interface (UI) design but influenced strongly by cognitive psychology, visual perception theories and didactical methods like constructivist explorative learning. At the core of my PhD project stands the formative development and evaluation of a prototypical information space (IS) for the web as reasoned in the introduction above. We aim to create two separate instances of this IS which will apply the domains of "computer security" and "nutrition", each with the aim to address a broad but unique audience and stimulate collaboration. The prototype will provide means to communicate, contribute and of course access information. The ease of performing all of these relevant tasks will be part of the investigation. Especially with the novelty of the approach proposed here in mind (in terms of a novel interface and a novel interaction strategy) long term results are crucial, especially in terms of users' satisfaction. It is intended to involve users in every stage of the development, to test improvements, gain qualitative feedback and improve the IS continuously alongside user requirements and expressed desires.

The main novelty of this IS will be the way it structures and displays information in a modularized and hierarchical manner. The design of the UI will make use of and develop further the Focus-Metaphor Approach [1, 2, 3] (see Figure 1).
This approach suggests a shift in structuring information on the Web. It proposes a separation of navigation and content that would have a similar impact as CSS had on separating layout from information. Using this

Figure 1 - Screenshot of a Focus-Metaphor Interface

approach, information will be modularized, hierarchically structured and displayed like visible in Figure 1. A complete explanation of this theory can be found in the paper “The Focus-Metaphor Approach: A Novel Concept for the Design of Adaptive and User-Centric Interfaces” [1].
For the further development and research, it is planned to conduct long term user studies and extensive in laboratory testing using eye-tracking equipment as well as physiological feedback to significantly improve the users’ experience of online information environments. It is aimed to investigate effects of user confusion, user orientation and navigational behaviour, cognitive load and other related aspects.

Starting with Furnas’ work on “Generalized Fisheye Views” [4], user interface visualizations using a focus + context approach became increasingly popular. Since then, many different projects have aimed to develop solutions to create contextual interfaces and Card’s work at Xerox Parc on DOI trees [5] represents a quite popular alternative. But even today, these solutions target mainly an alternative form of navigation which links to external content. This represents a “cognitive break” within the interaction process, which might especially effect performance in more complex tasks and increases cognitive load. Another alternative is the direct application of Fisheye views for graphical visualizations [6], but these scenarios are only usable for very restricted domains, like maps, lists or the like.

In contrast, the proposed research is focussing on a much more holistic approach of combining this sort of contextual navigation with the actual presentation of content. The Focus-Metaphor UI is dynamic, seamless and optimized for cognitive load, offering a focus + context visualisation that aims to provide a personalised “window” onto the IS. This personalisation will be created through various means, manually by the user as well as automatically through a smart backend. Whilst work on this novel UI is one core area of research, the second area will be the design and integration of this smart backend in form of a novel feature rich tagging framework that allows structuring the entire information space and providing a personalised view for each user. With these mechanisms of social tagging, the IS will be structured and personalised in a semantic way. When accessing information, users will have control on displaying what is relevant and interesting as well as hiding unwanted or overhead information.

Relation to Workshop themes

At the core of the proposed research stands the aim to deliver a more intuitive and efficient experience of personalisation in web environments. One underlying thesis of my research is, that current web-based user interfaces are not designed for and do not work with personalised content. Their design is rigid and static, layouted in grids and tables, with rows and columns that blur the borders between information and navigation, between tools and content. Perceptual Bandwidth is continuously increasing [7], and when looking at phenomena like banner blindness [8] and second-visit blindness [9] it is easy to conclude that conventional interfaces represent a burden [10] and are more likely to confuse users than assist them in finding relevant information or services. Current efforts towards the provision of personalised content (like Google’s personalised homepage, Windows Live or My Yahoo) lead the direction of future developments in this area. Nevertheless, this research is based on the hypothesis that the aspects mentioned above [7, 8, 9] represent critical drawbacks for effective personalisation like addressed nowadays by Google & co. and that the Focus-Metaphor approach will be able to provide a solution to these problems. By shifting the current fixation on search-based interaction (which could be regarded as a defeat of information architects) towards a more contextual explorative interaction [11] there might be the ability to create a new paradigm for a personalised Internet.

The planned work especially addresses the first two themes of the workshop:
How can computerized technology enhance or affect collaboration and communication?
By providing novel means of seamless, integrated interaction with content and services on the interface side and by integrating social tagging to categorize and personalise information on the backend side, we aim to facilitate collaboration and communication among users through a smart user-driven information space.

How can user-centred design help in the design of systems that adapt to individual profiles?
Having a tag-based information space presented in a focus + context interface, user profiles (based on a user's tags and an analysis of a user's navigational behaviour) will enable us to completely personalise the view onto the information space.

Workplan & Methodology

The research will focus on the formative development of a "large scale" prototype that simulates/represents a collaborative web-based information space. Studies will target both qualitative and quantitative evaluations in a mainly scenario-based fashion that is close to simulating real-world usage. As the prototype will be available online for participants, these studies basically reflect realistic usage (e.g. in a planned course accompanying style). Besides logging statistical data through means of web-mining, we aim to get quality feedback, participants' opinions, suggestions and complaints, to base further work on the prototype on these and to report findings. Another core aspect of the research methodology are in-lab experiments, where we will measure and analyse users' gaze and stress levels through eye-tracking and physiological measures.

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How can video-games deliver educational content in an intelligent fashion?

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Abstract. This paper describes a research proposal which explores the feasibility of utilizing cognitive and motivational scaffolding techniques from tutoring systems, in the development of video-games. The motivation behind this project is that we could build a video-game to tackle difficult school topics for children in year 5. We believe that the use of tutoring systems' techniques for cognitive and motivational modelling could enhance the "intelligence" of the video-games so that these adapt to particular children offering personalized experiences in the context of a video-game that could also deliver educational content.

Introduction and background

The employment of video games in educational settings has been thought to be motivating for children (Malone 1980). With this idea in mind some video-games such as "Zoombinies" (Hancock and Osterweil 1996) or "Prime Climb" (Conati and Zhou 2002) have successfully exploited the video games' appeal to deliver educational experiences to children. On the other side of the spectrum, the use of Intelligent Tutoring Systems (ITS) has tried to emulate an educational situation aiming at delivering appropriate feedback to improve the children's performance in the use of the software and arguably, in the children's knowledge of the topic. The nature of the ITS's feedback depends on the approach taken for its construction. The provision of help has been an important element in the definition of such systems. Luckin and du Boulay (1999), for example, have operationalised Vygotsky's philosophy of teaching and learning by incorporating an implicit "more able partner" that suggest, but not directs, the type of help the ITS "believes" the child needs. The system's beliefs are based on artificial intelligence techniques that dynamically model the learner's cognitive state regarding help-seeking.

In the last decade, a great deal of research has produced ITS's that have considered the learners' motivational and emotional state together with the cognitive state (Hudlicka and Fellows 1996; De Vicente 2002; Chaffar and Frasson 2004). Del Soldato and du Boulay (1995) for example, developed a set of motivational rules taken from theories of motivation and video games, to produce motivating feedback that could encourage the learner to put more effort or take more challenging activities. Another example of the use of emotions in agents has been presented in Lester, Towns et al. (2000). The provision of such feedback is underpinned by models of the learners' motivational states that, similarly to cognitive models, are based on artificial intelligence techniques. The efficiency of ITS that are both ognitively and emotionally intelligent has been studied producing some interesting effects (Lester, Converse et al. 1997; Rebolledo-Mendez 2006).

Research Proposal

Although we do not question the effectiveness of ITS in enhancing, sometimes significantly, the children's performance we believe their use is confined to short interaction times, normally happening during school hours. Video games, in a striking counter position, prove to be a more engaging medium and seem to captivate children who effortlessly spend many hours in front of them. One of the reasons for this could be the child's perception of the video game as an extracurricular, fun activity. Another reason could be the context; as tutoring systems are normally used in the classroom, they might be perceived as "school stuff". It would also be interesting to study why children appropriate video games. Based on our experience, we have observed that children normally "own" video games and often share game-related situations with friends, whereas intelligent tutoring systems tend to be overlooked and do not receive the same degree of attention. To try to shed some light onto these issues, we have defined a set of four hypotheses:

1. Games are perceived by children as "fun", extracurricular activities.
2. Tutoring Systems are perceived as educational activities or "school stuff".
3. Games are more easily appropriated by children than educational software.
4. Children engage more intensely with video games than they do with tutoring systems.

Because of the intrinsically motivating nature of video games, we propose to examine the characteristics that make video games fun and develop a video game to deliver educational content and evaluate its effectiveness. Our approach to developing a video game, however, is unique as we propose to include cognitive and motivational modelling techniques borrowed from artificial intelligence. Our video game would be "intelligent" in the sense that it should be able to adjust the game experience considering the learners' state of cognitive development and motivation, just as successful ITS's do. The resulting product would be advertised as a video game with the hope that children perceive it as an extracurricular activity. By developing an intelligent video game, we could exploit the motivating benefits of video-games and at the same time retain successful, adaptive cognitive and motivational scaffolding techniques based on sound theoretical background.

Developing an intelligent video game

The development of both, video games and tutoring systems is not an easy task. However, the use of HCI techniques could greatly inform the design of such systems. In particular, our approach to design will consider Curtis and Vertelney (1990) technique for the design of evolving prototypes. Under this philosophy various prototypes are created at different stages. Each stage represents a more complex prototype evolving from the previous one. The use of this technique allows for the use of other user-centre design techniques (NECTAR 2002). The stages involved in the development of such a complex video game would be:

1. Design of a video-game experience covering topics of Science for children in year 5. The resulting video-game should possess cognitive and motivational scaffolding techniques that have provided good results in intelligent tutoring systems. This stage consists of:

    a. Identification of Science topics for year 5 that prove to be particularly difficult for children.
    b. Identification of suitable game paradigms/stories/activities for these topics. The resulting activities should be suitable for different ability groups (according to SAT) and different motivational groups.
    c. Although possibly different in structure (due to ability and motivational considerations) the various video-games' prototypes will share common objectives, thread and emphasis.
2. Development of a video game.
    a. Employment of learner-centred design methods for developing the video game, keeping in mind particular needs according to the child's cognitive and motivational development.
    b. Programming of a single game into a multiplatform CD to be used at home or at school in any of the supported platforms such as PC, Macintosh, play station, game cube, XBox, etc.
    c. Development of a centralized, internet based, platform-independent database serving as repository of individual models, containing data about the children's cognitive and motivational development. Different models would be downloaded to the platform where the child works. At the end of individual sessions the models will be uploaded to the main repository. Note that children could change platforms depending on his/her location allowing the CD ROM use whether at school or at home. This infrastructure supposes the connection of home-based consoles and/or computers as well as school's computers to our databases.
    d. Development of a teacher interface where different teachers could analyse the cognitive development of their students. It should be possible for teachers to update the models and by doing so children would experience a slightly different version of their own video-games. The interface would be able to present factual data (time of play, duration of sessions, location of play, etc) as well as the tutoring system's beliefs about the child's cognitive and motivational development.
3. Evaluation
    a. Children in participant primary schools (year 5, 9-10 year-olds) would be given a CD ROM –the video game– that can be then used whenever they want wherever they are.
    b. Teachers would monitor and possibly update the children's cognitive development –via the teacher's interface– adjusting the activities provided by the video-game to the child's cognitive development. The teacher would be able to check the intelligent tutor's beliefs about the student's cognitive development against his or her own beliefs derived from the teaching experience in class.
    c. Researchers would collect data in the database coming from the child's activities and the teacher's adjustments from a period of 4 or 5 weeks, coinciding with the teaching of the topics covered in the video game.
4. Analysis
    a. With this information, we would be able to assess the impact of the video game in learning selected topics in Science for year 5 children.

