HCT – 2002

Tools for Thought: Communicating and Learning Through Digital Technology

PROCEEDINGS

6th Human Centred Technology Postgraduate Workshop

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FOREWORD

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

Many people have been involved in the preparation for this sixth workshop. I particularly thank Pablo Romero for chairing the workshop organizing committee, and the members of that committee: Claudia Gama, Beate Grawemeyer, Louise Hammerton, Michelle Hoyle, Anna Lloyd, Erika Martinez-Miron, Genaro Rebolledo Mendez, Jonathan Matthews, and Benjamin Zayas. I would also like to thank the British Computer Society Human Computer Interaction Group for their sponsorship and Ann Light for helping to arrange this.

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

All the above are members of the Human-Centred Computing Technology group in the School of Cognitive and Computing Sciences (COGS) at Sussex. This group comprises faculty, research fellows and graduate students from COGS and other schools, interested in research on the design, implementation, and use of human-centred technologies. The group is organized into two labs: the Interact lab www.cogs.susx.ac.uk/interact/, and the IDEAs lab www.cogs.susx.ac.uk/ideas/.

The main objectives of the Human Centred Computing Technology Group are: (i) to develop frameworks for understanding how people interact with and communicate through technology; (ii) to apply this understanding to develop and support innovation. This energetic and highly-regarded group currently hosts a wide portfolio of grants, including the multi-million pound EPSRC Interdisciplinary Research Collaboration (IRC) Equator.

Benedict du Boulay
IDEAs Lab, COGS
September 2002

PEOPLE

Day one

How is interactivity affected by the characteristics of the user and by the characteristics of the system?

What do the user and the system need to know about each other?

Invited speaker

> **More Is More vs Less Is More: The Conflict Between Marketing And Development**
> Miss Alix Gryce
> digitalbrain PLC

Invited speaker and guest discussant

> **The Process of Doing A PhD**
> Professor Eileen Scanlon
> Institute of Educational Technology
> The Open University

Day two

What do we mean by digital technology and how is it changing?

Invited speaker and guest discussant

> **Why Are Mobile Phones Annoying?**
> Professor Andrew Monk
> Department of Psychology
> University of York

CONTENTS

How is interactivity affected by the characteristics of the user and by the characteristics of the system? What do the user and the system need to know about each other?

What do we mean by digital technology and how is it changing?

Day one – Sessions 1 and 2

How is interactivity affected by the characteristics of the user and by the characteristics of the system?

What do the user and the system need to know about each other?

Dynamic Adaptive Ontological Modelling to Support Children's Conceptual Understanding

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INTRODUCTION

Advanced computer technologies, such as multimedia tutoring systems, can provide stimulating interactive environments for children to learn new concepts. Studies show that while in classroom settings human teachers effectively support children's conceptual understanding, computer tutors may fail to communicate successfully the meaning of words (Aist, 2001) and miscommunications may occur due to lack of appropriate teaching tactics or incapability to address the specific needs of each individual. Even when the learning material is well structured, students may face difficulties to understand the meaning and relate the new lesson to their existing knowledge. Human teachers are able to communicate the meaning effectively by appropriately relating new concepts to the prior knowledge of each student. One possible methodology for designing effective intelligent tutors is to derive teaching strategies from theories of learning (du Boulay & Luckin, 2001). In the case of learning new concepts, theoretical models that explain the importance and the use of children's prior knowledge are fruitful.

This paper explores a novel way of designing intelligent tutoring systems (ITS) that help children understand and learn new concepts while communicating with the computer. The help is aimed to support the dynamic nature of the cognitive status of the children and is based on the schema theory (Baddeley, 1988). The main idea is that children understand a concept because they already have prior knowledge or *existing schema* related to it, and they do not understand it because they do not have or are lacking of prior knowledge (Marshall, 1995). The role of ITS is to support this mental process in order to enhance children's conceptual understanding. We propose here a system architecture to deal with the cognitive meaning-making process by taking into account the children's prior knowledge. The architecture is intended to act as a platform for the development of effective dynamic adaptive intelligent tutors that support conceptual understanding.

THEORETICAL FOUNDATIONS

The importance of prior knowledge in the meaning-making process is widely recognised and is mainly discussed in terms of schema theory (Bartlett, 1932).

Schema theory attempts to explain how meaning-making occurs and how knowledge is stored and organised in the brain (Schmidt, 1975). According to Henk (1993), a schema represents knowledge structures in the learner's mind, and these structures allow the learner to connect new information to what he/she already knows. Schemas are created through our daily experience with people, objects, and also events (Mandler, 1984). The mental structures represent generic concepts stored in the brain. Using the schemas, we will have a generic set expectations about what we will encounter in a new experience. This enables us to focus on specific details of the new experience in order to understand it.

Three processes have been proposed to account for schema modification: *accretion*, *tuning*, and *restructuring* (Rumelhart & Norman, 1978). Accretion is performed if there is an existing schema related to the current concept, and this schema will be used to interpret the current concept. Tuning is performed if there is an existing schema but it must be slightly changed in order to enable the understanding of the current

concept. Restructuring occurs if there is an existing schema but it cannot accommodate the current concept, and, hence, a new schema needs to be created to support the understanding of the concept.

The schema modification or creation processes that happen in our brain are externalised through communication. Following Shannon's theory of communication (Shannon, 1948), Gamble and Gamble (1998) have explored a human-human communication model where people communicating with each other play both roles as a sender or reciever of messages. The composition of these messages is based on the communicators' field of experience and is related to their prior knowledge. It can be argued that interactive computer tutors have to provide a means for addressing the student's existing knowledge properly in order to support his/her conceptual understanding.

APPLYING SCHEMA THEORY TO THE DESIGN OF ITS

The proposed architecture here is an extension to traditional multimedia systems. New functionality in terms of intelligent agent is added to enable a multimedia system to communicate with a child and explain concepts based on schema theory. Figure 1 presents the proposed architecture. A cognitive model of the learner is used by the intelligent agent to communicate dynamically and adaptively with the learner. The model is continuously updated by the agent.

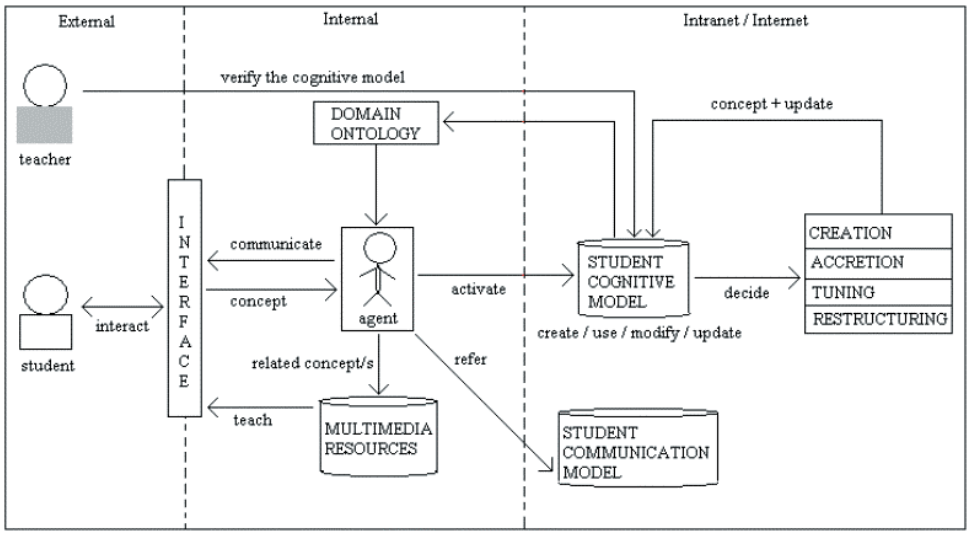

Fig. 1. Architecture of the proposed system

The cognitive model contains concepts learned by the child in his/her previous interactions with the system. They are acquired from a variety of lessons learned continuously and interactively by the child. Every time a student interacts with the multimedia material through the interface, it will trigger the intelligent agent to receive its tagged information as an input from the multimedia resources. The intelligent agent that functions as an activator of existing schemas searches the cognitive model for relevant schemas. If the agent finds a related schema (or schemas), it will decide whether to use it without any modification, with a slight modification, or with a major modification. If no related schema is found, the agent will automatically create a new schema in the student's cognitive model, which will be used in following interactions. The agent will update the student's cognitive model appropriately.

The domain ontology will be used in the communication with the learner. Using both the domain ontology and the student communication model, the agent will then

communicate with the learner by showing him/her textually and graphically how the current concept is related to the other concepts he/she has learned before.

The main role of a human teacher in this computer-supported environment is to verify the validity of the student's cognitive model created automatically by the system and to make alterations if needed. As a facilitator, the teacher will show appropriate learning directions to the student and in face to face lessons may foster the student to reason based on the newly acquired concepts.

CONCLUSIONS

In this paper, we have proposed an approach to designing multimedia educational tutors based on schema theory. The computational support includes an intelligent agent that will activate the relevant schema in the student's cognitive model and a communication component to enable a dynamic and adaptive communication with the student.

The work presented here is intended to contribute to the research on interactive intelligent tutoring systems by providing a computational framework to handle dynamic and adaptive communications between human students and intelligent multimedia educational systems. Such interactions are expected to provide an effective way for supporting children's conceptual understanding.

This work is still at its initial stage. To demonstrate the feasibility of our theory-informed design, we will implement multimedia educational software with components that enable schema activation and communication based on student's prior knowledge. We will then evaluate the software to assess the effectiveness of our approach for helping children understand and learn new concepts.

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A pilot study of individual preference patterns in information visualization selection using the AIVE prototype

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Abstract:
Over the last few years, the number of large volume databases has increased dramatically. Consequently, it is much more difficult to understand the retrieved - often multivariate - information. User-adaptive visualization systems could assist this process. This paper presents data from a pilot study of user preferences for different types of information visualizations under experimental conditions where they were allowed to choose between alternative information-equivalent representations in order to answer given questions. The results are being used to inform the design of a user modeling component of AIVE, an adaptive system for information display.

1 Introduction

Information visualizations are powerful ways of organizing multivariate data so that it can be better understood. Considerable advances in intelligent automatic matching of information to visual representations have been made over time, beginning with systems which use bar, pie and line charts, through APT [6], which included a composition algebra and primitives to create a wider range of designs, SAGE [7] which extended APT's graphic design issues, to BOZ [1] which included a task-analysis approach. However, these automatic information visualization systems are either information- or task-dependent, rather than dependent on users' familiarity, preference or cognitive style, which can limit their usefulness for individuals. Hence there is a need for visualization systems not only to take into account information dependency, but also to employ user modeling techniques. As stated in [2] individuals differ while reasoning about an external representation (ER) in terms of their prior knowledge, preferences and reasoning. The aim of my research is to create user adaptive information visualizations that take these factors into account. A user model should help to tailor the information to the special needs of individuals. The research required here is a pilot study to discuss requirements for the user model.

2 Rationale

The aim of the pilot study is to detect individuals' preference patterns in use of ERs. This is the basis for creating user models which can predict the kinds of ERs likely to be most useful to particular individuals.

2.1 Background

My work follows on from that of [8] and [9] who developed a 'visual task taxonomy'. This means that for a given task, there is an associated visual perceptual act. For example selecting similar items involves perceptually clustering visual data. Equally, acts like comparing, ranking, or identifying from a set may be important for other tasks. Visual perceptual acts need to be supported by ERs. How far different ERs achieve this support depends on individual differences. For example, some people may prefer to cluster using a scatter plot, others set diagrams. My research aims to support different users by finding out what ERs they prefer to enable them to carry out the visual perceptual acts essential for given tasks.

2.2 Subjects

The initial set of subjects included six postgraduate students and one research fellow (3 females and 4 males). Six of the subjects had a strong math or computer science background, whereas one had a language/linguistics background.

2.3 Procedure

The experimental procedure (two pre-tests and main test) took around 50 - 65 minutes.

2.3.1 Pre-tests

The pre-tests were used to find out about people's (1) cognitive style and (2) experience with ERs. The paper folding test from [4] was used to measure subjects spatial ability. Here a decision has to be made between five different results when a piece of paper featuring punched holes is folded - only one is correct. To find out about prior knowledge of ERs, the card-sort taxonomy task from [3] was used, which investigates the relationship between people's prior knowledge of ERs and the selection, construction and use of ERs in analytical reasoning. They developed a taxonomic pre-test, which involves a sorting procedure as in [5]. The items which have to be sorted included e.g. texts on graphics, physics textbooks, fragments of computer programs, instructions, charts and circuit diagrams. Three principle clusters could be detected. The first cluster is composed of algorithms/maths, notation, logic, tables, text, work scratchings, scribbles and lists. The second cluster includes circles, sets, venn diagrams and directed graphs, networks, tree diagrams, music, instructions, directions, pictures, graphs, charts and diagrams. The third cluster consists of maps. On this basis, the following hypotheses were derived:

- Low spatial ability means general preference for verbal and better performance on this type of ER.
- High spatial ability means general preference for visual and better performance on this type of ER.
- Low background knowledge means indiscriminate selection and no big advantages for particular ER types.
- High background knowledge means careful selection and significant advantages for particular ER types.

2.3.2 Main test

Subjects were presented a set of 25 information retrieval tasks. In these tasks they were asked to make judgments and comparisons between cars based on information from a database (the same domain as used in Mackinlay's APT). A typical question was "Which car has the greatest fuel efficiency in terms of miles per gallon of petrol?". The questions were based on the work of [8] and [9], as described above. Subjects were asked to choose between various types of ERs, including graphs, diagrams, tables of information, which they thought would be likely to be most helpful to answer the questions. After the choice was made, the information relevant to the task was visualized according to the chosen representation type. The subject was asked to answer the question using the visualization, and was presented with the next task until all questions were completed. Records of users' choices, task completion times, and answers were logged for further evaluation.

2.4 Results

Results show important effects of spatial ability and background knowledge. Some subjects despite high background knowledge always chose the same ER. This may mean that high experience of using such an ER has led to expertise in interpretation regardless of task type.