Discussion

This paper constitutes a first step towards the definition of a research proposal. It is based on the idea that the use of video games in education could bring about an effective way of conveying educational content in a medium frequently used by children. Although there have been attempts to transform intelligent tutoring systems into video games, or including educational content in video-games, we believe that the use of successful modelling techniques could provide video-games with an element of intelligence that existing games do not have. This “intelligence” could endow video games in such a way that they adapt the presentation of their content according to individual children’s cognitive and motivational development. Such video-games would utilize user-centred design techniques to ensure that the resulting product be widely used by children whether at home or school. By allowing the video-game to upload/download models to a central repository of models, we could analyse our hypotheses and could provide a vast resource to assess the impact of cognitive and motivational modelling in video games.

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Assessing Knowledge Monitoring of Ill-Structured Subjects: Using Concept Maps to Represent Knowledge

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Introduction

An essential component of successful learning is the ability to assess the state of one's current knowledge and consequently monitor and regulate the learning process. This is a complex process that is typically, though not universally, conceived of as an aspect of metacognition. So far it has predominantly been defined within the context of well-structured knowledge. This is reflected in the methods that have been developed to measure it. For example, Everson and Tobias (1998) have developed a method for assessing students' ability to estimate their vocabulary knowledge or their ability to solve math problems by asking students to state whether they believe they can solve a problem correctly and then comparing this estimate with their actual performance. Even studies that have focused on ill-structured topics have used well-structured tasks in measuring student estimates of their knowledge. For example, Pressley, Snyder, Levin, Murray and Ghatala (1987) reported studies in which undergraduate students were asked to read passages from an introductory psychology textbook and then estimate their performance on multiple choice and fill-in-the blank tasks.

However, most knowledge is not well-structured and knowing or not knowing about a topic is not clear-cut. For example, one may know about a given topic but have no understanding of how that knowledge has been derived. Consequently, monitoring one's knowledge of ill-structured subjects involves a more complex analysis and one's conception of what 'complete' knowledge is will influence the monitoring process. Thus students' knowledge monitoring will be influenced by their ideas of the nature of knowledge and knowing, that is their epistemic cognition. For example, a student who perceives knowledge of any given topic as being utterly subjective may rate their ability to answer a question on the topic as near the same as an experts' as for them everything is just a matter of opinion.

Therefore, applying the rationale of the current measurement methods that use well-structured tasks to ill-structured tasks does not appear to be adequate. The issue is not that appropriate ill-structured tasks cannot be set and the students' answers to them assessed. Rather, it is hypothesised, that it would not be an accurate measurement of students' ability to estimate their knowledge. For example, a student who is aware of the complex, socially constructed nature of knowledge may understand the material they have read and, in fact, have relatively deep knowledge of the topic. However, they may have not read widely enough to gain confidence in their knowledge. They would likely underestimate their knowledge, but without this meaning that they have inadequate knowledge monitoring skills.

Moreover, the type of task that is used to assess students' ability to estimate their knowledge is likely to affect the measurement. If the student is presented with a well-structured task, such as multiple choice questions, they are likely to be accurate in their estimate of their performance, even if they have a relatively simple understanding of the knowledge. Using tasks that require students to represent their knowledge in ways that bring out the complexity of it, such as concept maps, may have the potential of improving their ability to successfully assess the current state of their knowledge.

The present research aims to address the following questions:

- Does knowledge monitoring of ill-structured subjects involve different processes to the monitoring of well-structured subjects?
- How does students' epistemic cognition impact on their knowledge monitoring of ill-structured subjects?
- What methods can be developed to assess students' ability to monitoring ill-structured subjects?

Metacognition in Ill-Structured Domains

Metacognition, broadly defined as 'thinking about thinking' has been widely recognised as an important aspect of learning. Researchers disagree as to what processes should be conceived of as components of metacognition and there is no universally accepted theoretical framework. However, the process of monitoring the state of one's knowledge is generally considered a metacognitive skill in current frameworks (Pintrich, Wolters & Baxter, 2000).

Although there is a substantial amount of research that has studied knowledge monitoring processes, it has largely focused on assessment of performance on well-structured problems. *Well-structured* problems are problems where the initial and goal states can be defined and there is a limited set of operations that can be applied on the initial state to reach the goal. An example is solving an algebra problem. In *ill-structured* problems, on the other hand, the initial state is not well-defined and there are unlimited ways of getting from the initial to an acceptable goal state, though the question of what constitutes an acceptable goal state is also debateable. An example is deciding whether recent climate change is due to the activities of humans. All scientific domains are ill-structured. However, at the novice level, learning in domains such as physics and mathematics involve predominantly well-structured problems in contrast with domains such as psychology and politics.

It has been argued that different processes are involved in solving well-structured and ill-structured problems (Kitchener, 1983; Jonassen, 2000). However, very little empirical research has attempted to investigate this. It is hypothesised that solving ill-structured problems is different in that it requires the learner to assess the epistemic nature of the problem and consequently their epistemic beliefs will influence their proposed solution.

Epistemic cognition

A person's epistemic cognition is the way they perceive the nature of knowledge and knowing. There is no single theoretical framework for conceptualising epistemic cognition (Hofer & Pintrich, 1997) and a number of different schemes have been developed for classifying different 'levels' of sophistication along a continuum of increasing complexity (e.g. Perry, 1970). In general terms, a person with a simple epistemic cognition perceives knowledge as absolute and 'discovered', whereas a person with a complex epistemic cognition views knowledge as relative and socially constructed. Recent research indicates that students' epistemic cognition plays an important role in learning (Hofer & Pintrich, 1997; Laurillard, 2002). A more complex epistemic cognition has been associated with more sophisticated thinking and problem-solving skills, higher motivation, and persistence (see Hofer & Pintrich, 1997 for a review).

Pilot study

The initial pilot study was carried out with a different set of research questions. However, the results helped inform the current line of research. The study was designed to explore the impact of epistemic cognition on how students collaborate in assessing their current knowledge, the gaps in this knowledge and what strategies to use in order to cover these gaps. The study was carried out in two phases, the first in an experimental setting with psychology students, and the second in a class setting with students taking a masters course in Interactive Learning Environments.

<u>Participants</u>
Small groups of 3-4 students participated in this study. Participants were 1st, 2nd year, and master-level psychology students (13 students in 4 groups), and masters students taking a course in Interactive Learning environments (12 students in 4 groups). They were of various ages and academic experience.

<u>Procedure</u>
The study was conducted in two parts. In the first the participants worked individually. Participants were given a question and asked to write down in bullet-point form their answer to it. They were asked to rate the extent to which they knew something to be true for every point they made. They were also asked to note what knowledge they believed they were lacking in order to answer the question more completely and how they would go about finding out more information. In the second part, participants were asked to combine their answers and create a single one that they all agreed with.

<u>Results and discussion</u>
The findings that are relevant to the present research questions concern the participants' approach to representing and estimating their knowledge. The main findings were:

a. Students' found it quite difficult to represent their knowledge in a coherent way, that is to bring together all of the different pieces of knowledge that they judged as being relevant to the question to answer it.
b. They might initially rate their knowledge on a point as high but when asked to elaborate on that knowledge their confidence decreased.
c. Almost all the psychology students indicated an understanding of the role of empirical evidence in supporting theoretical positions and cited research in support of the points they made. However, they acknowledged that their knowledge of the literature was limited and hence had low confidence in their opinions.

These findings suggest that the process of estimating knowledge of ill-structured subjects involves a more complex analysis than whether the information is available or not. On the one hand, a bullet-point representation does not support the integration of knowledge on a topic. Different representations, such as concept maps, may support students in structuring the different pieces of knowledge thus making it easier for them to estimate their knowledge as a whole. On the other hand, estimating one's knowledge is dependent on an understanding of the wider scientific literature. The students who participated in the pilot study appeared to have a sophisticated understanding of the relationship between theory and empirical evidence. They were confident in their knowledge of the material they had read and demonstrated a deep understanding of it, but were not confident that this knowledge was complete.

Summary & Future research

Traditionally, researchers have assumed that solving well-structured and ill-structured problems involve the same processes. However, theoretical analyses (e.g. Kitchener, 1983; Jonassen, 2000) have questioned this assumption and postulated that epistemic cognition places an important part in ill-structured problem solving. The present research aims to investigate these theoretical claims with a specific focus on the process of knowledge monitoring. Initial pilot work supports the idea that estimating what one knows about an ill-structured subject is a complex process that involves assessing the nature of 'complete' knowledge. The next step in this research is to design a study to investigate different methods of assessing students' estimates of their knowledge of ill-structured subjects. This will involve exploring the use of concept maps to support the estimation of one's knowledge on a topic as a whole, and the use of different types of tasks.

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Metacognition in Context: a Study of Metacognitive Activity in a Pair Programming Class

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Abstract. Pair Programming is recent approach for teaching programming. Students who practice it have shown better results and more satisfaction when doing course projects. Despite its popularity, the knowledge about how and why this could be beneficial for learning is unclear. This paper suggests the analysis of this collaborative situation through the study of the metacognitive activity that could spontaneously happen in this social situation.

Introduction

Teaching programming is not an easy task. For this reason, it has been the subject of study for many researchers. Brusilovsky et al. [1], for example, in a review of approaches and tools for teaching procedural programming, noted that programming causes cognitive overload and for this reason should be taught in small chunks of material. With Object-Oriented Programming, an approach that is increasingly becoming the standard in academic environments, this is not different. The large number of concepts, whose familiarity is required for handling Object-Oriented programming constitutes a major difficulty for novices [2]. Thus, new tools and methods that could facilitate the learning of programming must be explored.

Pair Programming is a promising new approach for teaching programming. Students who practice it have shown better results on graded assignments and more satisfaction/less frustration when doing course projects [3]. There is some anecdotal evidence that Pair Programming is beneficial for learning (Jensen, 2003; Nagappan et al., 2003; Laurie Williams et al., 2000). However, these studies have focused on the costs and benefits of having pairs compared with solo programmers. Little attention has been paid to the factors that could make it an effective or ineffective experience in a learning context. This raises a number of important questions. What is the nature of the Pair Programming task in a learning context? How does the interaction affect learning mechanisms such as mutual regulation? Thus, this work intends to search for evidence of metacognitive talk when students are pair programming.

This paper will briefly review the literature on collaborative programming trying to build a picture of the knowledge we have so far of its use in universities. Later, it proposes the study of this collaborative situation through the analysis of the metacognitive activity that could occur in this interaction showing the interplay between collaboration and metacognition. Finally, it will propose pair programming as an interesting case study of collaborative learning in computer science courses.

Collaborative Learning

Learning in a collaborative environment is a process that can be viewed from two different perspectives [4, 5]: individual effort and social sharing of knowledge. The first derives from Cognitive Constructivism [6]; the second derives from Social Constructivism [7]. In the early stages of collaborative learning research the individual was seen as the unit of analysis, a single cognitive system that exchanges messages. Later, the unit of analysis became the group; the goal now is to understand how these cognitive systems merge to produce a shared understanding.

Social Constructivism focuses on learning as an action that occurs within a social context during the interaction between the learner and his or her interlocutor(s). It has tended to stress cooperation rather than conflict. For that reason, this approach stresses learning as a process triggered by social interaction in the context of dialogue (e.g. tutor-learner). For social psychologists the idea that a group will frequently outperform individuals working independently on certain problem solving tasks has been well established [8]. Resulting from their engagement in collaborative activities, individuals can often master something that they could not do before the collaboration [5, 9, 10]. From a Social Constructivist perspective, learning will occur in social environments which support rich interaction between a learner and his/her peers [11].

In the classroom, effective collaboration with peers has proved itself a successful and powerful learning method [10, 12]. Students learning effectively in groups encourage each other to ask questions, explain and justify their opinions, articulate their reasoning, elaborate and reflect upon their knowledge, thereby motivating and improving learning. These benefits, however, are only achieved by active and well-functioning teams [13]. Regardless of the subject area, placing students in a group and assigning them a task does not guarantee that the students will engage in effective collaborative learning behaviour [4, 10, 13]. This contradiction helped to motivate researchers to seek conditions in which collaborative learning might or might not be efficient.

Many conditions may affect the efficiency of collaborative learning. One factor is the composition of the group, which encompasses several variables [4, 14]. The group could have people with different skill levels (social, related to the task, etc), ages, gender, backgrounds, and so forth. Thomas, Ratcliffe and Thomasson [15] have looked for the importance of skill level in learning programming. They found that grouping people with similar expertise seems to be better. A previous studied conducted by Webb [16] with small groups found similar results regarding the ability of solving mathematical problems. Authors have also shown that social skill could impact on the collaboration. Crook [17], for instance, holds that there are features of interaction that are central for a successful collaboration, among them: intimacy among participants and histories of joint activity. Studies have also shown that collaboration varies according to the task [14, 18]. For example there are tasks that are essentially distributed and lead group members to work on their own, sometimes completely independently from each other. Another important variable is gender. Underwood and Underwood [19] in their study also looked at gender in children's collaboration. They found that, for pairs, the combination girl-girl seemed to be more efficient.

Indeed, there is not one single variable that could be considered responsible for the failure or success of collaborative learning. Moreover, one of the problems is that most of the variables presented above actually interact with each other. For instance, the effect of gender on group composition is not the same with different group sizes or with different tasks. Therefore, research has to look at the mechanisms by which collaboration is efficient [14].

Metacognition and Collaboration

Flavell [20] defined metacognition as the notion of thinking about one's thoughts. It refers to the active monitoring and consequent regulation of our cognitive processes. Putting it in simple words, it is thinking about thinking [21 p.1]. The development of metacognitive skills has proved to be beneficial in different areas of learning, such as reading comprehension [22], mathematics [23], combinatorics [24].

Research on how peer interaction could improve metacognitive strategies is limited and has produced contradictory results [25]. Eizenberg and Zalavsky [24], for example, examined the effect of collaboration in solving combinatorial problem on the extent to which control processes were employed. They noted that student who worked in pairs showed more metacognitive control, and performed better than students who worked individually. They reinforced the relation between collaboration and metacognition, suggesting that success in collaborative problem solving might depend on the extent where the peer interaction could generate metacognitive strategies, such as monitoring and regulation. Goos [25, 26] had similar findings; however she also noted that peer interaction is not always beneficial. She argued that there are some situations where paired decision making could hinder metacognitive decision. In her opinion, if during the collaboration students fail to share metacognitive roles such as idea generator, calculation checker, procedural assessor, etc the interaction could result in what she called metacognitive failure.

These conflicting results illustrated a gap in the literature. More need to be explored on the interplay between metacognition and collaboration. Does collaboration only exists in an interaction with signs of metacognition? Does metacognition always promote beneficial results? Therefore, this study aims to explore the relation of metacognition and collaboration in learning programming.

Pair Programming

Programming in pairs is not a new idea, but dates at least from 1970 [27]. What is new about Pair Programming is the way it has been structured in the eXtreme Programming[1] literature, enforcing its use in all phases of software development.

Essentially, Pair Programming is a situation where two programmers work side by side, designing and coding, while working on the same algorithm. According to Cockburn and Williams [28], who observed the method in academic environments, Pair Programming improves the quality of the software design, reduces deficiencies in the code, enhances technical skills, improves team communication, and it is considered to be more enjoyable for the participants. According to Cockburn and Williams [28], who observed the method in academic environments, Pair Programming improves the quality of the software design, reduces deficiencies in the code, enhances technical skills, improves team communication, and it is considered to be more enjoyable for the participants. Moreover, other studies [29-32] that compared the performance of Pair Programming students and solo students showed that the former were more likely to hand in solutions for their assignments.

However, literature has shown that similar to other collaborative learning situations, it is not always successful. Tessem [33], for example, showed that some students found the experience irritating, extremely inefficient and very exhausting. Gittings and Hope [34] found very similar results in their study where participants described the experience with Pair Programming as demanding and sometimes frustrating.

Conclusion

The present research aims to investigate the metacognitive activity of students who are learning programming in a collaborative context. Thus, this work intends to search for the evidence of metacognitive talk (monitoring and self-regulation) when students are Pair Programming. The main hypothesis driving the research is that collaborative programming, in this case Pair Programming, could enhance the students' monitoring skills to pursue programming problems, together with an improvement in self-regulation skills on cognitive strategies used to solve programming problems.

The outcome of this work could provide additional understanding on the topic for practitioners and researchers and inform the design and implementation of tools to support collaborative programming in universities. It will help to understand how metacognition is mediated by collaborative peer interactions. Moreover, the findings from this proposed work could also help to shed more light on the benefits that the use of collaborative learning can bring, in particular for computer science courses, extending previous works [23, 25] conducted on the mathematical problem solving field.

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Social and Affective Processes in Collaboration: Building an Affect Sensitive Foreign Language Learning Community

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Abstract: The authors report one aspect of work in progress on the development of an affect sensitive foreign language learning environment.

The aim of this project is to investigate how resources might cognitively and affectively support members of the community through the process of learning a foreign language. The resources will include technology, which aids the learners as they move through the learning and teaching process, which supports the learners in conveying messages and their identity and which supports the group processes paramount to creating and maintaining successful educational collaborative interactions.

The language learning community in development has the theoretical perspectives of Vygotsky's social constructivism at its core. Fundamental to social constructivism is the belief that an individual's learning and development stems from supportive social interactions.

This paper will discuss the social constructivist roots of collaborative learning, the role of affect and group dynamics in collaborative learning interactions and how technology might be utilised to support the affective side collaboration.

1 Introduction

The relevance of collaboration in learning is firmly rooted in Vygotsky's social constructivist theory (1962, 1978), which is based upon the belief that an individual's learning and development occurs as a result of his or her social interactions.

The central importance of social interaction in cognition is expressed by Vygotsky's concept of the Zone of Proximal Development (ZPD) (Vygotksy, 1978). The ZPD represents the conceptual space between what the learner can do alone, and what the learner can do with the assistance of a more able partner. In other words the ZPD represents the mental processes or functions that are in development, but have not yet matured to a state where a learner has full grasp of them. The greatest learning gains can therefore be obtained when the more able partner interacts with the learner within their ZPD.

Perhaps as an outcome of the relative popularity of social constructivist theories, a number of Intelligent Tutoring Systems (ITSs) and Interactive Learning Environments (ILEs) provide the opportunity for collaborative learning situations (Belz, 2003; Luckin, 1998; Von der Emde, 2001; Ware, 2005; Wood, 2001). The nature of the collaborative interactions differ from systems where the ITS plays the role of the more able collaborative partner guiding the individual through learning episodes (Luckin, 1998; Wood, 2001), to systems which facilitate learning collaborations occurring between individuals working at a distance (Belz, 2003; Von der Emde, 2001; Ware, 2005), which are otherwise generally known as Computer Supported Collaborative Learning (CSCL) environments.

The focus of this project is the development of an environment which will support interactions and collaboration between language learners in Germany and in the UK. As a consequence, the remainder of this paper will focus on the affective and social issues which stem from learning collaborations between people and how technology might be used to support collaborators better.

2 The Social and Affective Aspects of Collaboration

The success of CSCL environments has been somewhat varied. Although a number a of CSCL-based research studies have described positive results and increased learning gains (Hallet, 1997; Von der Emde, 2001), there are equally a number of research studies which have reported negative results, including reduced learning gains, low levels of collaboration, low participation, and high drop-out rates (Belz, 2003; Ware, 2005).

Kreijns et al (2002) have hypothesised that the cause of these negative results is related to the lack of support provided by these environments to the affective and social side of the collaborative learning process.