Consistent with this, where background knowledge was low in a particular representational type (as measured by the second pre-test) this means subjects do not use it, or when they do find it hard to interpret. However, a result which contradicts the first is that some people are very good in choosing the optimal representation (measured by speed and correctness of answering), reflecting their high background knowledge. These results are preliminary and some seem contradictory, but they already suggest that there are individual differences in the use of ERs sufficient to motivate the development of user-models in automatic information visualization engines. A fuller analysis, together with implications, will be presented at the workshop.

3 Conclusion

Information and task goals go some way towards matching representations to tasks and users, but users also differ in terms of individual differences in representational preferences and familiarity with particular types of ERs. Hence, the next phase of intelligent information visualization system research should address adaptivity to individual differences between users. User modeling is one technique to do this. The knowledge about how users make decisions and find a solution for their required task in an ER should be included in a user model. Ideally, a system should accommodate information and task goals and also be adaptive to the user's representation preferences. The data gathered in this pilot study represent the first step in informing the design of a user model for AIVE, an adaptive system capable of tailoring information displays to users' preferences and background knowledge of representational forms.

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Mapping conceptual structure to graphical representations

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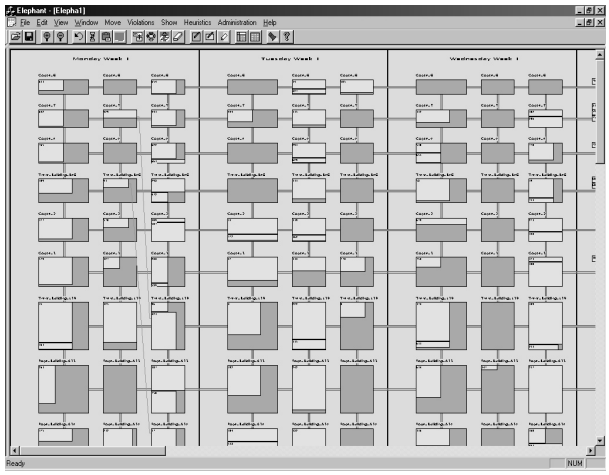
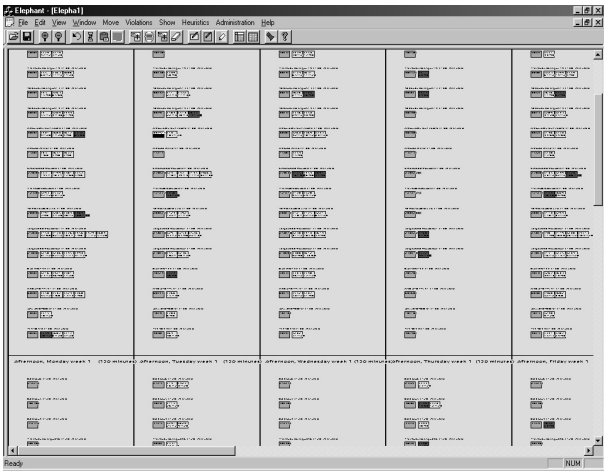
One of the important factors of a good graphical representation concerns the level of conceptual structure it encodes [1]. The conceptual structure of a knowledge domain includes the relational organisation that exists between concepts (e.g. taxonomic relations) and the imagistic structure that forms a part of individual concepts (e.g. periods are metaphorically construed as "containers"). An external representation has conceptual structure by virtue of the homomorphism that exists between the graphical structure of the external representation and the conceptual structure of the problem. I use the term homomorphism loosely to refer to a similarity in structure between two representations. Cheng has developed design principles that aim to encode the conceptual structure of a knowledge domain in the graphical structure of an external representation [2]. The principles were developed through previous studies that examined the effectiveness of different representations in scientific and mathematical domains [1]. Each of the principles is concerned with how to organise a different conceptual factor (e.g. taxonomic relations, levels of abstraction and alternative perspectives) in the external representation of the problem.

Cheng has proposed that the level of conceptual structure encoded in a representation contributes to its effectiveness in understanding and problem solving although the definition and evaluation of conceptual structure has not been given clear or elaborate expression from a cognitive point of view. The following discussion will provide an informal cognitive evaluation of the capacity of Cheng's design principles to encode the conceptual structure of a domain in the graphical structure of an external representation by using case study representations to make explicit the types of homomorphism that result. The analysis will be discussed with reference to the STARK representation for examination scheduling (ES) developed using the design principles and a conventional style ES representation that fails to adequately satisfy the principles. Both representations were compared in a recent problem solving experiment in which subjects who used the STARK interface showed superior performance [2]. For each principle I shall provide examples of the relevant homomorphism or a lack of it using the STARK and conventional interfaces as shown below. Due to space limitations I shall only examine two of these principles.

Figure 1: The STARK (left) and conventional interface (right) for examination scheduling





P 1: Combine a globally homogeneous and locally heterogeneous interpretive scheme
The principle states that a representation should provide a global conceptual scheme that encodes each universal concept in a consistent and uniform manner (global homogeneity) and simultaneously provides specific structures that differentiate local distinctions between concepts at a low level (local heterogeneity). Globally homogeneous concepts typically refer to conceptual dimensions or high-level classes of information whilst locally heterogeneous information usually represents the individual units of data that describe a given problem. The principle can be understood in terms of the users schematic knowledge of the problem. Schemas are abstracted packets of knowledge traditionally described by fixed conceptual attributes and slots that can take on variable information [3]. Different schematic concepts that exist of a domain typically share conceptual attributes with other concepts in the same domain. Globally homogeneous concepts refer to those conceptual attributes that intersect between different schemas. Locally heterogonous values on the other hand can be seen to refer to the slot filler attributes of a schema.

A globally homogeneous interpretive scheme is produced by mapping each globally homogeneous concept to a unique graphical identity (e.g. entity, spatial relation etc.). A locally heterogeneous scheme is produced by mapping distinctions between different instances of a concept to different values of a graphical dimension (e.g. location, distances, colour etc.). The last part of the principle demands that locally heterogonous values and globally homogenous concepts are combined with the representation of the schematic entities that they belong to (In ES schematic entities include exams, slots, periods, rooms etc.). Adhering to the principle ensures that there is a homomorphic mapping between the schematic conceptual structure of the problem and the diagrammatic structure of the representation. The nature of this mapping preserves the intersection relations between the set of schematic concepts, the variability of the slot filler attributes of schemas and the individuation of intersecting conceptual attributes and slot filler attributes with other conceptual attributes of the represented schemas. This strict form of graphical schematisation allows users to clearly interpret diagrammatic expressions and helps structure their understanding of the problem.

Figure 1 (left) shows the STARK representation provides a globally homogeneous and locally heterogeneous interpretive scheme. Time and space are mapped to horizontal and vertical axes of the representation and all temporal and spatial entities adhere to this scheme. For example, the duration of an exam (light rectangles) or slot (dark rectangles) is shown by the length of the rectangle and the number of students taking the exam or the room capacity of the slot is shown by the height of the rectangle. Individual periods are represented by columns of slots and rooms by rows of slots. This example includes three globally homogeneous mappings (QUANTITY->DISTANCE, TEMPORAL->HORIZONTAL ORIENTATION and SPATIAL->VERTICAL ORIENTATION). The actual distance of the side of a rectangle encodes the locally heterogeneous values. In the conventional representation shown in figure 1 (right), temporal entities are organised along both vertical (periods) and horizontal (days) axes. The temporal and spatial values of exams and slots are numerically displayed in and above icons or in a list structure of a separate window. This representation fails to display a coherent mapping of the globally homogeneous concepts and provides a poor schematic integration of locally heterogeneous values.

P 2: Integrate levels of abstraction
The principle demands that the levels of abstraction that characterise a problem should be integrated in such away that the representation establishes close conceptual connections

between each level. It is common for graphical representation to encode little of the abstract relational information required for reasoning about the problem. I use the term inferential structure as discussed in [4] to refer to the kinds of inferences a user can abstract from different kinds of spatial relations (e.g. Containment relations: If A is in B and B is in C then A is in C). Informal analysis of graphical representations reveals that to effectively integrate an abstract relation is to encode a spatial schema that provides the relevant kind of inferential structure that matches or is homomorphic to the inferences required to reason about the domain. Spatial schemas (CONTAINMENT, PATH, PART-WHOLE etc.) are commonly expressed in graphical representations and are often used to reason metaphorically about abstract concepts in everyday situations [4]. The diagrammatic integration of abstract relations reveals the kinds of judgements and inferences that should be made between entities and relations in the problem.

Arithmetic relations are one of the main classes of abstract relations that characterise the ES problem. In the STARK diagram arithmetic relations are homomorphically integrated in the representation using a spatial alignment scheme. The part-whole relationship of vertically staked exams encodes the addition relation. The subtraction relation between a slot's room capacity and the students assigned to it is shown by the distance between a slot's height and the total height of stacked exams. In the conventional representation however arithmetic relations are absent even though the input and output values of the relevant arithmetic functions are numerically displayed.

The discussion has provided examples of the types of conceptual homomorphism associated with the application of Cheng's design principles. I have also suggested reasons why this conceptual structure may contribute to better problem solving behaviour in comparison to the conventional representation as reported in [2]. Through better understanding the conceptual homomorphism in graphical representations the design principles can be further developed to include a more detailed specification of how they should be applied and interpreted. In addition, little is known about the cognitive mapping processes involved in decoding conceptual structure from graphical representations. My current research is concerned with integrating ideas from theories of analogy, metaphor and cognitive linguistics to better understand the types of conceptual processes users perform in graphical reasoning and further inform the design of effective graphical representations.

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WISDeM: Communication Preference and Learning Styles in HCI

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1 Introduction

This paper is based on the Research Hypothesis that "*When an intelligent distance learning tool interacts with the learner using his/her Communication Preference Language Patterns, Learning Styles and Motivational requirements it increases the Human Computer Interaction (HCI) communication capability and, thus, enables the learner to learn more effectively and easily*".

2 Domain Expertise is not very Generic

[Murray 1997] considers that domain expertise is not very generic. As a result of this the pedagogy-oriented systems tend to have different representational schemes and different teaching strategies for several different knowledge types using simple overlay student models, whilst performance-oriented systems tend to incorporate more complex procedures and have more fine-grained student models coupled with simplistic instructional strategies. Thus the challenges of developing good authoring tools have constrained developers to focus their efforts on one or the other. [Sporre 2001] highlights the requirement for one-to-one interaction between learner and tutor: this is rarely practical in the modern university. [Djian et al. 1999]'s research indicates that the joining a Distance Learning Tool (DLT) with an Intelligent Tutoring System (ITS) producing a generic Human-Centred ITS tool for the World-Wide-Web has a lot to offer to the different users concerned with such a tool encompassing, for example, Avatars, Natural Language (NL), Neuro-Linguistic Programming (NLP), Multi-modality, Autonomous Hyperlink Searching, linking/using other ITS or indeed any other development that would further the ability of a DLT to effectively and efficiently interact with every learner who uses the system.

3 Communication Preference

Communication preference has been the basis of much research [Borchert et al. 1999; Fleming 2001; Robotham 1999] showing that people use their own preferred technique/s to exchange ideas with others, acquire knowledge and pass knowledge to a third party. [Catania 1992] reports that almost all learning is external to the body being introduced by one of the five senses with the input using the Iconic (60% sight), Echoic (30% hearing) and Haptic (10% touch) cortex of the memory (Olfactory {smell} and Taste use proportionally little). [Cotton 1995] reports that input is filtered and interpreted by being compared with preconceptions, existing beliefs and concepts, [Sadowski and Stanney 1999] report that there is a tendency to prefer one sensory input over another in a given context (**v**isual, **a**uditory or **k**inaesthetic {tactile and haptic} instances), and [Pasztor 1998a] reports that rapport with a partner is key to effective communication and that incorporating NLP language patterns and eye-gaze (see also [Colburn et al. 2000; Sadowski and Stanney 1999]) in intelligent agents will allow customisation of the (virtual) personal assistant to the particular habits and interests of the user; thus, making the user more comfortable with the system. [Pasztor 1998b] also confirms that introducing the correct sub-modality (**v**isual, **a**uditory, **k**inaesthetic) will enable the subject to more easily remember and recall instances.

4 Learning Styles.

Students have preferred learning styles that directly impact their ability to assimilate and retain course content [Borchert et al. 1999]. These learning styles can be established using psychometric models such as VARK or MBTI®. VARK is a well-respected model to establish learning styles developed by [Fleming 2001]. A student's VARK descriptor is formed as a combination of up to five different modes of information input: **V**isually, **A**uditory, Read/write, **K**inaesthetic and Multi-modality: the last is a recent addition [Borchert et al. 1999]. [Driscoll and Garcia 2000]'s research is interesting in that results, obtained for student class profiles using VARK, indicate that their learning styles are firmly in place by the time a student goes to university. They further report that profiles may well differ substantially from what their tutors perceive and/or assume.

Another very successful model is the Myers-Briggs Type Indicator® [Murphy et al. 2002; Myers and Myers 1995]. MBTI® is a self-report personality inventory designed to provide information about your Jungian psychological type preferences. Research shows that it is more widely used by educators in USA than any other. [Murphy et al. 2002] report that more than three million MBTI®s are conducted in the USA each year and that the system is widely used around the world in many languages. Both [Borchert et al. 1999; Myers and Myers 1995] provide analysis of MBTI® questions and reports. In essence MBTI® has four preference categories: i) Interpersonal Communication, ii) Information Processing, iii) Information Evaluation, and iv) Decision Style: most researchers see Information Processing as the most important in terms of implications for education [Borchert et al. 1999].

5 Student Learning Styles to Teaching Styles

[Hoover and Connor 2001] report that matching your learning style to teaching style can result in more effective learning and greater academic achievement. [Fuller et al. 2000] outlined the Teaching Styles preferences for the MBTI® styles and provided suggestions for faculty development for seven of the sixteen MBTI® types. [Montgomery and Groat 1998] point out that "*matching teaching styles to learning styles is not a panacea that solves all classroom conflicts*" that other factors such as the student's motivation, pre-conceptions, and multicultural issues also impinge on the student's quality of learning; nonetheless, understanding and reacting to learning styles in teaching enhances the quality of learning and rewards teaching. [Brightman 2000] discusses the four MBTI® sections and provides guidance on matching Learning and Teaching styles. Higher-level education motivation normally operates at the Maslow's Hierarchy of Needs 'Cognitive Need' level though the 'Esteem Needs' level can play an important part [Cotton 1995].