Support for this hypothesis may be found in research which details the inextricable link between cognition and affect (Bower, 1992; Damasio, 1994; Schumann, 1997). Certainly, if a link between cognition and affect can be forged, then by definition any learning resulting from social interaction will also be dependent on the affective states of those involved, since the quality of interactions will be influenced by how much the collaborators trust one another, what risks they are prepared to take, and among other things, how motivated they are to collaborate and learn (Crook, 2000; Jones, 2005; Wegerif, 1998).

One approach which addresses the affective and social processes involved in collaborative learning is group dynamics, which is concerned with the scientific analysis of the behaviour of small groups.

According to group dynamics there are five main stages that any healthy group will go through, these are: *group forming*, *group storming*, *group norming*, *group performing* and finally *group adjourning* (Dörnyei, 1997). The processes that occur at each stage are wide ranging and need to be supported in a variety of ways. For example, within group forming the participants are likely to feel anxious, overwhelmed and lack confidence, they will be within a new group, but will not be certain of what is expected of them and what they can expect from the group. To support the group adequately through this stage, resources and tasks will need to be organised to help the participants become acquainted with one another and develop group norms. Methods which have been appropriated in face-to-face learning environments include: encouraging the sharing of genuine personal information, seating the students next to one another and providing contact outside the normal learning context (Dörnyei, 2003).

3 Supporting Group Dynamics through Technology

There are a number of well documented techniques that might be used in face-to-face learning environments to support group dynamics (Dörnyei, 1997, 2003; Dörnyei, Malderez, 1999; Hadfield, 1992), however of central interest to this paper is the way in which the group dynamics of learners collaborating at a distance from one another can be supported by technology. This section will focus in particular on the role of technology in supporting the groups through the *group forming* stage, emphasising in particular how technology might support trust building and friendship forming processes.

There has been some research on how trust and friendship can be developed in online collaborative business environments (Jones, 2005; Preece, 2004), but as yet there is very little research investigating how trust and friendship can be supported in distance-based collaborative educational interactions.

One method used to establish trust in business based collaborative environments is the availability of member ratings, where members of the community rate one another based on criteria such as reliability (for example, eBay). However it is unclear whether the use of ranking of learning collaborators will be something which is beneficial in an educational setting, since the trust issues do not centre around potential financial losses but instead around, amongst other things, potential loss of face.

Borovoy (1989) suggests that trust and friendship may be developed between learning collaborators through the sharing of personal stories, jokes and identity. In keeping with this proposition, the potential resources that the learning environment developed by this project might provide include are: devices for sharing jokes and stories through means that do not rely on extensive language use (since our learners may not have a strong grip of the language their partner speaks) and personal web pages or blogs which individuals can use to share their identity with their collaborative partners.

In another vein, Gunawardena (1995) has investigated the amount of social presence (levels of intimacy and immediacy) in online conference facilities, concluding that environments which allow for greater social presence are more conducive to supporting learning interactions. Social presence can be increased in online learning environments through the portrayal of external contextual cues (such as facial expressions, eye contact and gestures) and touch. To provide a greater sense of social presence this project will incorporate a tactile technology, such as shared mechanical floorboards which move in both locations as collaborators in each environment walk across them as well as audio and video streaming technology for the sharing of language and external contextual cues.

4 Conclusions

This paper has presented part of a theoretical framework which provides the groundings for continuing work on the development of an affect sensitive foreign language learning environment. This research is based on the pedagogical theories of social constructivism, with the additional notion that a student's affective state plays an integral role in what they can and will learn from their interactions with a more able partner.

The importance of affect in learning and cognition has been widely accepted, yet still a large percentage of collaborative online learning environments fail to support the affective nature of collaborative learning.

This research, in part, will investigate what types of resources might need to be available in order to support the group and social processes which are seen as integral in an educational setting.

This project will shortly move towards the design phase, which will be an iterative process based on user centred design techniques. Once a working prototype is developed, the language learning community will be set up for use over a number of weeks in order to evaluate the potential usefulness of such a community.

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Does the improvement of affective state enhance the quality of student's answers?

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Abstract: This paper is an extension of our previous paper (Yusoff & du Boulay, 2005). It aims to report the results from a user centred approach experiment. The objective of the experiment was to find the evidence to support the importance of the integration of domain independent strategies into an intelligent tutoring system. Results from this study indicated a significant correlation between the improvement of student's negative affective state and the quality of student's answers.

Keywords: affective framework, domain-independent, user centred approach.

1.0 Introduction

A general affective ITS framework has two major components: the detection of the student's affective state phase and the reaction to the student's affective state phase (see e.g Conati, 2002; del Soldato & du Boulay, 1995). To model and infer student's affective state effectively in an intelligent tutoring system, various methods and several model have been deployed and reported with different degree of success (e.g Yusoff & du Boulay, 2005, Conati, 2002; del Soldato & du Boulay, 1995, Picard, 1997). As for the reaction phase, although present ITSs deploy various techniques, the emphasis is mostly on the use of domain dependent strategies to manage the student's affective state. These include, provision of feedback or solution to the student's problem, or scaffolding the student with appropriate help level to suit his or her individual learning style (Yusoff, 2005).

However, according to emotion regulation theory (Gross, 1999, Lazarus, 1991), an individual uses two strategies to manage his or her affective state: emotion-focused strategies (domain-independent) and problem-focused strategies (domain-dependent). Using the underlying emotion regulation theories, Yusoff & du Boulay, (2005) have proposed the integration of domain-independent strategies in an affective framework. In the integration, it was hypothesised that the use of both domain-dependent and domain-independent strategies could help students manage their affective states effectively.

As, this paper is the continuation of our previous study (Yusoff & du Boulay, 2005), we present the result of a user centred approach experiment which was conducted to study the correlation between the improvement of student's negative affective state and the quality of student's answers. Positive results from these studies have yielded some evidence to support the need of domain-independent strategies integration into an intelligent tutoring system.

2.0 Experimental setup

The main research question of the experiment is to find the correlation between students's positive affective state and student's negative affective state with the quality of student's answer in using the ESA framework. There were 28 unpaid students taking part voluntarily in this experiment.

The participants were asked to complete two experimental tasks. At the beginning of the experiment, participants were asked to self report their affective state at two learning stages: at the beginning of the lesson, and at the end of the lesson using the PANAS questionnaire. The PANAS questionnaire consists of 18 different positive and negative emotions in a scale of 1 to 5 used to gauge the level of student's positive and negative affective state. It was then followed by a 15 minutes learning session. During this session, students were asked to select and answer their preferred learning topic. To assist the students, notes of the selected topic which include selected examples were provided.

3.0 Results and discussion

The study of the relationship between student's affective state and the quality of student's answer is the first research question of the experiment. The result of this study is important as it provides the significant justification of the use of the domain independent strategies. We postulate, if improvement of student's answer quality due to the improvement of student's affective state was observed and significant, it suggests that the use of the domain independent strategies was essential. To study the relationships, for both the negative and positive affective states, the bivariate correlation test was used. The results of the test are presented as Figure 1 and Figure 2 below:

Correlations

		Quality	Positive Affect
Quality	Pearson Correlation	1	.152
	Sig. (1-tailed)		.220
	Sum of Squares and Cross-products	8.024	1.807
	Covariance	.297	.067
	N	28	28
Positive Affect	Pearson Correlation	.152	1
	Sig. (1-tailed)	.220	
	Sum of Squares and Cross-products	1.807	17.569
	Covariance	.067	.651
	N	28	28

Figure 5: Correlation between the positive affect and the quality

Correlations

		Negative Affect	Quality
Negative Affect	Pearson Correlation	1	-.348*
	Sig. (1-tailed)		.035
	Sum of Squares and Cross-products	32.527	-5.627
	Covariance	1.205	-.208
	N	28	28
Quality	Pearson Correlation	-.348*	1
	Sig. (1-tailed)	.035	
	Sum of Squares and Cross-products	-5.627	8.024
	Covariance	-.208	.297
	N	28	28

*. Correlation is significant at the 0.05 level (1-tailed).

Figure 6: Correlation between the negative affect and the quality

Findings of the test indicates that the correlation between the student's positive affective state and the quality of student's answer($r = 0.15$, $p > 0.1$) was not significant. Based on the result, the increment of the student's positive affective state at the beginning of the lesson did not improve student's answer quality. However, a contrast result was observed for the negative affect variable. Result from the bivariate correlation test has indicated there was a significant negative correlation between student's negative affective state at the beginning of the lesson and the quality of student's answers ($r = -0.35$, $p<0.05$). It means, at least to this group of students, the quality of student's answers would improve when their negative affected state reduced.

4.0 Conclusion

Results from the experiment have provided evidence that the improvement of student's negative affective state significantly contributed towards the improvement of student's quality of answers and performance. It means, at least to this experimental group, the deployment of strategies that could help students manage their negative state may improve the students' performance. In our future plan, as we belief the use of domain-independent strategies such as breathing exercises are useful to reduce student's negative affective state at the beginning of a lesson, we will conduct another user centred experimental design to gather more evidence to support the important of the integration of the domain independent strategies into an intelligent tutoring system. .

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Designing a Prospective Memory Aid for Cognitively Impaired Elderly Individuals

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ABSTRACT

This paper introduces a technology mediated prospective memory aid for elderly individuals with memory impairments. The design of this device utilizes the user centred design approach, aiming to involve the users in every step of the design process from design conceptualisation to operation. The purpose of this research was to develop a usable piece of technology to act as a surrogate memory for those individuals with prospective memory problems enabling them to live relatively independent lifestyles.

INTRODUCTION

This paper presents the concept for the design of a memory aid for cognitively impaired elderly individuals. The proposed device is a prospective memory aid for elderly individuals whom are reliant on external aids to help them remember to perform future tasks. The concept was to design a tool to help individuals with very mild to early Alzheimer's disease (AD) to help prolong an independent lifestyle. The proposed device will be a mobile memory aid, which displays reminders appropriate to the users needs (i.e., text, alert sound, voice over) at particular times. This reminder can be accepted and confirmed when the task is completed, postponed or ignored, in which case the carer will receive a message that the reminder was not seen.

Although prospective memory aids have already been developed in modern technologies, for example functions on mobile phones, computers etc., the design of these devices are not appropriate for the physical, cognitive and social factors common with aging. Therefore the current research takes these issues on board to help construct a usable and efficient device for the elderly population. It is important that the design is inclusive for all users so that it can be used by carers as well as memory impaired elderly individuals.