6 Scenario

A new learner connects to WISDeM (Web Intelligent Student Distance-education Model) and selects his/her school and module. The learner uses his/her University Registration ID, password and Module selection to log on. The system checks if the user is new or existing: if the former, the Communication Preference (CP) question/answer screen is opened. When completed the Learning Style question/answer screens are activated. The questions/answers are couched using the learner's NLP Language Pattern as ascertained from the CP answers. The resulting Learner Profile is saved in the Learner Profile Repository and the module front page is opened. The student is asked to complete the Communication Preference questionnaire by selecting only those statements with which he/she agrees, as follows:

Communication Preference (CP) : Following learner identity validation, 21 questions are output: 7 questions covering each of the 3 main sensory memory input: i) **V**isual memory, ii)

Auditory memory, and iii) **K**inaesthetic (feelings) memory that are specifically related to the student's sensory perception; for example for (V) "*I prefer a lecture to be illustrated with slides",* for (A) *"I like music more than art",* and for (K) *"When I recall an experience, I usually remember how I felt about it".* The answers are evaluated, a report output and a link opens a Learning Styles questionnaire.

Learning Styles (LS): This questionnaire outputs questions couched in the language pattern relevant to the learner's CP. The LS questions were developed using the MBTI® principles and style with five pairs for each LS. The LS questionnaire asks ten questions, split into couplets, on the four sections (Inter-personnel Communication, Information Processing, Information Evaluation, and Decision Style). Each set of questions has been replicated using the three language patterns (VAK): for example for (V) "*I notice that I tend to talk more than I listen"*, for (A) "*I tend to talk more than I listen*" and for (K) "*I feel that I tend to talk more than I listen*" and presented to the student according to his/her CP. Provided all sections are answered, the Student Report is compiled of four sections of five answers selected as relevant for each answered question. The resulting computer analysis selects one LS profile out of the sixteen possible profiles, it reports on each section and provides an overall LS summary. The student can either agree with the profile report or redo the questionnaires: when agreed, the CP and LS are logged in the Learner Profile database. [Fuller et al. 2000] research results show the following LS type testing results over a small sampling: E=53%, I=47%, S=24%, N=76%, T=41%, F=59%, J=53% and P=47%. The LS combination scores were ENFP and INTP = 18%, ENFJ, INFJ, ENTJ and ISFJ = 12% and INFP 6%.

7 WISDeM current position

WISDeM is still being developed. The DLT section has been operative for some time and has successfully been used by three modules, the generic structure is complete. The database administration section for authoring is nearing completion: the front-end allows a tutor to enter staff and student authorization and make basic screen presentation changes. MS Word, Excel and PowerPoint are used to create module content: HTML authoring is not required though can be used if required. Of the ITS section the initial Student Profiler has been built and is currently be evaluated, initial replies from students indicate that this is working well and provides accurate profiles. The multi-choice question and answer section is part of the current DLT facility that has been used by the three modules. Work is now underway to change this facility to include the AI and Motivational aspects mentioned in this paper.

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EXTERNAL REPRESENTATION OF THE STUDENT'S KNOWLEDGE IN A WEB-BASED LEARNING ENVIRONMENT

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Introduction. Web-based learning environments are a kind of software which has reached great popularity in universities and colleges all over the world. They enable teaching using computer mediated communication (CMC) tools wired by an Internet connection. First environments where produced in 1995 - 1997 as spin-off projects in some universities, and today most popular products are WebCT and BlackBoard.
Thanks to their features, students are free to study with no limits of time or space, and tutors can take advantage of CMC tools for creating discussion groups, shared exercises, and delivering multimedia content.

If, on the one hand, this new way of delivering lessons can bring new advantages, like asynchronous learning[6] , collaborative learning [4], on the other hand it leads to new problems from the point of view of the tutor's work. In particular, the lack of direct interaction between the tutor and the students could generate some problems. One of the well known problems in distance education from the tutor side is the lack of check of the students' knowledge. It was pointed out that because of the lack of nonverbal elements in CMC (gestures, facial expressions, etc.), it is very hard for a tutor to know what sort of concept each student is currently working on, and the level of comprehension he or she has achieved for that concept.

Even if some environments like WebCT provide a single page that allows the tutor to check the activity of students (in particular the history of the visited pages, the number of posted messages in discussion, the marks he/she received for the quizzes provided by the tutor and automatically graded by the system), this information is presented in a format that is very uncomfortable for the tutor to derive assertions from the state of knowledge of the students. In fact, with the term "knowledge" we are not referring to the grade that the students achieved in a particular exercise, but to the level of mastery of each skill that each student achieved studying in that course.

Student modeling in educational systems. What lacks in today's commercial web-based learning environments is a process of student modelling. This process gathers relevant information on the course's activity and creates a system's belief about the knowledge achieved by students. This representation is called student model [5].

Student model is already used as main component in Intelligent Tutoring System (ITS) and Web-based Adaptive and Intelligent Educational Systems (AIES) [1], but these systems are used only in very specific and limited cases. In fact, even if they are very sophisticated environments, that have the great advantage of providing personalized tutoring, from the tutor's perspective they require a great effort for the authoring of the teaching material. The most significant limitations of these systems is that they can be developed for only few topic areas,

like engineering and mathematics, since they need to represent, in an expert system, the complete knowledge of the subject area. Moreover, many of them are domain dependent. Because of these limitations nearly all prototypes of this kind of systems remained as experimental tools.ent

Open learnern models for instructors. The student model can be a hidden component of a complex system like in ITS and AIES, or can be externally available for inspection to students and/or tutors. The latter case is referred to in literature as *open student models* or *inspectable student models* or *scrutable student models* [3], and is mainly used by students in order to promote reflections by themselves [2]. We think that an external representation of the student model available to tutors can also be useful to assert some facts about the students of the course.

My approach in solving the problem is to integrate in the instructional learning environments a representation of the overall state of knowledge of the class of students. In fact, from a pragmatic point of view, the concrete state of the art of commercial tools are environments where the content materials are static HTML pages. In this way, it is very easy for a tutor that wants to create an on-line course to convert his/her material produced, for instance, with a word processor in HTML format, and put this material on-line very quickly. Instead of force the tutor to use (and learn) another system, I propose a tool, which runs in conjunction with a commercial web based learning environment and it is able to represent, in a very comfortable and intuitive way for the tutor, the actual state of knowledge of the whole class of students.

The final consumer of this representation of students' knowlege is the instructor. Even if a lot of research has been done in order to export the student model to the students, I wasn't able to find any research were the target user of the student model is the instructor. Most of research in open student models are solution where the student model is opened both to students and instructor, but the primary target is the student.

With the instructor's needs in my mind, I started to project a tool which aims to provide a graphical representation of the knowlege level of the entire class of students. The tool will be composed by:

- *a content exporter*, which uses the IMS exchange data format provided by many commercial tools able to export learning material, quizzes and tests in packaged IMS Content Packaging and IMS Question and Test Interoperability XML standard format,
- *user activity exporter*, is a module able to export in XML format each specific action executed by each student, (like the history of the page visited, the marks that students received for each quiz, messages posted and so on); obviously this module depends on the particular learning environment we use,
- *a domain designer module,* is a tool that can be used by the tutor to describe the domain model of the course, in terms of *concepts*. Each concept is associated to a set of pages and quizzes of the course. There are no relations or dependencies among concepts in this representation of the domain,
- *a modeler,* is the part of the system able to create a representation of the user's knowledge of the concepts of the course, starting from the domain provided by the domain designer and the user activities on that domain. The logic used in this module is to utilize user activities to diagnose the level of understanding and mastery that the learners acquire immediately after a concept has been discussed. The underlying assumption that we use for the modeler is that if the learner achieves a high mark on a quiz, and he/she visited the pages related to a concept several times, then the level of mastery of the learner on that concept is positively affected,

- a *graphic representer* is the part of the system able to display in a graphical format the knowledge representation produced by the modeler.

Student model is largely simplified if compared to other sophisticated environments, but the big advantage of this application is the ability to run in conjunction with the existing distance learning platform, that we are using to provide our course, without changing the content or the structure of our course. Tutors continue to use the distance learning tool in the same way, without forcing them to use a further authoring tool, as required by a ITS or a AIES.

Conclusion and future work. This work is only in its early stages and some of the modules above descritped have not yet been implemented. The student model is largely simplified in order to allow a simple authoring of the domain. The system will be more usable as the authoring of the course is simplified. Information about the knowledge of the entire class could be useful to the work of the tutor in order to:

- assess the learner's knowledge
- keep track of those students that are having problems with the study (e.g. are too slow or too fast, during the study of the course)
- discover what concepts in the course are harder to understand

Future work will be focused on implementing the tool and testing it in a real on-line course.

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Comparison of novice and expert learners' perceptions of instructional feedback in computer-based training to develop managerial problem-solving skills

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Introduction

As a research topic within the field of cognitive science, computer-based training enjoyed strong interest in the 1970s and early 1980s, spurred by the promise of intelligent tutoring systems driven by artificial intelligence technologies. The past 20 years has seen a shift in emphasis away from instructivist pedagogies, towards experiential and collaborative forms of learning inspired by constructivist and socio-cultural perspectives. Many academic studies are now exploring ways in which technology can support collaborative learning (for example using on-line conferencing) or experiential learning (for example using simulations and games). However, this has resulted in a gap between academic research and the practice of vocational training: many business organisations continue to use stand-alone, self-paced CD-ROM and web-based training, yet for these non-collaborative forms of learning there is limited current research, particularly for training aimed at developing managerial problem-solving skills. The aim of the current research study is to contribute towards addressing this gap, by exploring business learners' perceptions of computer-based training ('CBT') for managerial problem-solving skills, with a particular emphasis on their perceptions of instructional feedback.

Instructional feedback in computer-based training applications

Instructional feedback has a vital role in theories of learning and teaching. However, the concept of feedback provokes disagreements and confusions because alternative learning paradigms (e.g. behaviourist, cognitivist, constructivist) each promote a different function of feedback (Askew & Lodge, 2002). Behaviourist notions of feedback emphasised its function as a positive reinforcer of desired behaviour (Thorndike, 1913). Cognitivist notions, based upon information-processing theory, emphasised feedback's function to diagnose and correct misconceptions of learning (Anderson et al. 1971). However, meta-analyses of prior research grounded in the behaviourist and cognitivist paradigms have found results to be confusing and contradictory, suggesting that the underlying theoretical conceptions of feedback were flawed (Mory, 1992). There is little constructivist-inspired research on the function of feedback for non-collaborative, self-paced CBT applications.

There are also important omissions in the prior research literature. For example, few studies have considered the experiences of adults engaged in vocational learning. Another omission is the lack of research on individual differences among learners, raising concerns that academic research is failing to inform the design of *adaptive* feedback (Kulhavy & Wager, 1993). Sales (1993) suggests several categories of individual-difference data, including prior knowledge and expertise. Research from related fields has shown that novices and experts differ in important respects in the way they process information and represent problems (e.g. Chi et al., 1981). This suggests that novices and experts are likely to differ in their instructional needs, and in the way they perceive the effectiveness of instructional feedback.

Purpose of the current research

Given these omissions in the prior research literature, the aim of the current research is to explore business learners' perceptions of instructional feedback, in applications designed to develop their managerial problem-solving skills. The research design is exploratory. The third study, discussed in this paper, examined four propositions relating to apparent differences in the way novice and expert learners perceived key attributes of feedback received on completion of multiple-choice tasks, where those differences were suggested from Studies 1 and 2. The four propositions are presented below:

P1: Novices prefer feedback offering explanations, over feedback offering multiple perspectives but with no single-correct-answer; Experts prefer multiple perspectives over explanations.

P2: Experts prefer feedback offering guidance on underlying principles, over feedback offering prescriptive detail; Novices prefer detail over underlying principles

P3: If feedback presents only a video scenario of the consequences of an response option, novices - more so than experts - will express preference for a supplementary issues-based debrief.

P4: Novices experience dissatisfaction more frequently than do experts if correct-response feedback does not elaborate on why the alternative response options are incorrect.

Research methodology and procedure

The research adopted an exploratory, interpretive approach, using semi-structured interviews with learners as the primary data-source. 72 employees of a management consultancy firm were interviewed during Studies 1, 2 and 3, and each was categorised as novice or expert according to their organisational grade. Study 3 involved 12 employees. Discussions revolved around four 'constructed' CBT activities - one for each proposition - which were built from activities embedded in 'real' CBT applications discussed in Studies 1 and 2. The four constructed activities were combined in a hypermedia Powerpoint presentation, and interviewees were asked to complete each activity (e.g. chose a response from a multiple-choice question ('MCQ') list) in order to simulate CBT training. To examine the propositions, each activity task was followed by two styles of feedback, so that interviewees could compare and comment on them, and rate the perceived usefulness of each style. In this way, apparent differences in the way novices and experts perceived feedback - suggested from Studies 1 & 2 - could be further explored.

Research findings

Key findings for each of the four propositions are discussed next. Whilst some propositions were not supported, further analysis revealed important differences in the *reasons* given by experts and novices for their apparently similar feedback preferences.

Proposition 1: Both novice and expert interviewees preferred explanatory feedback over feedback offering three alternative perspectives on the problem. Different reasons were cited. Novices felt uncomfortable with the apparent ambiguity of the multiple-perspectives feedback: it was not sufficiently concrete to give them closure on the thoughts and questions which had been aroused by the preceding task. Expert interviewees were tolerant of multiple-perspectives feedback which they felt reflected the relativistic nature of real-life. Although, like the novices, they preferred to be told the 'optimal' answer, their reasoning was different: their expectations of CBT MCQs was that a single correct answer had been

previously determined by the CBT designers, and they were curious to know the rationale for their answer, even if they might have disagreed with it.

Proposition 2: Both novice and expert interviewees found detailed feedback to be useful, but different reasons were cited. Novice interviewees liked detailed feedback because they interpreted it as a prescriptive protocol to control future behaviour. Expert interviewees liked detailed feedback but only because they declined to accept its *prescriptive* nature. For experts, the richly descriptive phrases brought to mind existing knowledge and mental models, which could be reflected upon and modified in the light of the detail presented in the feedback. Feedback was received as guidance and not as prescription.

Proposition 3: P3 was supported. The instructional strategy behind video-consequence feedback was that interviewees would learn inductively. This strategy was fundamentally flawed in its execution, however, since only a single-instance of the problem-type was presented. Novice interviewees were unable to draw out the implications of the video-consequence feedback via a process of abduction, and wanted analytic, debrief feedback to explicate the key learning points. Experts *were* able to infer the key learning points, because they drew on prior experience.

Proposition 4: P4 was supported. Novice interviewees were dissatisfied if correct-response feedback did not give retrospective coverage, for example by elaborating on why alternative response options are incorrect. Novice interviewees wanted retrospective coverage because even if they knew (and chose) the correct response, they did not necessarily understand *why* it was correct. They wanted elaborated feedback to help them deepen their understanding of the topic. Expert interviewees were usually able to draw on their experience to 'fill in the gaps' if correct-response feedback did not give retrospective coverage.

Conclusion

Study 3 revealed differences in the way novices and experts perceived instructional feedback. A possible reason for these differences is that novices and experts hold different epistemological perspectives about the training topic, which leads them to prefer different instructional strategies. These differences in preferences have important implications for instructional design, and suggest that there are advantages in adapting CBT feedback to the level-of-expertise of the user.

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Helping to provide meaning to the students' learning by considering their goal orientation

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Abstract Motivation is a relevant factor in the learning process because teachers often interweave motivational techniques with their domain-based decisions, aiming to build conditions that stimulate and/or mantain the desire to learn. Few attempts have been made to develop a tutor with considers this aspect. But there is also another factor, that we consider relavant in the learning process, which is the student's goal orientation. Students with a mastery goal orientation aim to develop new skills and competencies, whereas students with a performance goal orientation try to demonstrate competence or to achieve at high levels of normative ability. On the one hand, much research suggests that mastery orientation fosters an adaptive pattern of achievement, whereas performance goals promote a maladaptive pattern (Ames, 1992b; Dweck & Elliot, 1988; Deci, Betley, Kahle, Abrams, & Porac, 1981). On the other hand, other research supports a multiple orientation view in which it is considered that performance goals have some positive consequences that complement the positive effects of mastery goals. The research reported here analyzes the possibility for improving students' motivation by considering their goal orientation.

1 Background

According to Ames (1990) students can be classified into two main groups: students with a mastery goal orientation and students with a performance goal orientation. The former define success as developing new skills, understanding content, and making individual progress. The latter interpret success as a reflection of their scholastic ability and a comment on their self-worth. They regard learning as a vehicle to public recognition rather than as a goal in itself. In addition, it is suggested that more effort is expended by mastery- than performance-oriented students because the former think that by attempting more, they have more possibilities to achieve their goals; whereas the latter think that by spending more effort they show lack of ability (Dweck & Elliot, 1988).

So, Ames's claim might be reasonable: if we want students to seek challenging tasks, to develop more positive attitudes, and to expend reasonable effort toward learning, we must develop classroom styles that are specifically designed to foster mastery goals. Ames proposed strategies to develop mastery-oriented experiences for at-risk students (Ames, 1992a).

However, other authors (Barron & Harackiewicz, 2001; Harackiewicz & Barron, 1998; Harackiewicz & Elliot, 1993; Sansone & Morgan, 1992) suggest that we need to research more about multiple goal perspective before concluding that a mastery goal perspective is best. For instance, Sansone and Morgan (1992) suggest that the same information and feedback can either aid or obstruct intrinsic motivation, depending on its match with how students define the goals of their involvement. In the same direction, Harackiewicz and Elliot's results suggest that by providing feedback consistent with the general goal orientation established at the beginning of task engagement, the perceived competence and task enjoyment can be enhanced. That is, subjects in mastery goal conditions should receive positive, mastery-relevant feedback, and subjects in performance goal conditions should receive positive, normative feedback. A related principle is considered by Lepper and Malone(1987): "Normative feedback should be very effective for highly competent learners;

self-referenced feedback may be more effective for less competent learners" (p.273). Taking into account this research, it is our interest to investigate more about the relationship between students' achievement orientation and the motivational context established by performance or mastery goals.

In order to do that, we will consider the principles in common of Lepper and Malone's and Keller's motivational strategies, which are shown on Table 1. Ames's strategies, taking into account goal orientation theory, also match with some of these principles.

Table 1: Principles in common of Lepper and Malone's and Keller's motivational strategies

1) Variability in audio and visual effects
2) Clear goals or an environment where the students can generate them or themselves;
3) Instruction responsive to learner motives and values (meaningful goals)
4) Appropriate metaphors or analogies
5) Challenging experiences (graded difficulty levels)
6) Techniques to offer personal control (responsive learning environment, activities with moderately high levels of choice)
7) Frequent, clear, constructive, and encouraging performance feedback
8) Verbal praise, real or symbolic rewards

2 Research question and hypotheses

Ecolab is a software system for the domain of food chains (Luckin & du Boulay, 1999). This system was developed to offer adaptive scaffolding through the operationalisation of Vygotsky's Zone of Proximal Development (ZPD), which is described as:

... the distance between the actual development as determined by independent problem solving and level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (p.86) (Vygotsky, 1978)

The Ecolab system (more able partner) fulfills several of those strategies listed in Table 1, for example, providing appropriately challenging activities and the right quantity and quality of assistance. But it has some weakness related to variability in audio and visual effects; instruction responsive to learner motives and values (meaningful goals); frequent, clear, constructive, and encouraging performance feedback; and verbal praise, real or symbolic rewards. Therefore, instead of designing and implementing a new computer system, which would involve a lot of work, we consider that making some adjustments to Ecolab will help us to focus in our research question:

Is it possible to provide relevance to students' learning by considering children' goal orientation using a Vygotskian software?

The main hypotheses are:

1. By providing a goal context corresponding to student's goal orientation, the motivation could be affected positively.

2. Giving adequate performance feedback according to student's goal orientation might help to maintain a motivated student.

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A tool for helping the translation of math word problems into math expressions: Description of an Exploratory Pilot Study

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Abstract: This paper describes a pilot study that aimed to evaluate the design of a tool, called PAL Tool. This tool is a component of a reflection-based learning environment under development and the study is part of ongoing research on metacognition and math problem solving. Seven students used a pen-and-paper version of the tool. The paper also reports on interpretation of results of the study and how they will be incorporated into design changes in the tool.
Key Words: problem solving, algebra word problems, translation skills, metacognition.

Introduction

The main goal of my research is to design and implement a computer-based learning environment that uses reflection as a means to improve metacognitive awareness and regulation skills in the domain of algebra word problems [2]. Although algebra problems require basic math, previous research found that college students and adults experience great difficulty in solving those problems due to comprehension failures of relational schemas to create problem representations [1]. Heffernan & Koedinger [4] argue that the ability to take a problem situation and formulate a mathematical model, called *symbolization*, is the single most important skill needed to succeed in algebra problem solving. These abilities are essential to perform the first stage of algebra problem solving, named *translation stage* [5]. The learning environment under development focuses on metacognitive awareness of problem translation. A tool, called PAL Tool, was designed as part of the environment for helping students to translate algebra problems.

Overview of the PAL Tool

The goal is to create a simple and intuitive tool providing basic support to students who need help in the translation stage. In the context of my research the tool is not the sole source of help for students. Unlike other previous, more complex, systems developed, like TAPS[1] and HERON[7], the PAL Tool focus exclusively on the translation stage of algebra problem solving and intents to provide limited help on the task, letting students figure out the equations on their own. This version of the tool asked students to:

- find and label relevant elements of the problem
- classify those elements in three distinct categories: givens, goals, and unknowns [6].
- identify relationships linking those elements together which could then be translated into simple equations.

This version of the tool also provides some basic instructional aids. It can:

- show hints to guide the search of important elements in the problem
- hand in some of the elements (one at a time) to avoid students getting completely stuck.

PAL's interface is simple. It has several tables in which a line stands for an element of the problem and buttons that trigger help on the task. **Fig.1** shows the initial mock-up of the tool. The Fade-out function allows students to cross out irrelevant information. The Show Hint button can be used whenever the learner is not sure about the givens, goals, unknowns or relations of the problem. It shows a question and 3 possible answers to make the learner think about the specific element she is having problems to identify (but the correct answer is not provided). If the student still feels confused, the Give Me One option gives one piece of information.

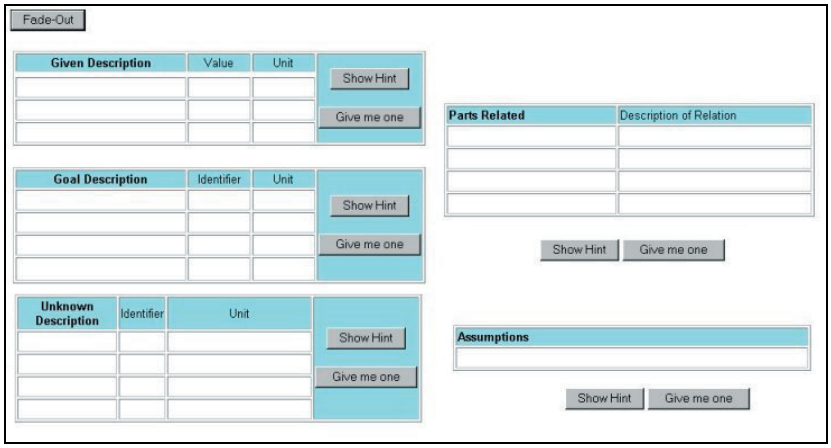

Fig 1. Pen-and-paper version of the PAL Tool

Goals of the Pilot Study

The pilot study aimed to evaluate the usefulness of the PAL tool and perform a usability test. The questions put forward were: (1) To what extend is the PAL tool useful to students? (2) Does the tool help students go further in problem translation than they would do without? (3) How do students with difficulties in problem solving use the tool? What type of difficulties do they report?

Methodology

Participants: The sample was made up of 7 participants over 21 years old. Six of them had already graduated in social sciences and 5 of them had not taken a math course for more than two years. All of them reported difficulties in math problems solving in general.

Procedure: Participants filled in a demographics form and did an 8-items math test that evaluated algebra translation skills. Then, participants read a tutorial about the tool and saw an example. Two different procedures followed: (1) four students used a pen-and-paper version of the tool to translate a difficult algebra problem; (2) two students that reported being very weak in problem solving (and did poorly in the math test: 1 out of 8 questions), first solved a simple problem using a blank sheet of paper and then, organized the same problem into the tool. Then, they were given a second, more difficult problem to organize into the tool. Participants were asked to think aloud during the session. At the end, participants were interviewed and asked about the interaction with the tool.

Results: Although it is not possible to get statistically significant data with only seven participants, some quantitative information was extracted: (i) Average time spent translating problems: 22 minutes; (ii) Task Completion: 2 students translated the whole problem without difficulty; and 5, either did it incompletely or needed interference of the experimenter to go further; (iii) Difficulty: the goals were the easiest parts to identify (5 students did it correctly), followed by the givens (3 students did it correctly, 3 did partially, including wrong givens, and 1 did not identified the givens at all); drawing relations was the most difficult activity (only 2 students completed the task).

Discussion: The study results are in line with research showing that construction of relations is the most difficult part of this process [3].The two weakest students, even after receiving hints and items to complete their task, were unable to understand the meaning of the relations in order to continue the problem. It suggests that for very weak students the tool is less helpful, because it does not provide instruction of algebra (why translate the problem into algebraic expressions, what is a variable, etc.). In the interview 6 students reported that they benefited from the tool organization, and the hints were useful to keep them in the right track. Nevertheless, putting parts together into relations was reported by all as confusing and hard.

The time spent on the task was not well balanced, and some students spent most of their time identifying the elements of the problem and lost view of the necessity of integrating them.

Implications to Changes in the Design

The scope of the study was limited, but generated some design ideas. One of them is related to the learning environment: the level of difficulty of problems should be adjusted according to each student, avoiding very hard problems. Students with very poor translation skills should first receive easy problems to develop experience with the task and tool use.

Some possible new directions for the design of the PAL Tool are:

1. do not ask students to identify the parts explicitly, but focus on the creation of relations. Try to guide the student, through the hints mechanisms, into thinking about the problem elements in their order of difficulty (ex: hints about goals, followed by givens, possible unknowns, etc.).
2. provide a *algebra dictionary* with terms in "natural" language and their algebraic meaning. See example below.

Relation Description	Algebraic Expression	Example	Expression in Example
Three less than the unknown	x – 3	*Bob has three apples less than Jim*	B = J- 3

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"Oh No, Not Another Web Search Guide!" - Addressing a Skills Gap among Undergraduate Students

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Introduction

The aim of this research is to design and evaluate a software tool that encourages the acquisition of an important study skill for undergraduate students - locating useful course-related resources on the World Wide Web. Even though the Web has been in widespread use in secondary education for a number of years now, indications are that a significant proportion of new undergraduates are still arriving at university lacking the confidence and skills to easily find what they want and/or need, and there seems to be a gap in skills and confidence between those studying computer science or similar subjects, and those studying predominantly humanities or social science (Lloyd, 2001).

There are many existing guides to Web searching, both on the Web itself and in printed form, and although the software tool being developed does aim to provide practical information and guidance, the research is not simply about evaluating yet another Web search guide - it is also about fostering metacognitive awareness during Web searching, and assessing the extent to which that might be useful.

Metacognition - 'thinking about thinking', including planning ahead, monitoring, self-questioning and self-correcting - is a concept popularised by Flavell (1979), among others; he found evidence of its usefulness to learners during cognitive tasks such as reading or memorising. Vygotsky, cited in Day et al, 1985, argued that "children's increasing ability to direct and control their cognitive behavior ..." [*i.e. metacognition*] "... reflects the gradual internalization of the means by which adults and more knowledgeable others have previously organized and directed the child's behaviour".

The increasing use of the Web as a learning tool, either instead of, or as well as, libraries, would seem to require the internalisation, by Web searchers, of some of the skills of the librarian. Ryder and Wilson (1996) ask "who are the librarians in this virtual library? Who will provide the scaffolding and coaching for the unskilled researcher? Who will undertake the task of conjoining people and knowledge ...? Who will classify knowledge and information?", and their answer is that, on the Web, "the agency of librarianship shifts from the center to the periphery. The role of virtual librarian is distributed. In the virtual library there is no central keeper of knowledge.... The role of organizing and classifying knowledge is passed to each user."