Technology for the Elderly

The interest in designing technology for older adults is increasing. This has in part to do with the increasing life expectancy of people and the rapid aging of society that is predicted in the 21st century. Demographic studies have estimated that the percentage of older adults in Ireland will have doubled from the year 2000 to the year 2050. The fastest growing subgroup represents those over 80 years of age, increasing by 5.2% in 50 years. According to population projection, this aging trend will be seen across Europe, with older adults almost 35% of the population by 2050 (US Census Bureau, 2005).

These statistics emphasise the importance of technology developers to focus their attention on the older user. Designing for older adults requires developers to take into consideration their capabilities and limitations including psychosocial needs and their acceptance of technological supports. Much of this research has considered the needs of individuals suffering from dementia. As aging is the highest risk factor for developing dementias, developers are aware that technological supports will be needed to provide relief for carers. The main purpose of these technologies is to offer a high level of independence to elderly individuals, to improve communication between them and their family or carers and to allow them to age in their home environment.

Prospective Memory

Prospective memory involves remembering to do things at the right time and prospective memory tasks are pervasive to daily living (Driscoll, McDaniel, & Guynn, 2005). This ability is vital for everyday living and failures in prospective memory can result in a range of consequences, from missing appointments to forgetting to take medication. Individuals who have impairment in their prospective memory have to depend on other individuals or external aids to help them remember to do things in the future.

Studies investigating age-related effects of prospective memory have revealed suprising results. The majority of these studies implement telephone or mailing tasks in which the participant is required to contact the experimenter at particular times. Although it was predicted that younger participants would perform better than older participants, in the majority of these studies a positive age effect was found (Henry, McLeod, Phillips, & Crawford, 2004). It is believed that older individuals outperform their younger counterparts by using external aids or reminders. Several studies have also shown that individuals, even in the late stages of AD, can benefit from the use of external memory aids in their environment (Nolan & Mathews, 2004)

It is believed that difficulties in prospective memory tasks could be an early indicator for the onset of AD (Huppert & Beardsall, 1993). Huppert & Beardsall proposed that in contrast to retrospective memory tasks where participants with mild Alzheimer's perform at a level between normal and more demented participants, individuals with mild Alzheimer's perform just as poorly as demented participants on prospective memory tasks. This finding suggests that remembering to execute intended actions may be particularly disrupted in the early stages of AD.

Related Work

It appears that the bulk of the research into electronic prospective memory aids focuses on the development of technology for patients with acquired memory impairments to manage prospective memory failures. The methodologies used in these studies included case studies and clinical trials following brain injured patients' treatment and training using various technologies prospective memory aids (Wilson, Evans, Emslie, & Malinek, 1997; Thöne-Otto & Walther, 2003). Neuropage (Wilson et al.) was designed as a portable paging system for memory impaired patients. Users are reminded through an alarm/vibrator alert with explanatory text and control the device with a single large button. The simplicity and ease of use of this memory aid is an obvious benefit to a brain-injured patient. It also however restricts the systems flexibility. For example, the device fails to provide a feedback and reminder delay function and any schedule changes have to be made through a paging company. Thöne-Otto and Walther compared two standard devices as memory aids, a palm organizer and a mobile phone and found some common usability problems. Patients reported that the labels, keys and letter size were too small and that there were too many steps involved when inputting data. Overall however these results exhibited a positive affect of using an electronic memory aid to manage prospective memory problems.

User-centred design process

To gain an understanding of the social, physical and cognitive issues surrounding the lifestyle of the older user, interviews and questionnaire sessions were carried out with individuals with mild to moderate dementia and also carers of people with dementia. This data was used to come up with the concept for the design and to help begin designing the first prototype. Eight individuals with mild to moderate AD were interviewed and ten questionnaires were distributed to carers of individuals with AD. The objective was to gather information concerning the potential users' attitude and experience of technology and memory aids and their expectations for an electronic memory aid. The questionnaires also included topics concerning the day-to-day problems experienced by the impaired individuals and the strategies they used to help them. Some answers were widely varied and often dependent on the individuals living status, physical impairments and financial well being. From these methods several points were highlighted. It was found that the majority of the participants had little technological experience and that they believed new technologies were too complicated for them to use. The most commonly used external aids were calendars, written notes, putting objects in conspicuous places and asking someone to remind them. The majority of carers believed that the proposed device would be useful for when they could not be present on the condition that it accommodated their physical needs (e.g. voice reminder for blind user). Overall these findings provided a positive attitude towards a prospective memory aid from both groups and pointed out the issues that where important to the user including cost, ease of use and design requirements.

FUTURE WORK

The information from initial interviews and questionnaires will be used for the design of the prospective memory aid prototype. Before designing the prototype, a layout analysis for the design interface and structure will be carried out with elderly participants, to gain an idea of preferred styles, layout and functions. This data will be used for the first prototype design and following an iterative process will lead to a fully functional prototype to be tested and evaluated by potential users.

CONCLUSION

Prospective memory problems have been shown to be one of the first symptoms of AD and also the most frustrating for both sufferers of the disease and their carers (Huppert & Beardsall, 1993). Although prospective memory aids have been developed and have shown to have a positive effect on performance, these devices do not cater for the limitations common with aging. The current study is a work in progress; to design a technology mediated prospective memory aid which meets the capabilities and limitations of the older user as identified in the user centred design process.

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Hermes@Home: Keeping in touch with the home

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Introduction

It is quite common, nowadays, that people are required to be away from home for most of their day, or for longer periods of time, when on long trips. There is often still a need, however, to establish communication with the 'home', even when away, e.g. to coordinate household activities, or to simply keep in touch.

This communication is directly related with issues such as awareness and intimacy, and also required for coordination. The need for such communication with the home was emphasized when two members of our department had to make individual long trips to Australia. The large time difference introduced a requirement for more asynchronous communication, but the cost of established messaging methods, such as SMS, to a different country, were factors hindering regular communication. E-mails might fit the model for this type of communication to a certain extent, but require communicating parties to have enough technical knowledge to be able to perform tasks like sending and checking e-mails, while they often also require physical presence in the room where the home PC is located.

The Hermes@Home system was conceived as a technology probe (probe which logs how new technology is used e.g. [1], [2]) that would allow us to explore this type of regular communication between members of a home, and issues arising from lack of it. The system was initially a quick modification of the Hermes system [3]. Written notes are characterised by the handwriting of the writer, while people often annotate their text with faces, drawings, etc., which makes this medium much more expressive than, for example, e-mail. This expressiveness also allows for playfulness which, as highlighted in [4], is an important aspect of communication. Hermes@Home provides this type of messaging method adapted to the home while a webcam aims to promote awareness, by offering a window into the home.

Related Work

The Hermes@Home system is directed towards real home environments. Most research relating to the home domain, which is conducted outside purpose built 'smart-homes', includes user studies and workshops (e.g. [5] ,[6]) where mock-ups, and non- or semi-functional prototypes are used, as these are quick and cheap to produce, allowing for a different focus in research.

There are, however, also exceptions. ScanBoard, one of the Casablanca semi-functional prototypes [6], allowed a group of people to share a common message board through individual displays on which they could draw. The ASTRA prototype [7], deployed in 2 pairs of households, allowed sharing of pictures and handwritten notes between the deployed units. The messageProbe and videoProbe prototypes from the interLiving project [2] enabled sharing of scribbled messages and pictures taken by a webcam, on units deployed in two households. All of these systems required deployed units for each communicating party, rendering this type of solution somewhat unsuitable for a person going away.

TxtBoard [8] (newest version called HomeNote), a prototype person-to-place communications device via SMS, presented as a small, fixed display appliance for home environments. This system receives and displays text messages and allows local messages to be scribbled, but does not offer sending messages to a remote user from the home.

On_message@home is a similar project being undertaken by Mark Perry and Dorothy Rachovides in Brunel University, which investigates the communication within the home, with the aim of supporting the design of a home-based messaging system, but do not yet have a working prototype (see [9] for more information).

Finally, it should be noted that there has previously been some research in issues related to communication, such as awareness and intimacy. In [10] the writers are discussing awareness issues with elderly family members living separately from the rest of their family, while [11] discusses interesting ideas and designs for interactive systems supporting intimacy

System Description

Hermes@Home is a system which allows people to send messages to their home (these we call the 'away' users). People at home (the 'home' users) can also send messages to people away, through a custom-built unit, which is deployed in the home and also handles displaying received messages. A sketch of the system architecture is displayed in Figure 1 below.

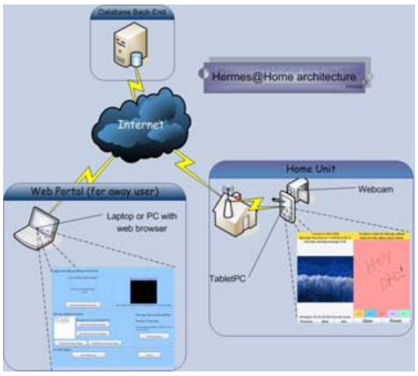

Figure 1: Hermes@Home system architecture overview

The 'home' unit is currently a modified TabletPC running Windows XP. The software is written in Java, and uses the Java Media Framework for webcam access allowing for cross-platform deployment. The touch screen on the TabletPC provides for more intuitive interaction than the traditional mouse and keyboard input methods, especially for members of the household that might not be experienced or comfortable with computers. This is important as such users can be commonly expected to use the system in the home environment. The unit is also equipped with WiFi, meaning it is also portable within the home, at least for as long as battery life permits it.

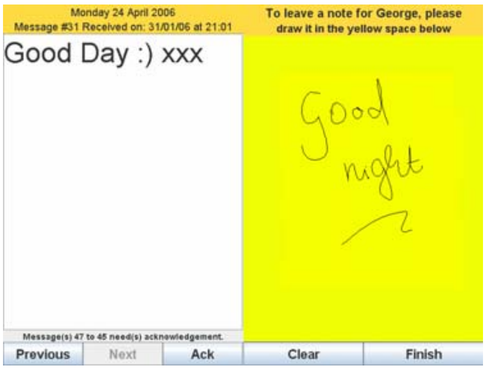

Figure 2: The Hermes@Home Graphical User Interface for the home unit.

The 'home' interface (see Figure 2) takes up the whole display area and allows users to navigate through received messages on its left half and acknowledge the ones they have read. To send a message they can simply scribble it on the yellow pad on the right and send it with a single click, adhering to the requirement for a simple design. This expressivity and character of 'handwritten' notes, created through an 'always-accessible' system, are areas where Hermes@Home complements other commonly used communication technologies, such as e-mail and SMS.