This research aims to transfer some of the skills of an experienced and skillful Web searcher to a relative novice. The scaffolding provided by the software will include both domain knowledge - of the organisation of the resources, and of current cataloguing & retrieval methods and their limitations - and metacognitive knowledge - planning ahead, monitoring, self-questioning and self-correcting.

The research follows previous work (for example, Forrest-Pressley et al, 1985; Puntambekar & du Boulay, 1995) on the relevance of metacognition for the acquisition of other important study skills, such as reading, problem solving, mental arithmetic, and remembering, which have suggested that students who engage in metacognitive thinking about a cognitive task seem to perform better, in terms of skill acquisition and transfer, than students who do not seem to engage in metacognitive thinking, or who do so less.

The Web Search Guide is a website which will be evaluated by three groups of first-year humanities undergraduates, all carrying out the same search task - one group will use the complete version of the Guide, including both metacognitive elements and domain-level elements; another group will use a

reduced version, lacking the metacognitive elements but including the domain-level elements, and a third group will use no guidance at all. The effectiveness of participants' search sessions in the three conditions will be assessed by a number of measures, especially (i) participants' confidence that they have found material relevant to the search question, and (ii) the 'accuracy' of their assessments of website relevance, where 'accuracy' is defined as the closeness of their assessments of relevance to those of a postgraduate tutor on their course (a more knowledgeable peer).

I report on low-tech prototyping of the Web Search Guide; a pilot evaluation of an initial software prototype of the Web Search Guide; and plans for a larger-scale evaluation of the software prototype.

Low-tech Prototyping of the Web Search Guide

An experiment carried out in December 2001 evaluated a set of colour-coded cards that simulated the planned website. Eleven participants, self-defined as 'novice' web searchers, and from a variety of backgrounds in the author's university, carried out a timed web search on any topic that interested them, using a set of purpose-made cards that were placed face-down on the table beside the computer. The cards were either:

(1) Brown 'stage' cards which guided the participant through the stages of the search task;
(2) Pink 'activity' cards which provided practical exercises (e.g. choosing a search engine);
(3) Blue 'information' cards which gave useful background (e.g. possible reasons why searching might sometimes be slow).

Simulated 'hypertext' links between cards was achieved by highlighting, in the relevant colour, text on one card that matched the title of another card, and participants had to turn over a card in order to read it. The experimenter was nearby to help or answer questions, if required. The sessions were recorded on video, and participants completed forms for website evaluations and a post-session questionnaire.

Nearly all participants used the cards carefully and conscientiously to structure their search session. The simple post-session questionnaire yielded 12 positive responses to the question 'What did you like most about the session?' and a number of useful pointers for improvement were obtained in response to the question "What did you like least about the session?". In reply to the question, 'Did the session help you find something useful or interesting?' the average score was 4.0 (where 1 = strongly negative & 5 = strongly positive); and in reply to the question, 'Did you learn something about web searching?' the average score was 4.3. These results were encouraging and indicated viability of a website version of the Guide.

Pilot Evaluation of an Initial Software Prototype

An initial prototype of the Web Search Guide website was evaluated during May and June 2002. It consisted of about 30 documents & forms written in HTML and PHP, and it was run in a separate browser window from the one in which the actual web search was carried out, so that normal browser functionality, such as 'Back' and 'History', could be applied to the search activity and the Web Search Guide independently.

9 undergraduate or A-level students, studying either Cognitive Science, English, or Maths, were given a task related to their course and allowed 30 minutes for the search; and they completed pre-test and post-test online questionnaires, and online website evaluations. For the 5 Cognitive Science students, the students' website evaluations were compared with a postgraduate tutor's evaluations of the same websites, and for the other students, the experimenter took the role of the more knowledgeable peer.

Preliminary results indicated that students who used the control version of the software were more confident that they had found useful task-relevant websites than those who used the test version; but that those who used the test version were more 'accurate' than the control group in their assessments of websites' relevance, where 'accurate' is defined as closeness of their ratings to those of the more knowledgeable peer. These results will be tested more thoroughly during the larger-scale evaluation.

Plans for a Larger-Scale Evaluation of the Software Prototype

The main evaluation study is planned for October-November 2002 and it aims to repeat the pilot study, with 30 first-year undergraduates all studying the same course in a non-scientific domain such as English. Some of the minor problems discovered during the pilot evaluation will have been eliminated; and the different conditions more carefully designed, to test the hypothesis that students who engage in metacognitive activities will be (i) more likely to have an accurate opinion of the relevance of the web pages they find, than students who don't, but that (ii) they will be less confident in the relevance of the results (i.e. more critical).

Screen shots of the Web Search Guide will be presented during the workshop. In summary, the complete version provides the searcher with

(A) an external representation of a framework of stages, through which the learner is asked to work iteratively - (1) defining a topic (2) defining a question (3) deriving keywords (4) deciding on a search engine (5) passing the keywords to the search engine and running the search (6) examining the results list (7) selecting web sites to view and evaluate, and (8) exploring links from a web page;
(B) stage-related information and guidance, available via 'More' links;
(C) general help with Web searching, available via a 'Help' button;
(D) interactive components for the learner to record decisions;
(E) opportunities to reflect on their strategy, available via a 'Review' button;
(F) pre- and post-test questionnaires, and online forms for evaluating websites.

The reduced version of the Web Search Guide lacks all metacognitive components but provides practical assistance in web searching. The control condition provides no guidance, but includes the pre- and post-test questionnaires and website evaluation forms.

Possible Future Work

Data recorded during the experiment will be used to form the basis of a scaffolded version of the Web Search Guide, in which the assistance provided by the software will be related to the level of expertise of the individual learner.

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Virtual Learning Environments for Children with Autism

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Abstract

This paper presents research concerning a novel virtual learning environment designed to help children with autism develop empathic understanding useful to them in the real world, including emotional recognition and predicting others' thoughts. The system is based on accepted autism-specific pedagogy, specifically "social stories" and seeks to provide realistic learning scenarios.

Keywords:

Autism, Theory of Mind, Empathy, Social Story, Virtual Environment.

Introduction

Autism is a neurodevelopmental disorder characterised by a triad of impairments: in communication, social understanding, and rigidity of thought (Wing 1996). It is often held that a "theory of mind deficit" (ToM) underpins this triad. At around 3-5 years old, most children are able to make the link between people's behaviour, intentions, desires and beliefs (Harris 1989). Otherwise, children with autism have a specific delay in the development of a "theory of mind" and hence may have a lack of empathy (Baron-Cohen, 1993; Frith, 1989, Howlin et al. 1999). In other words, unlike 'normal' children, children with autism do not develop an understanding of mental state concepts in the natural course of their development (Howlin et al. 1996).

Howlin et al (1996, 1999) argue that children with autism can be taught to understand emotions and belief, and hence overcome the ToM problem. They can also be taught to judge a story character's emotion when this was caused by a situation in the story (Howlin et, al, 1999). One specific approach for teaching empathic understanding involves "social stories" (Gray 1994, Gray and Garand 1993, Swaggart et al. 1995). Of particular interest from the point of view of ToM, the *perspective* aspects of a social

story describe a person's thoughts and feelings in a given situation and explain the consequences of those emotions on the thoughts of others (Attwood, 1998).

Therefore, the research is novel in that it addresses one promising use of computer technology not so far much studied, namely virtual environments. The research is also novel in that it seeks to encompass questions about the user's *own* mental states, and to adopt autism-specific pedagogy as its theoretical basis.

Virtual Environments for children with autism

A Virtual Environment (VE) is a computer-generated, three-dimensional environment that aims to "surround" the user so that he or she becomes part of the experience in a simulated environment (Cromby, et al. 1996) and potentially allowing the transfer of skills from the virtual to the real world. Moreover, Gantz, Durlach and Glantz, (1996) point out that VEs have much potential for the simulation of human social interaction, and since children with autism are lacking social interactional skills and often find being with people quite stressful (Leicestershire County Council. 1998), this further suggests VE will be useful. It might be noted that one of the strengths of VLE is the potential to empower children with autism by giving them immediate and direct control over their own learning experience (Parsons et al., 2001). This makes these learning experiences feel less threatening than the "real world".

A new VE for autism

Our work aims to contribute to the research effort discussed in the previous section, by building and evaluating an interactive Virtual Learning Environment to improve empathic understanding amongst children with Autistic Spectrum Disorders. The following three aspects of ToM will be addressed: (a) *Situation-based emotions.* Concerning whether a particular situation would make a person feel. Since autism involves a difficulty with "self-disclosure" and "sense of self" (Cumine et. al., 1998), that is, talking about one's inner feelings (Attwood 1998), the question of one's own feelings relating to certain circumstances is also relevant here. (b)*Desire-based emotions*. Concern the principle that someone getting what they want is likely to make them happy and not getting what they want is likely to make them unhappy (Howlin, et al., 1999). (c) *Belief-based emotion*: Concerns the principle that beliefs can make a person happy, angry or sad (Howlin, et al., 1999).

Users are given questions involving appropriate emotional responses. Role-taking has

already been suggested for VE use (Moore et al., 2000), and in this research will be used by the children in acting out situations involving emotional reactions (cf. Cumine et. al., 1998; Leicestershire County Council, 1998); the role-taking concerning interpersonal understanding involves "thought bubbles" (cf. Rajendran & Mitchell 2000).

A further innovation is straightforward but potentially significant. The tendency in social stories and "mind-reading" exercises is to present a story or scenario and discuss with the child the resulting facial expressions and underlying emotions. Further, the aspect of the work will enable us to study how children with autism make sense of and relate to expressions of emotions as represented in the characters populating the VLE. Lessons from this will underpin a further innovative aspect of our research, namely the study of how people with autism can make use of *collaborative* virtual environments (CVE). In a CVE geographically dispersed users communicate with each other via their avatars – their on-screen representation or "embodiment". We argue that lessons about emotional recognition in the VLE can and should inform the design of avatars for CVEs for people with autism.

The evaluation of educational interactive systems such as our VE is a difficult issue (Moore and Taylor 2000). We propose ultimately to use a suitable instrument to study our systems as used initially by children with high-functioning autism. Results are expected to provide us with valuable guidelines for the systematic empathic development of the VLE.

Summary

Virtual learning environments potentially offer predictable and repetitive environments and hence many potential benefits for children with autism. Our VLE system provides a representation of scenarios representative of real-world demands that children with autism are often faced with. In this regard, it is hoped that our VLE system will be of significant benefit for the very specific needs of children with autism and that the approach will have a direct impact on the development and design of new VLE and CVE for children with autism.

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"The system should speak the users' language." An investigation into users' language.

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Introduction

> *Heuristic: Match between the system and the real world*
>
> The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order. (Nielsen 1994).

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

My DPhil research has focused on people's use of the Internet, the web and other networked technology. By carrying out long and short-term field studies of helpdesks around the UK (e.g. Rimmer & Wakeman 1999), I found that many callers used mismatched language to describe their problems. Frequently, they did not seem comfortable using language that was composed of system-oriented terms. Often callers couched their language in non-technical terms, which needed to be clarified and translated by the expert. It was apparent that incompatible language contributes to user frustration, disappointing user-experiences and the necessity for helpdesks; a waste of time for both user and service provider.

An experimental lab study was contrived which presented participants with a trail around the Internet that was sabotaged with typical network breakdown situations, thus hindering their tasks. The study explored user strategies for overcoming these obstacles and examined the language the participants used to explain these problems. Their descriptions were based on their own knowledge coupled with the language presented within the interface. There was indeed a problem, a mismatch between the knowledge and expectations of the user and the language of the system (see Sheeran, Sasse, Rimmer & Wakeman 2002).

Having established the problem space of the thesis, in that whilst using the Internet a language mismatch can be detrimental to both user and service provider, the solution is to demonstrate techniques for the usability practitioner to investigate the user language. This can then be used to inform the language used within the system design. However,

investigating user language can be problematic. There is very little research within the HCI literature regarding the investigation of this language. Therefore this thesis investigates methods to capture and analyse this language drawing, in particular, upon discourse analytical techniques.

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

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

Flash Cards
This approach was a variation of the card sorting techniques used by researchers often to look at hierarchies and grouping of words from a consumer's perspective. It is grounded on the idea that the organization of information on user interfaces should be based on the cognitive models of users rather than the intuition of designers. Single word flash cards were used to prompt explanations both in and out of a 'network' context.

Error Messages
A variety of messages produced by popular web-sites were scrutinised by expert evaluation as well as interviews with network users. This revealed that standard error messages have a poor construction, which goes against most (if not all) of the guidelines for writing effective error messages. A critique of the different styles of dealing with errors is presented and a checklist of design considerations for use by web designers and site managers that pay close attention to good customer service and experience is provided (see Rimmer, Wakeman, Sheeran & Sasse 2000).

Contemporary Legends
Contemporary legends were collected as a method for gathering information about users' background knowledge and experience - the first step in conceptual design. Contemporary legends are products of people's need to channel their insecurities and fears about the world around them into something concrete, and can therefore help us identify the issues that are important to a group of users. These were used to elicit users' existing knowledge of computer networks. They showed the misconceptions and fears, especially of computer viruses, which exist among Internet users. Addressing these fears and misconceptions in future network applications will ensure more confident users who are less likely to waste valuable resources (see Sheeran, Sasse, Rimmer & Wakeman 2000).

Drawings
Having shown that adults have a poor understanding of how the Internet works, how do we expect parents and teachers to impart the correct information to children? Longitudinal research was carried out that gathered children's drawings and explanations of how the Internet worked. Drawings proved to be a valuable resource when eliciting explanations from

children which was perhaps less intimidating than an interview without 'props' (see Rimmer 2000, Luckin, Rimmer & Lloyd 2001).

Repertoires

This entailed analysing the texts gathered from interviews, think aloud protocols and authored accounts using the tools from discourse analysis. This can be used to capture these lexicons, and show how they vary according to the function of the text. Analysis showed a variety of repertoires used to describe typical network applications, such as Email and Web use. These repertoires are presented and a description of how they can be used in the design of the user interface is given (see Rimmer, Wakeman, Sheeran & Sasse 1999).

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

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Towards an Interface that Effectively helps in Relieving User Frustration

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Introduction

How can interaction be improved for users at the computer interface? Traditionally users interact with a computer through Direct Manipulation, through the use of point and click affordances. Adding Intelligence and Adaptability to the interface has been seen as a step forward in enhancing usability for the user at the interface (Hook, 1999).

It is also common that users can be frustrated (Amsel, 1992) at the interface and it is possible to improve interaction by introducing a more recent innovation known as Affective Computing, which takes into consideration the users emotional state.

This paper describes a project that will look at ways in which to help relieve user frustration at the interface, when detected. The project will critically review and evaluate work in this area and initially carry out an experiment based upon work that has already been done (Klein, 1999). The experiment uses an agent that displays active listening, empathy and sympathy skills in order to relieve frustration. Results of this experiment will aid the design and development of an interface/agent and future experiments.

Background

Interaction at the interface can be improved by giving computers the ability to detect and respond to, in an appropriate way, the users emotional state. This is the goal of Affective Computing, which has been defined as "computing that relates to, arises from, or deliberately influences emotions" (Picard, 1997, p.3).

Picard (1999) proposes that we should give computers the ability to recognise, express and have emotions, and discusses four broad areas of Affective Computing that relate to HCI those being:

1. Reducing User Frustration
2. Enabling Comfortable Communication of User Emotion
3. Developing Infrastructure and Applications to handle Affective Information
4. Building tools that help develop social-emotional skills

The paper highlights recent and ongoing work that is being carried out at the MIT Media Lab. Such work in Affective Computing includes developing systems that gather and analyse physiological signals to detect a users emotional state. Physiological states include measuring user respiration, heart rate, pulse, temperature, galvanic skin conductivity etc. It is

from the results of these measurements that the users emotional state at any time can be monitored.

Once users negative emotion has been observed agents are then used to help in trying to reduce user frustration. Klein (1999) in his thesis describes an agent that actively helps relieve user frustration. The Agent used social emotional content feedback strategies, which are used by human listeners. In this thesis evidence has been provided that users can benefit from a computer that responds in a socially appropriate way using the following techniques, active listening (Scarnati, 1998), empathy (Hodges and Klein, 2001) and sympathy skills.

Affective Computing can be used within the context of Intelligent and Adaptive Systems in order to create applications that can truly meet all of the users needs at the interface from the users goal state through to their emotional state.

Initial Experiment

The first experiment will be a repeat of Klein's (1999) Computer Response to User Frustration. Within the original experiment, which was in the context of a game, the system frustrated users by including delays within the game. The three therapy condition's that were used were a Control condition, which did not allow user's the ability to express their feelings. A Vent condition, which allowed users to vent their feelings at the computer and the last, was the Casper agent, which demonstrated social, emotional context feedback strategies, which included demonstrating active listening, empathy and sympathy skills. The results showed that the Casper Agent was the most effective than the other two controls in reducing the users frustration levels.

The experiment that I will be conducting will be very much similar to the above experiment, but will be conducting within a different context. Subjects will be using Microsoft® Word 2000, and the task will be to copy and paste information from a file into a Newsletter Template. After which subjects will then have to format the pasted text. To elicit frustration in the subjects the text will automatically change randomly without any interaction from the user such as the text font and size changing. Spaces being inserted tab indents increasing and text being deleted or moved.

The three therapy conditions will be the same as above. The measures that will be used will be behavioural. Users Self-Report will be gathered on how they are feeling. Also the time users spend on the last task will be recorded and their quantity and quality of work produced will be marked. The outcome of this experiment will help in determining the next experiment to be carried out and future work.

Further Research

The Casper agent that was implemented above was a text based agent it did not display any human characteristics, therefore I will be looking to use an agent that is more human like and incorporate within this agent Emotional Intelligence (Goleman, 1996). The context will still be within Microsoft® Word 2000, but maybe within the Microsoft® Word Help System since this may be a more unobtrusive way to interact with the user if they have requested help themselves.

The answer may lie in an interface that displays the following competences: -

1. The interface detects the user frustration.
2. Offers the user help whilst displaying emotional intelligence.
3. Carries out intelligent help if requested.
4. Clarifies with the user through users feedback or automatic detection of the users emotional response that what was implemented was correct.
5. Adapts itself for next time.

Given the above the system has to have the ability to help in reducing the users frustration but also must help the user in completing their original goal. If not the user will still have a problem that could still induce frustration, and the experience at the interface will not be as engaging for the user (Rizzo, 2000).

The outcome is an interface that can reduce user frustration and help the user in reaching their goal. An interface that can meet these needs will be Intelligent, Adaptive and Emotionally Intelligent.

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Modelling the motivational state of the learner in a Vygotskyan inspired ITS.

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Abstract. An analysis of the influence of motivation on the ZPD is being carried out. To investigate the impact of motivational factors on the ZPD, the inclusion of a motivation differentiator layer into the Ecolab (Luckin 1998) is proposed. Mechanisms to measure the motivational state of the learner and apply motivational strategies to adjust them for individual pupils are outlined. The main research question on which this proposal is centred is: Does this relationship identified between the ZPD and theory of motivation help the pupils in terms of their learning?

1. Introduction.

Tutoring Systems are being used ever more as a way to fulfil the users´ needs for high quality education at low cost and as tools to augment classroom learning environments (Reiser 1992). Although the convenience and potential effectiveness of such systems is not in question affective aspects of the learner's motivation have been largely overlooked. Some proposals (Minsky 1985; Picard 1997) have appealed to researchers leading to the design of Tutoring Systems that add affective features (del Soldato and du Boulay 1995). This paper discusses the creation of a motivational module in a Vygotskyan inspired ITS (Luckin 1998). The relevance of the work proposed here lies in the relationship of the concept of the 'Zone of Proximal Development' (Vygotsky 1978) with motivational variables. Although such a relationship is not directly addressed by Vygotsky it is argued here that some motivational aspects such as effort or confidence are implicit in the ZPD. This relationship is made explicit in this proposal in order to be able to include a motivational module into the Ecolab (Luckin 1998). Another important aspect of this proposal is the claim that the use of motivational strategies could increase the degree of development of the child within the ZPD. In order to do so, a relationship between metacognition and motivational variables is established and a mechanism to measure the motivational state of the pupil is proposed. The main research questions governing this investigation are: Does a relationship exist between Vygotsky's ZPD and the theory of motivation? If so, how do they relate? Is it possible to apply motivational strategies within the ZPD? And with regard to a Vygotskyan ITS, how is it possible to scaffold motivational issues? How is a motivational state measured? What is the rationale for this change? Could this motivational module cause learning gains in pupils?

2. Research Proposal.

To address the gaps in previous research an investigation is proposed into the role of motivation within the ZPD (Vygotsky 1978) which implies both the role of motivational variables and motivational strategies to further develop the Ecolab (Luckin 1998). An investigation about the relationship between the ZPD and motivational variables is described next to suggest that with the use of motivational techniques common in instructional design (Keller 1983) it is possible to enlarge the Ecolab so as to scaffold the motivational techniques and adjust them according to the motivational needs of the learner.

It is proposed here that the learner model in the Ecolab can be extended with the maintenance

of a motivational tag which will be useful to decide whether to use some motivational strategies or not. This tag represents the relationship between motivational variables and the concept of the ZPD. This relationship can be addressed considering Vygotsky's (1978) definition: The ZPD refers to the discrepancy between the child's actual mental age and the level he reaches in solving problems with assistance. Vygotsky emphasized the difference between learning and development which are neither separate nor identical processes; teaching and learning play an important role in the development of the ZPD.

Metacognition indicates the degree of self regulation and awareness of the learning process which is desirable in children learning within the ZPD. Self regulation involves a clear mastery of the task at hand and a high degree of independence from the more able partner. It also implies high degrees of confidence and control over the learning process. In principle it is possible to argue that high displays of three motivational variables: effort, independence-control and confidence are all characteristics of developed children learning in the ZPD. However, higher degrees of these variables are seen in children after the process of learning with a more able partner has taken place. If this relationship is true, the duty of the more able partner is to increase effort as well as feelings of independence – control and confidence during the learning situation, hoping to maximize the child's potential within the ZPD.

Modelling motivation within the ZPD.

The analysis of the motivational variables within the ZPD seems to relate these variables in a coherent way. However, if this relationship is correct, how could these variables be measured in the context of the ZPD? What can be done to increase the value of these motivational variables? Does this increment affect the child's development in the ZPD? Is it appropriate to increase these values within the ZPD at all?

It was thought that the rules proposed by (de Vicente and Pain 2002) constituted the most interesting proposal regarding motivational measurements, unfortunately these inferred rules are not available yet. The motivational tag proposed here is made up by three elements: effort, independence - control and confidence (referred as E, IC and C respectively). The calculation of these values is carried on considering that effort is a function of the learners' ability, independence and persistence during the learning situation. Independence – control is calculated considering the degree of collaborative support provided by the Ecolab and the degree of challenge that the learner undertakes and finally, confidence is directly proportional to the degree of challenge that the user is willing to take. So the measurement of a motivational state at a given time will be carried on following the formula (E+IC+C)/3.

This motivational state will be the base for a motivation belief tag use to model the motivation of the learner within a decision belief network which is the main component of the motivational layer proposed that used in the frame of decision theory (Russel and Norvik 1995) will provide the motivational layer with a set of techniques to choose the action that yields the highest expected utility (i.e. better motivate the learner) averaged over all the possible outcomes of the action.

Rather than taking control over the learning situation, the motivational layer will use information in the model of the learner already provided by the Ecolab (Luckin 1998) in terms of level of abstraction, activity differentiation and world differentiation to activate strategies at the level of learning which has been already reached by the student within the Ecolab. The content of the learning activities will remain the same but the activation of

strategies would alter their presentation to adjust them to the learners' motivational state if that is necessary.

3. Discussion.

It has been suggested that the notion of the ZPD by Vygotsky does not take into account motivational issues. It is assumed that this apparent lack of consideration of motivation is not a flaw in the ZPD theory but rather it is assumed to be true if two conditions happen: that the learning situation happens in a social context and two people take part in it, a pupil and a more able partner and that the more able partner, being so, is knowledgeable enough to pull the pupil's learning within the ZPD possibly with the use of motivational strategies if it were necessary.

In the previous sections an attempt to reinterpret the ZPD considering motivational theory was carried out; this reinterpretation resulted in the notion that metacognition implicitly assumes motivational variables. A new motivational belief tag in the Ecolab is proposed to expand the learner model to acknowledge motivational issues within the ZPD. This tag would use some of the values already maintained in the Ecolab plus some new ones.

If the Ecolab is going to be further developed to consider motivational issues, then it should include a new layer, the motivational differentiation which would measure the motivational state of the learner. This proposal argues for the explicit consideration of motivational issues in a Vygotskyan inspired ITS focussing particularly on the influence of effort, independence – control and confidence identified as key motivational variables influencing the learning process within the ZPD. It is suggested here that the use of motivational strategies and techniques will enable the Ecolab to be a more able partner which considers affective issues.

The social and cultural orientation of the Ecolab makes it a particularly suitable ITS to consider affective issues such as motivation. Ecolab is strongly rooted in the philosophical foundation of integrated apprenticeship of younger members of society (Luckin 1998) and assists children through differentiation of activities and help provision. However, as human tutors are aware of affective issues in their pupils and react accordingly, it is suggested here that the set of motivational strategies proposed for the Ecolab would make it a more robust ITS fostering the possibilities of the Ecolab giving it the potential to deal with a wider variety of learners.

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Day two – Sessions 3 and 4

What do we mean by digital technology and how is it changing?

FIELDWORK IMPLICATIONS FOR THE DESIGN OF DIGITAL MOBILE INFORMATION AND COMMUNICATION TECHNOLOGY

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Introduction

The digital revolution continues to flourish in all facets of our lives and nowhere more so than in the realm of work. The development of current digital technology is advancing at a dizzy pace with technological innovations such as Bluetooth, General Packet Radio Service (GPRS), Global Positioning System (GPS) and 3G all vying for inclusion in future mobile information and communication technology (MICT). Given the fast changing nature of the workplace - in a time of hot-desking, tele-working, increasing mobile work and constantly evolving desktop technology - there arises three challenging questions to be addressed:

- Are designers of digital tools – particular mobile ones – taking into account appropriate models of human cognition and naturally emerging work practices?
- What methods are available for understanding and modelling the activities of users and their communities that take into consideration the wider information ecology when designing for new technology?
- How can designers effectively exploit the array of innovative technologies available to meet the informational and communicative needs of dynamic and fragmented users and their communities?

With our research we set out to explore some answers to these questions by carrying out two inter-related fieldwork studies - one focused on observing locally situated and distributed working practices; the other looking at collaborative mobile work. This paper outlines the **background to our research**, provides a brief account of the **methodological approach** employed in our fieldwork, outlines some **key observations from the studies** and, finally, discusses the **implications** that emerge from those observations with respect to the design of future MICT.

Background Research

In the past, mobile device development has often been driven by the frequent advances in hardware components and protocols; rather than by the needs of those who use the technology. Fieldwork in this area has been useful in drawing attention to this anomaly. For example, Luff and Heath [8] described the shortcomings of a mobile device for digitally recording work records on a building site, highlighting how the use of this technology actually led to immobility for the user. Ethnographically inspired fieldwork, such as Bellotti and Bly's [2], have also shown how useful short spells of fieldwork can be to providing insight into the work and communication practices of locally situated and distributed workers. More recently, Perry et al. [10] have used fieldwork to draw out the coping strategies that mobile workers use in resource impoverished environments.

With the affirmation of HCI and CSCW as valid complementary research areas in the design of new technologies, greater attention is now being paid to both the cognitive and the social aspects of users and their communities to aid a more holistic approach to user-centred design [1]. Drawing on previous analysis of collaborative situations [7; 11; 6], one of the goals of our inter-related fieldwork was to highlight how technology is currently being envisioned and designed without taking into account embodied and environmentally embedded cognition [4]. We chose to *adopt* the

concept of *breakdowns* [13], to stress the disruption that artefacts can cause to the natural coupling that human beings establish with external and internal resources.