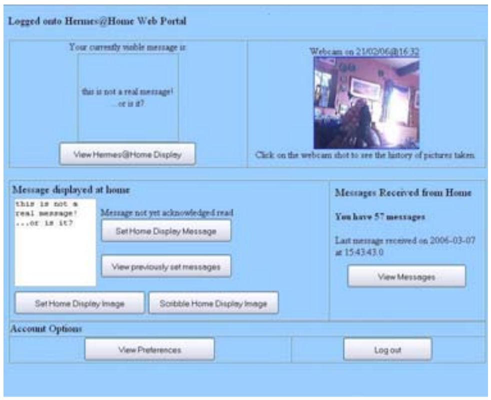

Figure 3: The Hermes@Home interface for the away user

The 'home' unit can also be equipped with a webcam, which can be set to take regular pictures of a set location. This webcam is, of course, optional as privacy issues can easily arise. It can, however, provide the away user with a pleasant, up-to-date reminder of home, which promotes awareness, that can couple as a monitoring device, e.g. for periods the house is empty.

The 'away' user interface (see Figure 3) for sending and viewing received messages is accessible online removing the need for a second unit. The interface is available wherever there is Internet access, whether this is an Internet café, WiFi access in a conference, or potentially WAP on a Smartphone, etc. This interface is currently under redesign, in order to improve usability. Throughout, we are adopting a HCD approach, by informing this redesign by feedback from past users, which have identified a number of flaws in the design.

Human-Centered Design in the Hermes@Home System

The Hermes@Home system is a communication tool, for use in real homes, enabling the study of communication patterns. The services offered by the system, however, are expected to suit certain households more than others, as different households can have different established methods of communication. To ensure the validity of this study, system use must be unaffected by factors, such as reliability and usability.

In their home environment people are used to commercial products for which they have high levels of expectations in terms of reliability and performance. By employing Human-Centered Design (HCD) practices, however, people have an active role in the design of the system. Furthermore, HCD practices can promote awareness towards the system, and a feeling of ownership, which is important if the system is to achieve a status of everyday use. For our system we must, however, also look beyond individual design and usability issues and focus on the person as a human, including physical, cognitive, social and cultural factors, as these are directly related to how that person communicates and could affect system use.

Current State

Figure 4: Previous deployments

We are currently in the process of deploying the system in a number of households. The system has been made available to academics going away for conferences (especially abroad). The initial deployments of the system had a rather explorative character. Additionally, as the system was initially quickly put together, more crucial aspects of the system, such as its reliability, had to be addressed, before further modifications and customisations could be made to the system. Such modifications can be discussed in pre-deployment interviews, with the person and their family, where we will try to identify already established methods and patterns of communication. We have, however, found making such modifications difficult in practice, as time does not always afford exhaustively testing these prior to deployment. This interview is, however, an excellent stage for discussing new design ideas and extensions to the system functionality and was gradually incorporated into the evaluation process.

Deployment	Messages sent by Away user	Messages sent from Home	Deployment Dates
1	30	126	25/11/2005-22/12/2005
2	20+	27	26/11/2005-08/12/2005
3	44	82	23/01/2006-21/02/2006

Table 1: Summarized use of Hermes@Home system for the three deployments so far

A post-deployment interview provides feedback on various aspects of the system, ranging from screen brightness, to noise levels, usability and reliability issues, to a higher level analysis of system use and communication patterns. For this analysis we also make extensive use of logging and semi-automated tools for visualising selected information in these logs (see Figure 5 for an example of such graphs). Such graphs can also be used in interviews where it can help users reflect on their own use.

Early results

Hermes@Home has already been deployed 3 times, for periods of a month, two weeks and a month, respectively. In all three deployments there was one person away and one or more in the home. Additionally, in the third deployment, the system remained deployed for nearly two weeks after the person returned, but received little use (Figure 5).

From these deployments we have also realized that, the deployment itself must be a quick and painless process, as it takes place at the users' home and takes up their time. In addition, the noise generated by the system can be quite annoying in the home environment In the very first deployment a lot of effort was spent silencing the system, and the noise was barely noticeable in our office. During deployment it was clear, however, that the system was still too loud. Further silencing it on site resulted in the system regularly overheating and shutting down. However, even with the reliability problems we faced, there was at least one message sent, on average, each way every day, in each deployment. In the latest deployment we held a separate hour long post-deployment interview with each parent of the family where the system was deployed. All users have so far commented positively on the system in general, and provided us with plenty of new ideas for improvements for future deployments.

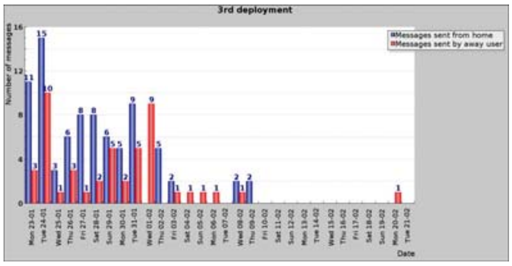

Figure 5: Example of graph displaying sent messages from home (blue) and away (red)

Conclusion

We have presented the Hermes@Home system, which, through its use as a technology probe, will be used as a tool in the study of every day communication. Evaluation and analysis of the system use is done through logging, as physically monitoring system use is rather impractical in the home domain, and, so far, through post-deployment interviews with users. We aim to reach a significant number of deployments, in addition to the three so far, in order to obtain a core of data from which we will be able to explore cross-deployment patterns of use, changes in daily routines provoked or supported by the system, and types of communication between family members and with hopeful insights into the routine of this everyday communication. The system supplements existing support for communication by providing a more expressive and 'always-accessible' messaging method, and through analytic evaluation of its use we aim to explore issues such as awareness, co-ordination and intimacy.

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CCTV Control Room Collaboration and Communication: Does it Work?

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Abstract

Despite the increased usage of surveillance systems and the technological advances, there is currently no conceptual basis and little evidence to assess how well CCTV actually works for the purposes for which it is deployed. It is important to identify whether CCTV systems and applications meet stakeholder goals, and support human operators effectively, in attaining the goals for which the system is set up. This exploratory paper highlights the early findings found in CCTV control rooms. A series of ethnographic observations along with semi-structured interviews were carried out at six CCTV public surveillance control rooms – six managers, six supervisors and 25 operators were interviewed. Findings reveal that current control room systems are not designed to support operator and system communication and collaboration when performing their tasks. Poor linked technology and a lack of task coordination was evident between operators and external agencies such as police operators and local businesses. Several Human Computer Interaction (HCI) issues were uncovered from the fieldwork. Findings will be used to form a set of best-practice CCTV control room design recommendations.

1 Background

1.1 Research Problem

A number of studies have investigated how dynamic systems and processes are managed by operators in control room environments such as air traffic control and nuclear power plant control centres. Despite this, there appears to be very little HCI research in security and surveillance control rooms. In the last decade, we have seen several changes take place in security - with a rise in crime rates, and the type and severity of crime events have also changed. Consequently the public's perception and fear towards crime have also changed. More funding is available for CCTV and more advanced CCTV technology is also available. These changes have led the research discussed in this paper to form a number of important questions: How are CCTV control room managers managing new digital technologies? Do operators understand how to use digital technology and multiple systems/tools? The overall question this research attempts to tackle through exploratory cognitive ethnography is: Are public surveillance control rooms operating effectively and efficiently. This research focuses on the difficulties operator face with control and co-ordination of surveillance tasks. The relationship and performance of communication and collaboration between operators and external agencies, information management and task performance effectiveness and efficiency were explored using cognitive ethnography techniques (see Hollan, Hutchins and Kirsh., 1999).

1.2 Previous Control Room Research

Luff and Heath (1999) examined how control room operators used CCTV and other technologies within an underground transport control room environment. Luff found that the control room technology was difficult to manage because there were *"so many separate interconnected* *systems…and the use of these systems are thoroughly embedded within the many disparate activities of the personnel."* From this study, various user-system interactions were considered, however very little focus was placed on the HCI barriers to task operations. Gill et al (2005) attempted to assess the impact of public CCTV surveillance as a whole on crime and touched on the technology issues in control rooms. Gill reported that many control rooms had street cameras positioned in poor locations, video recording rates were too low and communication flow between operators and other CCTV stakeholders was very low. The research focussed on whether CCTV as a whole effectively reduced crime and not the effectiveness of control room operator interactions where technology is heavily used.

The focus of the research presented in this paper looks at the effectiveness of CCTV technology within several city centre control rooms. Ethnography was selected as a research method for assessing the effectiveness and efficiency of control room task operations for two main reasons: (1) Many Computer Supported Cooperative Work (CSCW) systems often fail because the design process excludes the social work context, HCI and human factors issues; (2) *"Many of the existing methods fail to sufficiently recognise the social setting of the social nature of work,"* (Hughes et al., 1993) – i.e. task analysis and interviewing. The nature of the observations adopted was something Hughes termed as *"quick and dirty ethnography."* This method was considered appropriate as the current research contributions of this research (the best-practice design recommendations) aims to inform control room managers broader issues related to the acceptability and usability of CCTV control room design. The HCI aspect of this work was studied from a theoretical perspective of distribution cognition (see Hollan et al., 1999). This perspective works on the basis which *"seeks to understand the organisation of cognitive systems."* Cognitive systems can be distributed across members of a social group (CCTV stakeholders: i.e. operators, police, management, public etc.) and involve the co-ordination between internal and external (material or environmental) structures.

2 Communication and Collaborative Tasks: Field Observations at Six Control Rooms

The aim of the fieldwork was to obtain a better understanding of the human-to-human and human-to-system communication, coordination, and control mechanisms in CCTV control rooms when information flow is high. The control rooms visited were set up to support several stakeholders such as the local police staff and the community i.e. clubs, pubs, shops and the general public. The coordination of reactive and proactive surveillance tasks such as patrolling CCTV screens, responding to police radio calls, and sharing imagery with police when needed were achieved in all of the control rooms visited using the same type of equipment. Equipment included: CCTV wall monitors; camera controllers; a Personal computer (PC); 'spot' monitors (these are 2-5 video monitors located directly in front of operators which can be used to grab a CCTV video output selected from the wall monitors); radio; and telephones. Despite the similarities, it was found that the workstation layout, equipment set-up, communication flow between operators and external agencies and the design of the tasks differed between control rooms. A series of overt observations and semi-structured interviews with a total of 25 CCTV operators, six managers and six security supervisors were made by one field observer. Five of the control rooms were based in London and one outside London. Observations took place per control room on average over a period of five hours. Visits were made to control rooms during morning, afternoon, and evening shifts. This was so that the operator's tasks and activities could be analysed under different situations. For example, different cameras were used under different lighting conditions and different criminal and suspicious activities were observed at different times. An observation checklist of ideas and areas of interest to the observer was followed (tasks, equipment, communication, workspaces etc.) which was used as structured protocol for the observation exercise. Operators and supervisors throughout the observation period were informally asked questions about 'what was going and why they did tasks in that way.' Responses were recorded and supported the observation notes.