Methodology

We embarked on two inter-related field studies with the objective of opening a window of observation on two different, but complementary, scenarios of work: locally situated collaboration and mobile collaborative working practices. The locally situated collaboration focused on three design teams in fixed and distributed locations; while the research on mobile work looked at collaboration in knowledge work in a variety of remote and mobile settings - such as at airports and on trains.

Observations

Situated and distributed study: The dynamic work practices in our situated and locally distributed study was characterised by the generation of "creative contents" (concept design of information appliances, architectural and engineering specifications). This generally occurred without the support of computer or communication technology but instead focused on paper based artefacts as a medium for enhancing collaborative activities. One of the teams under observation devised the exploitation of a large collaborative area, the "project space", where information was embodied in artefacts supporting team activity. For the other two teams there was no available space solely dedicated to their projects and they needed to meet in temporary collaborative workspaces to perform casual as well as scheduled meetings. The lack of an external meeting space meant that members of both teams were forced to plan well in advance the procedures and the means through which collaboration would be accomplished.

Mobile and remote study: Collaborative work involving mobile technology was observed as often characterised by the substitution of the tabletop for the desktop. Mobile workers identified a need for a flat surface to work on before beginning to work and were seen to make a conscious effort to locate one - even if that meant using unconventional working areas such as tables in restaurants and bars in airport lounges. During our observations the mobile phone allowed the most flexibility of behaviour for 'on the move' workers due to its relatively small size (enhancing easy portability) and because the device could be used efficiently even when the user was focused on other events in the environment. However, any kind of combined use of devices such as a mobile with a laptop meant once again users having to seek out a tabletop surface to work on and if none was available adopt a seated position to balance their technology on their laps.

Findings and Implications

We can see from the observations of our inter-related fieldwork that technology often forces users to plan [12; 5] in detail before performing activities. However, planning is a cognitively expensive process for human beings because, we argue, the human condition is one of an emergent and distributed intelligence. Looking at our observational data, we witnessed that the design teams' activities were centred on low-resolution technology. We can argue this is because paper-based artefacts are more malleable, do not require the configuration of fixed working practices and, finally, put fewer constraints on emergent decision making processes. We also identified that *external scaffolding* in the environment, demonstrated by one of the project teams, was a key factor in developing an alternative strategy for supporting collaboration without overloading internal mental computation. Similarly, in our mobile work observations, we noted that mobile technology often failed to reinforce the natural relations a user establishes with their environment in order to achieve their given objectives. Instead, we observed mobile device users being forced to plan *a priori* their work activities as they hunted a table-space to occupy - ultimately leading to

immobility on their part. Reflecting on the fieldwork as a whole, we repeatedly observed '*breakdowns*' caused by the current manifestations of mobile technology, i.e. activities needing to be highly re-organised around the constraints of the MICT; disrupting users' attention and weakening the relationship that they naturally establish with their surroundings to realize their goals. Therefore, instead of being free to work 'anywhere, anytime' users were limited by the patterns that *closed-in* artefacts create. From our observations, we can conclude that current MICT fails to map efficiently the natural work strategies that users have developed over time and, in particular, they do not allow democratic access to artefacts in work activities: they neither provide support for multiple-users' control nor share-ability of devices among users.

Conclusions

One response to the above problems of current MICT, we maintain, is that new mobile digital technology needs to be designed to fit into an account of human action as instances of emergent distributed intelligence [9], where the powerful ally of physical, social and cognitive dimensions constitutes the strength of our nature, which technology should enhance rather than, as at present, disrupt. In this way, distributed cognition [7; 6] is a useful modelling tool to allow us to successfully model cognition across actors and artefacts in the environment. Likewise, another fruitful avenue which we are exploring at Brunel for developing user-centred mobile technology, is the methods of Contextual Design [3], allowing us to understand and design for the user and their communities in context using techniques such as affinity diagramming and workflow models. In conclusion, based on our fieldwork, we propose a re-focusing on design approaches for MICT that hone in on the *emergent* properties of human intelligence and behaviour. New technological artefacts should respect and enhance these properties, becoming part of the virtuous and natural cycle of interaction through which human beings shape their environment and this environment, in turn, empowers and augments their potential for effective communication and collaboration.

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Goal elimination: The role of feedback in cyclic interaction

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What is feedback?

An important part of interactivity in any system comes from the feedback that it provides for the user. The system should continuously inform the user about what it is doing and how it is responding to the user's action, thereby removing any doubt about the state of the system. If the feedback is inadequate, then the user will be unable to take their next action, or, plan their next goal.

Recommendations with regard to the implementation of feedback (e.g., Shneidermann, 1998) have concentrated on cases in which users cannot see the progress towards the completion of actions. However, the benefit of feedback can be observed in other interactive situations. For instance, consider the kind of feedback found in the DOS environment, when a user types 'del my.doc' to delete a file, and the system responds with a new command-line prompt. The new prompt is feedback, however, one cannot identify whether the file was deleted. Here, feedback is provided only with respect to the lower-level goal of typing a syntactically correct command (Preece, Sharp, Benyon, Holland, & Carey, 1994). In this sense, the concept of appropriate feedback should embody an explanation about how feedback is used in working toward the completion of a goal (i.e., goal reorganisation from feedback) as well as an evaluation of a single action. This paper reports an empirical study and a way of modelling how users employ system feedback as they perform a given task.

Empirical understanding of goal-elimination through feedback

An experiment demonstrated the importance and the notion of goal-elimination process through feedback. The purpose of the study was to examine the effect of system feedback in eliminating goals. The participants' task in the experiment was to switch off three sound-related functions (i.e., keypad sound, ringing tone, and message alerting) on a simulation of a mobile phone.

The experiment conditions are depicted in Figure 1. In the *IF* condition (standing for Implicit Feedback), there was no visual feedback that the participants had switched off the sound function on the display as they changed a setting. In contrast, the *EF* conditions (standing for Explicit Feedback) provided a corresponding visual feedback. Three different kinds of temporal duration regarding the EF conditions were investigated: 1 second, 2 seconds, and 5 seconds as showed in parentheses in Figure 1. The temporal difference was expected to show a practical implication of the design of feedback, in that industry has adopted different temporal duration on feedback, for instance, Nokia™ shows feedback for 2 seconds, whilst Ericsson™ over 3 seconds. The dependent variable was the number of revisits to sound-related functions, in other words, how often users tried to do a subtask twice or more, thereby serving as an indication that they still have the goal activated. The main hypothesis was that explicit feedback with sufficient temporal duration would result in better goal-elimination than implicit feedback.

Table 1 gives the number of participants successfully completing setting the three sound functions to off. As expected, explicit feedback gave higher success rates than implicit feedback, but there was no significant difference between the EF conditions on this measure.

Figure 1. Two experimental conditions: IF, EF(1). The other two experimental condition, EF(2) and EF(5) are the same with EF(1) except the time of displaying feedback, 2 or 5 seconds, respectively.

Table 1. The number of participants who succeeded the overall goal 'set three sound-related functions to off' and the number of participants who revisited at least one sound-related function

	N	Success	Revisit
IF	23	7	22
EF(1)	23	16	15
EF(2)	23	17	15
EF(5)	23	21	10

Table 1 also shows the number of participants who revisited at least one sound function. Participants in the IF condition frequently revisited the functions that they had already set to off. All but one participant in the implicit feedback condition had at least one revisit. In the EF conditions only about half made revisits. These results suggested that implicit feedback did not help subjects to recognise the completion of their subgoals, in that they would repeat the task they had performed; whilst there was no significant difference between the EF conditions.

It is possible to make sub-categories for the types of revisit. Specifically, one could ask how often a participant revisits one sound function immediately after setting it. This kind of revisiting pattern implies that a subgoal is still present because of poor feedback. Table 2 contains figures only from participants who revisit at least one sound function in Table 1. It is notable that the IF and EF(1) participants who made revisits had similar means on this measure. Significance tests group IF with EF(1) and EF(2) with EF(5).

Table 2. Mean frequency of revisits to one sound function immediately after visiting the sound function

	N	Mean	Min	Max	S.D
IF	20	1.55	0	3	.74
EF(1)	13	1.33	0	2	.72
EF(2)	10	.80	0	2	.17
EF(5)	7	.58	0	1	.51

These results supported the goal-elimination hypothesis through feedback. Furthermore, it can be seen that the timing of feedback can influence the effect of feedback, in that one second was sometimes not enough to eliminate the goal even when the explicit feedback was presented. In summary, these results suggest that only explicit feedback with sufficient temporal duration lead to appropriate goal-elimination process.

Understanding goal-reorganisation process from the perspective of cyclic interaction

We are developing a notation with which a designer could reason about the interactivity of a new user interface. This follows the cyclic interaction approach (Monk, 1998) and can describe the goal-reorganisation process in the experiment above: The environment constructs another goal 'Specify OFF', which leads to the next action 'Scroll down' in IU i of both Table 3 and 4. However, in the case of the IF condition goal elimination must be triggered or reasoned by *recall* of the previous action without the help of the environment (see IU i+1 in Table 3), in contrast, in the case of the EF conditions the user can *recognise* that the function has been switched to off (see IU i+1 in Table 4).

Table 3. A cyclic notation for setting key-sound off in the IF condition

	Environment		Current Goal	Recognition/ Recall/Affordance	Change to Current Goal	Action
	Most Recent Change	Other Information				
			Set OFF Keysound:			
IU i	[START *From MenuHeading(Keypad)* Visible; *MenuItem(ON)* Visible; *MenuItem(OFF)* Visible:]	-	Set OFF Keysound:	Recognise *MenuHeading(Keypad)*; Recognise Highlighted *MenuItem(ON)*; Recognise *MenuItem(OFF)*; Affordance Click *Button(∨)* --> *OFF* Highlight:	(+) Specify OFF:	Click *Button(∨)*:
IU i+1	*MenuItem(ON)* Disappear; *MenuItem(OFF)* Disappear: *when* Click *Button(∨)*:	*MenuHeading(Keypad)* Visible:	Specify OFF; Set OFF Keysound:	Recall Click Button(∨):	(-) Specify OFF; (-) Set OFF Keysound:	[END]

Table 4. A cyclic notation for setting key-sound off in the EF conditions

	Environment		Current Goal	Recognition/ Recall/Affordance	Change to Current Goal	Action
	Most Recent Change	Other Information				
			Set OFF Keysound:			
IU i	[START *From MenuHeading(Keypad)* Visible; *MenuItem(ON)* Visible; *MenuItem(OFF)* Visible:]	-	Set OFF Keysound:	Recognise *MenuHeading(Keypad)*; Recognise Highlighted *MenuItem(ON)*; Recognise *MenuItem(OFF)*; Affordance Click *Button(∨)* --> *OFF* Highlight:	(+) Specify OFF:	Click *Button(∨)*:
IU i+1	*MenuItem(ON)* Disappear: *when* Click *Button(∨)*:	*MenuItem(OFF)* Visible:	Specify OFF; Set OFF Keysound:	Recognise Keypad OFF:	(-) Specify OFF; (-) Set OFF Keysound:	[END]

The cyclic modelling notation is able to account for the intimate connection between goal, action and the environment, allowing designers to make explicit what a process achieves, as well as what triggers that process. Such a representation allows designers to build interactive versions of the designs so as to assess the assumptions made or being made regarding the interaction between the user and the system.

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'SnapShots': A Household Visualisation and Planning Tool for Major Family Events

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ABSTRACT

This paper describes the development of a design methodology for informing the design of new technologies for the domestic environment that harness the potential affordances of broadband technology. With reference to one possible new broadband service, 'SnapShots', a prototype application is being developed. This is a household visualisation and planning tool for major family events and will be evaluated in a home setting. A primary outcome of the thesis is to outline usability issues for designing such artefacts together with discussing the socio-cognitive implications of being 'always-on' in the home.

OVERVIEW

My dissertation is concerned with using ethnographic findings to inform the design of new domestic artefacts, intended to help family groups collaborate and communicate more effectively. It is part of an on-going research project, looking at how to exploit effectively the capability of having broadband in the home. A series of field studies and interviews were carried out to find out what kinds of activities families carry out but which also require considerable time and effort and which could potentially be more effectively supported with a shared tool, that is always available to all.

Within the domestic environment there are a number of artefacts used to mark major family events and milestones as well as aid with time management and utilisation. For instance, the photo album or 'home video' collection is a pictorial record of major events (weddings, birthdays and/or other milestones), the diary is more of a personal and therefore, private artefact to help organise personal priorities (such as work, leisure and family time) as well as time allocation or for personal thoughts ('Dear Diary…'). Within the home there might also be some sort of shared artefact such as a calendar or possibly even a dedicated 'notice' are (i.e. refrigerator door or pin board) which will be used for communicating details of a shared activity, event or other relevant information (i.e. important extended family birthdays), as well as other personal activities that may impinge on mutual time [1]. This would seem an ideal situation to develop some form of device or service harnessing the affordances of broadband technologies in order to aid family member communication within the domestic setting. What I'm proposing is some form of virtual visualisation tool ('SnapShots') that forms a multimedia record of the event that can be shared and celebrated amongst family members as well as a means of organising and aiding communication for that event.

KEY OBJECTIVES

A key objective of my dissertation is developing an appropriate design methodology in order to produce useful artefacts, technologies and/or information appliances for the domestic environment. In particular, I am looking at broadband technologies and the key usability issues for designing 'always-on' services, applications and devices. Further, I am looking at the socio-cognitive implications of being 'always-on' in the home as well as looking at the

way it might change the way people/households carry out their day-to-day activities. The methodology I am using is to examine in detail one aspect of home life (i.e. planning for a major family event such as a wedding) and how the affordances of broadband technologies can support the activities involved in this and to inform what might be the most appropriate digital device or tool.