2.1 Technology and Setup: Mapping Geographical Information

A recurring problem found in a majority of the control rooms was the way in which operators' located CCTV screen(s) when attempting to follow a vehicle or person. Operators used paper-based geographical street maps with lists indicating the street names and camera numbers. Many of the operators said for this type of task, *"having good local area knowledge was important."* Despite this, a minority of the operators lived in the areas they observed on-screen. Operators regularly shouted to colleagues across the room if they were stuck and could not recall the camera number or its location. Operators shouted louder and in a panic-like tone particularly when communicating with police operators via telephone or radio to follow targets of interest on-screen. The use of physical paper maps is a risky, ineffective, and inefficient method for searching and tracking targets. Paper maps can go astray and losing a map would lead to guess work, which adds unnecessary time to the task. Several managers reported that considerable funding was granted by senior councillors and the Home Office for adding additional CCTV cameras to their systems. Many of the operators complained that there were *"too many cameras to cope with"* and found these additional cameras were often not updated onto the paper maps and camera lists.

A method to improve the efficiency and effectiveness of searching and selecting cameras would be to link the camera monitor views with a graphical user interface (GUI) linked to a geographical map of the surveillance areas linked to a comprehensive database of camera names and street locations. Such a method would avoid operators mishearing numbers and locations when shouting information across the control room; it would also avoid the risk of confusion. A simple coordinated tool can be used to allow operators to communicate with a common understanding of the situation.

2.2 Reactive Surveillance: Information Overload and Poor Radio Language

Often, control rooms are thought of as small, dark underground rooms filled with surveillance cameras wall to wall, with a handful of operators idly waiting for something to happen on video monitors. This is untrue. In fact, tasks are not so much video driven and are more audio driven. Operators perform two key surveillance tasks - proactive surveillance (watching and waiting for something to happen) and reactive surveillance (responding to alerts from outside control room to react to a crime or suspicious event). From the two, the most frequent surveillance task operators perform was the reactive surveillance task. The most heavily used communication tool used for this task was the police and business radio. Close observations of operator actions and operator remarks showed that there were clear signs of cognitive overload with radios and telephones. Several operators commented that *"the control room radio has too many different channels assigned and sometimes it can be too confusing what's going on, especially when the phone is going off as well."* Operators also complained that business radio users such as city centre shop managers gave too much unnecessary information and that they did not give clear descriptions of targets. Excessive radio groups and poor information flow between users are two of the most common causes of cognitive overload: (1) too much information supply and (2) too much information demand (Kirsh, 2001). A simple solution to minimise audio information overload would be to distribute radio channels across the numbers operators and the level of activity over the day proportionally. Distinguishable audio tones is useful method for funnelling initial incoming contact that is made with the control room, so that operators can prioritise and respond to radio calls accordingly. Feedback and training should also be provided to all radio users, so that the method of communication and language type used such as phonetics and identity codes are commonly used by all users. Training should also inform users to keep radio talk "*short and accurate,*" a recommendation also put forward by Juhlin and Weilenmann (2001) for an aviation control room.

3 Conclusions

The field work described here highlights how computerised technology in city centre CCTV public surveillance control rooms are set-up and designed without considering what tasks are performed by operators. *"Any design of computer systems for control room, which does not support intrateam communication and coordination, is very likely to fail in the long run,"* (Garbis, 2000). Ineffective workplace designs currently in modern control rooms where information communication technology (ICT) is heavily used, can affect both internal and external communication – affecting the control and coordination of tasks. A combination of system re-design where existing systems can be linked together and training across stakeholders concerning the system can improve task effectiveness, efficiency, and overall work performance. Further control room visits are in progress. Findings will be used to form a set of best-practice recommendations for CCTV control room management.

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Large Displays for Document-Centric Meetings

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Abstract

We analyse the problems of supporting meetings in which remote participants discuss text documents. We present a proposal and initial work towards a large tabletop display that addresses these problems.

Introduction

The benefits of large displays are self-evident. For co-located collaboration, large tabletop displays allow participants to work together while adhering to social protocols of personal space and without formal turn-taking. For remote collaboration, large displays provide a shared view of the task in which participants can see each other's gestures and actions. In both cases, each participant is aware of the actions of others through their peripheral vision.

It is therefore not surprising that the literature abounds with large tabletop display projects for a diverse range of applications ranging from planning room layouts to sorting photos. However, for many workers, an important daily task involves reading, annotating and discussing draft documents [1], in what we refer to as document-centric meetings. Example scenarios include meetings to discuss draft reports, design briefs, or students' homework assignments. Very few large display projects have addressed these application areas. Furthermore, the widely-adopted meeting-support technologies, such as video-conferencing and electronic whiteboards, are designed to support brainstorming and decision-making, rather than these document-centric meetings.

This shortcoming in current research is not an oversight but, as we shall explain, is due to the difficulties of creating a large display suitable for the task. In this position paper we present our designs and initial work towards a large tabletop display to support both co-located and remote collaboration around documents containing text.

Collaborating over Paper and Electronic Documents

Our work is motivated by the problems of collaborating over electronic and paper documents. Two studies [5, 6] compare reading from paper and from a conventional computer screen. Subjects who read from paper used bimanual actions to navigate and organise documents effectively, while subjects who read from the screen had difficulty determining their location in the document, found the scrolling and annotating processes disruptive to reading, and could not use both hands to interact with the document. Furthermore, many tasks require reading from multiple source documents. The authors observe that paper documents on a table support this by permitting, for example, frequent shifts of attention and side-by-side comparison of documents, while electronic documents on a screen do not. Electronic documents offer a few benefits: they support up-to-date interactive content; they allow more complex interaction such as hypertext, alternative visualizations, and keyword searching; and they are easy to store, access and distribute securely and quickly.

Paper documents are therefore the superior medium for document-centric meetings in which the participants are co-located. They provide a shared visual workspace that all participants can see and in which participants can easily navigate documents and make gestures and annotations. However, geographically-separated participants cannot use paper in this way, and they can achieve a shared workspace with electronic documents only by using a conventional computer screen with an application-sharing system such as Microsoft NetMeeting. These systems suffer the problems of electronic documents described in the studies above.

Virtual Paper on a Large Tabletop Display

We aim to use a large tabletop display to create a system that allows users to interact with electronic documents in a way that overcomes the shortcomings identified in the studies above. Our system will support document-centric meetings involving co-located and remote participants by providing a shared workspace in which participants can interact effectively with electronic documents. The design we describe here is motivated by findings from our preliminary work and the studies described above.

Electronic documents will be projected on the display as life-sized sheets of virtual paper. Documents will show two pages at once, rather like an open book (Figures 1, 2 and 3). As with real paper documents, participants will use bimanual hand gestures to flick through pages one at a time, to move documents around the table surface for side-by-side comparison, and to add bookmarks. Each participant will have their own stylus with which they can add free-form digital annotations to the documents.

Remote or mixed-presence collaboration will be possible between two geographically-separated groups. Each group will collaborate around its own display, and the two displays will be linked so that both show the same shared view of the task. Thus each participant will be able to navigate the documents and create annotations for the other participants to see. Telepointer traces or some other form of embodiment will follow each participant’s hand and pen positions (Figure 4) allowing participants to gesture remotely to each other and to parts of the text. An audio channel connecting the two sites will allow the participants to hear each other.

As preliminary work, we have implemented a system based on the Escritoire project [2] to support virtual paper documents and hand input for remote but not co-located collaboration (Figures 1 to 4). Our early observations indicate that participants are comfortable using hands and a stylus to gesture to remote participants via telepointer traces, and that hand gestures are likely to be an effective way to navigate long documents if the gesture recognition system is reliable. We are currently implementing the full system proposed here.

We shall evaluate the display in two ways. Firstly, the usability of the document navigation and annotation system will be evaluated using an individual benchmarked reading task, such as a comprehension. We will compare our display to both paper documents and a PDF file reader on a conventional computer screen, examining effectiveness, efficiency and user satisfaction.

Secondly, a more qualitative evaluation will examine the collaborative aspects of the system. The task will be a small tutorial session in which a tutor discusses annotated homework assignments, lecture notes and exam questions with a small number of students, some of whom are remote. Such a task would normally involve a co-located group and many paper documents.

We believe the key issues for remote collaboration will be in resolving the disparity in information orientation and display form-factor between the two sites and in choosing an embodiment to convey presence.

Related Work

The Escritoire [2] presents virtual sheets of paper on a tabletop display for remote collaboration, though it provides no way to navigate long documents or to discuss several documents simultaneously, and provides no support for co-located collaboration. Many other projects augment paper documents on a desk with projected graphics to support interactive content [4,8] or for remote collaboration [7,9].

However, none of these projects have the capability to present pages of dense text and annotations on a large display as we propose. Many use only a single commodity projector over an entire tabletop and thus the display resolution is too poor. Other projects use multiple overlapping projectors in a tiled array. In this case, image warping techniques are normally applied to the individual projector outputs to create a single contiguous display [3], but unfortunately these techniques severely disrupt high-contrast features such as dense text and thus are not suitable for our display. The Escritoire suffered from this problem.

Hereld and Stevens [3] describe a technique to perform warping for multi-projector displays without disrupting dense high-resolution text. We have improved and evaluated their work, and found that users prefer this new warping technique over traditional techniques. We aim to incorporate this work and use multiple overlapping projectors to create the proposed large display capable of displaying dense text at high resolution.

Acknowledgements

We gratefully acknowledge the support of Thales Research and Technology, who are funding this work.

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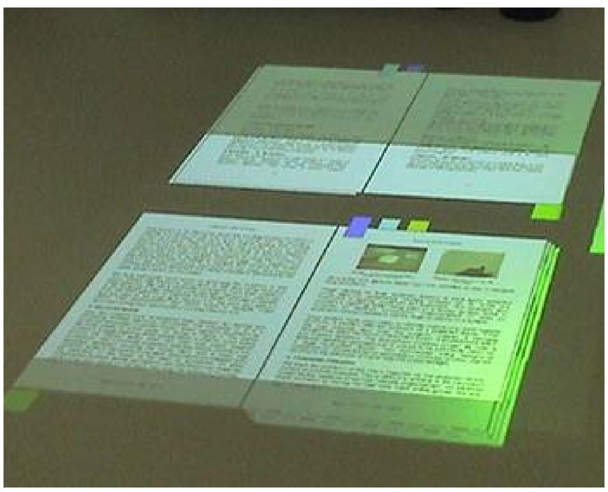

Figure 1. Virtual paper documents on a large display.

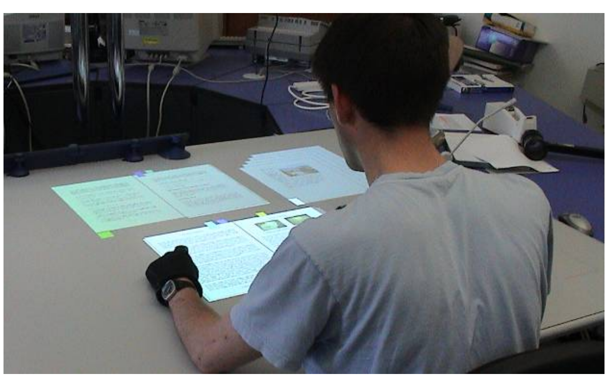

Figure 2. A user interacts with virtual paper documents on the large display.

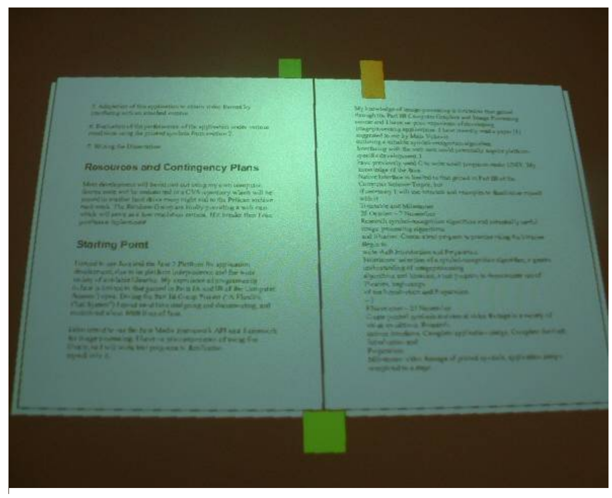

Figure 3. Virtual paper, showing two pages and bookmarks.

Figure 4. A telepointer trace follows hand gestures.

Participatory Design, Artistic Tools and Severely Disabled Participants

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Abstract

There are a number of challenges when designing accessible, computer based, artistic tools for profoundly disabled users. In this paper I discuss some of these issues, and how I believe Participatory Design can be adapted to meet these, through the case study of some video tools that I have been building for a participant with cerebral palsy.

Introduction

For my PhD, I am designing and building tools that will enable profoundly disabled users to engage in ludic, or artistic, practices. Such tools differ from those built for functional spaces being transformative technologies, creating new possibilities for interacting with the world, rather than solving existing problems. Paradoxically – the requirements are only known, once these technologies have been adopted by the intended users.

Unlike technologies which address a functional space (such as assistive technology), the only criteria of success for these tools is whether they are used by the end user. Given that there is a long history of inappropriate technologies being built for disabled users [2], it is particularly important that the disabled user is as involved as possible in the design process of these artistic tools. Consequently I have adopted a Participatory Design (PD) approach to designing these tools.

Participatory Design's (PD) origins lie in Scandinavian attempts to democratize the workplace. Researchers developed methodologies that allowed workers to actively engage in designing workplace computer systems [4]. Since then, PD approaches have been applied outside the workplace to involve end users as co-designers, rather than informants.

Given that profoundly disabled users will have a suite of impairments that may include sensory and cognitive impairments, as well as physical impairments that limit their independence, profoundly disabled users are likely to have both communication difficulties and a very different (as well as more limited) set of experiences to able-bodied people, further complicate communication between the designer and participants. Consequently, many of the methodologies of PD which assume that fluid communication between the designer and participants is possible will be inappropriate.

In this paper I discuss how we can adhere to a PD philosophy, while adapting some of its methodologies to work with the practical constraints posed by severely disabled users. In the first section I attempt to define the fundamental aspects of PD, before discussing how I have used PD for some of my PhD work.

Categorising Participatory Design

Greenbaum defined three perspectives on why PD approaches are required to design effective computer systems for the workplace: pragmatic, philosophic and political [4]. While the issues are different when working with severely disabled participants, the same perspectives are a useful framework in which to consider the issues when doing PD for severely disabled users.

Politically we need to consider on whose behalf we are designing new systems. Given the challenges of communication, it would be easier to rely upon the expertise of disability professionals (e.g. doctors, social workers, psychologists). However, these informants will have their own prejudices about the participant's capabilities/needs formed by their professional training, and this may conflict with the views of the participant. The expert may assume (and this is particularly likely if the participant has a learning disability) that certain things are beyond, or inappropriate for, the participant. Given how profoundly technology could transform the lives of disabled people, we should be trying to give them as much control over this process by involving them as much as possible in the design.

Pragmatically, the gulf between the designer and the disabled user will be greater than that there would be with an able-bodied user. While research methods such as ethnography can yield insights into the disabled experience (e.g. [1,3]) – the experts will be the disabled users. Many inappropriate systems have been designed for disabled people, because disabled people were not consulted in the design process [2]. If we want to design effective systems, representatives from our disabled user base should be involved in as much of the design process as possible. This is particularly true when designing ludic, or artistic, tools – as the only criteria for success is whether the tools are seen as relevant by the disabled user.

Philosophically, there is a significant experience gap between designers and disabled people, and this will cause significant communication problems. This is not a problem unique to disability – one of PD's insights is that there are gaps between designers and any user – and a wide variety of methodologies which have arisen to address this issue. However, the "disability gap" is far larger. Many disabled users will have spent their life dependent upon carers, or institutionalized, so their default mode of social interaction will be very different from the norm, so it would be inappropriate to assume that interfaces designed for able-bodied users will be appropriate. There will be less analogous experiences that we can draw upon to discuss the possibilities for technology. For example, if discussing computer based paint technology with a non-disabled participant, they could draw upon existing experiences of painting, whatever their technological experience. However severely disabled users will have few of these types of experience.

Many disabled participants will have cognitive, or physical, impairments such that they find communication challenging, or impossible. Methodologies that assume fluid verbal communication will be inappropriate. We could draw upon the expertise of those who work/know the participants as either informants, or translators, but this would reduce the involvement of the participants in the design process. Instead, if we provide the participant with hands on experience of technology (such as simple prototypes), then they can rework that technology according to their own experiences, needs, etc. So long as the designers can create tools that are sufficiently usable and engaging for the participant, then the designer can evaluate how the user uses and redefines the technology – while the user can learn about what the technology can do. Even if direct communication is difficult, technology can act as a boundary object.

These tools will act as speculative prototypes, allowing the participant to explore what they might want to do in the problem space identified. They will be simple devices, with multiple scenarios of use (allowing the participant to use them in a variety of situations). These prototypes will be based upon best "guesses" about the participant's interests and capabilities. These prototypes are differentiated from iterative prototypes, in that they are not intended to be a cut down version of the final solution, but instead to open up a new space for the participant so that they can begin to explore the requirement space.

The Participatory Design of Video Tools

For the past ten months, I have been working with a participant with severe cerebral palsy. He is unable to physically speak (although he can indicate 'yes' and 'no' to posed questions), and has limited control of his body. A control rig has been built that allows him to shoot video, but once this video has been shot he is unable to do anything with it. To address this, I have been exploring ways in which he might make use of the footage that he has shot, by building simple tools that allow him to explore the possibilities.

These tools must be sufficiently sophisticated such that he can use them to do something meaningful with video. However, they must also be simple, as if he failed to use a complicated tool, then we would not know whether this was because it was unusable, or inappropriate. Each tool must have a single function, as if he rejected a probe with multiple functionalities, then we could not be certain which function was being rejected. However, these tools also need to be sufficiently flexible, so that it could be put to multiple purposes. So for example, a video editor should not force a particular style of editing upon him, but would instead allow him to find his own style.

My original assumption was that he would want to create his own movies, as he had responded positively to movies that others had created from his footage. To test this, I built two simple exploratory prototypes: a video trimmer (fig. 1) allowing him to remove extraneous footage from video clips and a video assembler (fig. 2) that allowed him to assemble a movie from a collection of video clips. Both tools could be controlled using three push buttons. For the first trial, control was simulated through a wizard of oz protocol, so that if there were problems with the control mechanisms we could modify them on the fly. However this caused problems, as he was unable to grasp the relationship between his movements and the control of the program in front of him. We also had problems explaining what the tools were for. It was only when the video trimmer was modified during the evaluation, so that it was simpler, that he was able to grasp its purpose through use, however the Video Assembler remained too complex. Although we had known that communication would be a problem, this evaluation revealed that communication with James was more complex than I had initially assumed. Not only does communication need to be clear and unambiguous between designer and participant, but in addition any situation that requires him to *demonstrate understanding*, will fail.

There is no way of the designers to test whether the participant has understood an explanation. This means that if there are problems using a prototype, we will not know if the problem is understanding, or the functionality/purpose of the tool.

Through the evaluation, we learnt that he was interested in reviewing and selecting video from previously shot footage. We also learnt, to our surprise, that he was as interested in creating still images from the footage, as he was in defining shorter video clips. This suggests that not only can we use simple prototypes to test our assumptions, but also to gather requirements about our participant's requirements.

Current Work

The work described in the previous section suggests that for these speculative prototypes to be successful as, they needed to be simple and give immediate feedback. This would allow the purpose of the tool to be learnt by the participant through use. It is likely that one reason for the failure of the Video Assembly Probe was that its only feedback was through changes to an abstract representation of an assembled movie (the storyboard). This change in representation is essentially meaningless to anyone who has not already learned what this metaphor represents. I plan to address this problem at a later date.

Building upon this work, I have built a tool that allows my participant to mix video loops in real time. It has three controls: left, right and select - the latter control causes a new clip to be projected on a separate screen. The tool is both simple, with appropriate and immediate feedback. If early trials are successful we plan to use it in a variety of different contexts ranging from personal (as the basis of conversation with friends), to club nights. This tool will both help us to understand what our participant's requirements are, while educating him about the possibilities of video.

Conclusion

In this paper I have discussed how I have adopted a PD approach to designing artistic tools for profoundly disabled users. Given the profound challenges of communicating with profoundly disabled users, I have used speculative prototyping to allow my participant to explore the possibilities of this space. My original speculative prototypes identified several requirements for these tools, but were not sufficiently simple. To address this, I have built a live video mixer, which will allow our participant to control which video clips are projected.

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