BACKGROUND

O'Brien, Rodden, Rouncefield and Hughes [2] undertook an ethnographic study of a number of homes in order to, 'highlight key aspects of the social dimensions of households relevant to the potential uses of new domestic technologies'. Their findings, with regard to the social organization of the home, were used as a focused framework for an in-depth field study undertaken as part of my research to compare the Internet usage of twelve households with broadband access. With respect to the social implications of this new technology within the home, the studies examined Internet usage trends and how these may have developed and/or changed now those households have 'always-on' capabilities rather than dial-up access. This was determined by conducting semi-structured interviews in order to define how the technology had been adopted into the social organization of the household environment based on four parameters as expounded by O'Brien et al. The main findings concluded that households with broadband Internet access spent significantly more time online and visited more sites than when they had regular dial-up access. The two main benefits of ADSL/broadband, as perceived by participants, were the permanent connection and speed. Other perceived benefits included the fixed fee, freedom to use the telephone line and, even, a social concern regarding the benefits of working from home.

FURTHER RESEARCH UNDERTAKEN

An ethnographic study was used to examine the process of planning major family events as well as organizing domestic life via the use of diaries, calendars and other artefacts within the home. The main findings showed that planning a wedding or other major family event can be a complex, stressful and time consuming process. There are a number of details to be worked out and everyone, from the in-laws to friends and more distant relatives, will all have opinions as to how the day should look and progress. For example, in terms of planning a major family event such as a wedding people prefer a bespoke approach that reflects their personality, likes and dislikes. As one participant noted when planning her wedding, "I actually found the flowers quite difficult as I like flowers and wanted something different – I wanted every detail to reflect me". This highlighted that many suppliers require a definitive idea of what is required in order to produce quotes etc. This is not always the case and many participants expressed that they had an idea or feeling or theme that they wanted but did not always have the means to express this. The findings suggest that there are many 'hazy' areas where members of the family need advice from suppliers or are at odds with each other as to how to resolve their problems. One design implication is to provide a means of helping them visualize their idea in order that these can be shared amongst involved parties or to be discussed amongst suppliers.

SNAPSHOTS

'SnapShots' is a prototype tool I have designed to enable users to plan and organize major family events such as weddings, family reunions and other milestones. It incorporates functions to aid the planning and organization of such events including temporal requirements (e.g. three months before the event you should be doing these activities…), 'to-do' lists, guest lists, prompts etc. but because of the higher bandwidth associated with

broadband it has been designed to allow users to do other things, like create their own visualization of the event. For instance, 'SnapShots' is based on the idea that all young girls (and boys) dream and picture from an early age what their ideal wedding will look like. 'SnapShots' enables users to create the image they have for their wedding or other event in a digital format which can be shared amongst friends and family members but also acts as a starting point to complement and aid the planning process. A prototype is being developed at the moment and will form the basis for field trials over the coming months.

SNAPSHOTS – DESIGN REQUIREMENTS

The design requirements for 'SnapShots' can be viewed in terms of the visualization functions of the tool as well as the planning and organizational capabilities. It is envisaged that the 'SnapShots' tool could be used collaboratively amongst family members (parents of the bride and groom, extended family and friends etc.) as well as potential suppliers (florists, caterers etc.). Although, 'SnapShots' will include this collaborative functionality it will be left to the discretion of the principal players (mainly, the bride and groom) to determine to what extent they wish to use these capabilities. The visualization capabilities of the 'SnapShots' tool serves two purposes but is also an integral part of the planning and organizational process. Firstly, it could be used to develop and build-up a picture of the proposed wedding which could then be shared amongst family and friends for comments but, more importantly, also given to suppliers as a basis for preparing quotes, as well as offering suggestions or alternative ideas. The design of 'SnapShots' recognizes that not everyone has a clear idea of the wedding they would like or find it difficult to visualize their perfect day, as one participant quoted, 'I think the florists that I approached wanted me to have a definite idea of what I wanted...but it was more a case of knowing what I didn't want'. 'SnapShots' would then offer the opportunity to work collaboratively and in conjunction with a potential supplier in order to design and develop the perfect day as well as automatically adjust any budgetary requirements accordingly. The schematic visualizations, of say, the reception venue, are included to help aid the organization of the seating plan but also to build-up a database of guest information. For instance, this might include personal details (names, addresses etc) as well as wedding appropriate information such as guest lists etc. The ethnographic information suggests that determining the seating plan can be a very difficult and stressful process as personal relationships can dominate (For example, Auntie X cannot sit on the same table as Uncle Y because…). Some suggestions have included taking into account guest's personal interests when seating groups' of friends or attaching 'magnetic' type forces to guests that will attract or repel depending on their vicinity in the seating arrangement. The 'planning and organizational' functions of the 'SnapShots' tool will be temporal based and will offer suggestions and prompts based on calendar requirements (for example, 'Six months before the event you should consider doing these activities…') and the creation of 'to-do' lists. Various checklists will also be available depending on the task. For instance, when considering appropriate flowers the checklist might include bride's bouquet, headdresses, buttonholes, corsages, the wedding venue, the reception etc. It is envisaged that any such purchasing decisions will automatically affect the overall budget, which will reflect the cost of the wedding thus far and will be presented as a budgetary spreadsheet for the information of those concerned at the discretion of the bride and groom.

FIELD TRIALS – EVALUATION

In order to evaluate the prototype during the field trials, appropriate use scenarios will be developed. At the moment, there are two distinct elements to the prototype: the 'visualisation' capabilities and the schematic view. Also, one major aim of the prototype is to

encourage collaboration and communication between parties. With this in mind, I have created some possible testing scenarios as follows:

Visualisations

- Participants are given the task of creating a visualisation. Ideally, this would involve participants who are in the process of planning their wedding to gauge how the prototype has helped them with the planning and organisational process.
- Participants create a visualisation but are given certain constraints. Again, following 'real-world' problems encountered when planning a wedding. For instance, constraints might include a fixed budget and/or a defined colour scheme and participants have to create the visualisation whilst taking into consideration these limitations.
- Collaboration – this would involve developing scenarios whereby two parties have to work together (for instance, suppliers and couples) to finish a task. Of course, as in the real world, one party may be privy to information that the other party may not be aware of such as which flowers will be out of season etc.

Schematic

- Similar to the visualisations, above, participants will be encouraged to use the prototype to hep them create a guest list and seating plan for their own wedding.
- When creating the seating plan using the schematic tool certain constraints may apply. For instance, Aunt 'X' cannot sit near Aunt 'Y' because…; or 'using a disparate number of friends how might you seat them appropriately?'. These scenarios could reflect real-life problems that people encounter when planning weddings.
- One of the aims of the prototype is to encourage collaboration and cohesive group planning. I want to set-up a task whereby a number of users have input to the problem such as creating a seating plan but each person has a different agenda/levels of information etc. Each participant will be remotely based and the only 'communication' between parties would be via the prototype.

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Multimodal Communication in Mediated Environments

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1. Research

The current research has been supported by fieldwork studies that have been carried out in engineering companies. The people who are working in such organisations have to cope with a large amount of workload, to work in multidisciplinary teams, with members from dispersed locations and at inconvenient time-basis. These people are described as mobile knowledge workers and are the experts within an organisation. There is increased demand for them but they are never in place because of the nature of their work. Therefore there is a sustainable need for communication and knowledge sharing among the mobile knowledge workers.

Nine semi-structured interviews plus nine role-play interviews based on extreme scenarios have been conducted in three organisations with mobile knowledge workers. The limitations of the media and more specifically the interface, was one of the issues that the fieldwork studies addressed. In such highly distributed environments, where common ground needs to be established between the different mobile users, the interface that follows desktop metaphor is inadequate because:

- The knowledge workers need a rather "direct" interaction with their colleagues, in contradiction to the access to information that can compromise with interaction between human and technology.
- The network-like organisation and team structures of the knowledge workers demand a more dynamic rather than a static interface of the desktop metaphor.
- Dispersed knowledge workers who are members of virtual teams assume dispersed knowledge worker communicative instances during the collaboration that might be more complex to one to one assignment to team members.
- Time and space loose their initial meaning and barriers in the mediated environment where the knowledge workers have to collaborate.
- The location of the resources, both human and informational, is diffused. It is not necessarily in a specific place.

As location, time and nature of work are something fluid for the knowledge workers, different ways to communicate with their colleagues are necessary in order to help with their expertise or participate in meetings. In these communicative situations the main issue is the way that technology can be used in order to manage the workforce that is not present. Moreover, there is a need for understanding how people use communicative modes and media in actual, concrete interactive instances of communicative practice.

In order to provide with different communicative modes, the design of different channels of communication is necessary between people who are not working in the same location, which is frequently the case of mobile knowledge workers in distributed organisations. To design such channels we need to visualise the people who participate in communicative situations, the circumstances they are in and the role they have under these circumstances, by using enriched computer interfaces, considering that 60% of the face to face communication is non verbal and actual words only account for the rest 40%. The fieldwork studies showed that the way knowledge workers select communication modes depends on the roles that they have under the specific circumstances. Therefore, the enriched interfaces should be able, apart from the relevant content, to promote individual's or team's identity, context and emotional situation.

One of the key findings of the fieldwork studies was that the first time meetings of knowledge workers should preferably not be mediated meetings, considering the available technology. It seems that it is very important for mobile knowledge workers, in order to establish common ground with others, to "specify" their identity. They need to conceptualise a portrait of themselves, of the others and of the team, both internally and externally. Identity manifests itself in visual elements, communicative instances or roles within a team or an organisation. It generally describes how a knowledge worker or a team describes itself. The knowledge technology, and more specifically the use of shared knowledge representations, plays a pivotal role for the formation of identity in mediated environments. A knowledge representation is a medium of human expression. It is most fundamentally a substitute for the thing itself, used to enable an entity to determine interpretations by thinking rather than acting.

In order for a shared representation to be meaningful, it should always refer to a specific context. The fieldwork studies showed that apart form the organisational identity the contextual information of the environment needs to be indicated. Context is a feature that needs to be promoted by the enriched interfaces. It may vary from absence of setting to the most fully articulated and detailed setting. Generally, the absence of setting lowers modality. By being de-contextualised in a mediated environment, a knowledge worker becomes generic rather than particular in space and time. On the other hand, full contextualisation might lead to overexposure to setting and therefore overexposure to unnecessary information for the knowledge worker activity. Alongside the outcomes of the research, a mediated space of knowledge workers should not replicate the physical circumstances, in which they are in, but it should be able to eliminate the disruptions and enforce the contextual information of their physical space. Towards this attempt, the multimedia, the spoken language, the memory and the visual display of information are all able to support with the necessary awareness and sharing of context.

But apart from the external context there is always an internal condition, emotional situation that may affect the collaboration with others. The emotional status of the people who participate in a communicative situation needs to be visualised through a systemic approach of the formal elements and structures of the visibility. Thus in the mediated environments, while the context needs to be kept at a balance in order to avoid the contextual noise, the emotional status needs to be represented in a hyper-real manner in order to overcome the technological limitations for communicating the emotional condition. Therefore, a behavioural observation and emphasis of the emotional status is necessary to be represented by the enriched interfaces.

In a more general level, the fieldwork studies addressed the way knowledge workers use space and technology and the way they interact with others while they are doing their work. Based on the outcomes of the fieldwork studies, the current research attempts to propose a system of mediated communication that integrates three elements: a multimodal interface, a set of representations and a dialogue system.

The current research investigated the grammatical elements of language versus visual communication, the way these can help in the understanding of concept and the way they are related to the context of the knowledge workers. Based on these elements, mediated communication needs a multimodal interface where the modalities are those natural to human conversation like speech, facial displays, hand gestures and body postures.

More specifically, the communication of meaning through images gained the interest of the research, considering that the culture is moving from language to image oriented and the knowledge workers need to be fast and efficient. Therefore, a set of shared representations of the interactive participants and the resources that they share as agents is necessary for a mediated system.

Finally the flexibility of communication modes in the form of language, image, music, sound, texture and gesture which could act either interactively or separately depends on the situation or the context that the knowledge worker is. The modality and multimodality in mediated environments, which is the result of the ability of the knowledge worker in the specific context to select, alter and combine communication modes, identifies the need for a dialogue system with verbal and non verbal functionalities that supports the context awareness.

Primary source of this research are literature review in the field of CMC and knowledge work as well as the outcomes of Human Environment Modelling based on the Common Ground Approach within the framework of a project for designing Sustainable Accommodation in the New Economy (SANE IST 2000-25257).

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INTEGRATING ON-LINE LEARNING TECHNOLOGIES INTO UK UNIVERSITIES

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INTRODUCTION

This doctoral research studies the response of two universities to the challenges and opportunities presented by on-line learning technologies. The contribution of this research in progress is to offer some conceptual foundations for considering activities associated with integrating on-line learning technologies from an organisation-wide perspective and to offer some preliminary themes for analysis suggested by initial work in the field. A review of existing literature finds the responses to on-line learning technologies from UK universities have fallen into three categories: individual departmental initiatives to use pedagogical technologies for a particular unit or programme of study; formation of strategic partnerships with private sector companies; and the founding of university consortia for the purposes of providing on-line courses (Collier 2001). Each of these categories represents a reconstitution of organisational and academic practices that are directly and indirectly re-shaping the provision of higher education. To this end, this research aims to address the following questions: how are on-line learning technologies being integrated into higher education? What are the debates, activities and concerns arising from the introduction of these new technologies and what do they tell us about educational values in universities today? The performative model of society (Strum & Latour 1987) informs and supports the analysis of an interpretive, qualitative case study at two universities: the London School of Economics and the University of Brighton.

METHODOLOGY

The fieldwork design for this research is informed by the work of the actor-network theory (ANT) and science and technology studies (STS) authors. As a touchstone, Latour and Strum's work on the 'Performative Model of Society' (1987) has provided a basis for fieldwork design and the collection of empirical materials. The performative model is derived in part from Garfinkel's Ethnomethodology (1967). Garfinkel proposes a view of sociology in which society is achieved through interaction, rather than "it being a given, existing, structure within which interaction takes place". The performative model provides a hypothetical basis, or what Latour refers to as a perspective frame (1999), through which activities taking place within the field can be viewed. Activities are understood in relation to the following tenets: no one, including the researcher, has a *privileged* view of events; actors, regardless of their size, define for themselves and for others what society is; a variety of elements or properties can contribute to social relationships, whether they be material, symbolic or human.

One of the key theoretical and analytical insights that this model and the ANT / STS authors provide is the equal status which they afford human actors and non-human actors (Haraway, 1990; Latour, 1999). Authors such as Haraway and Latour argue that it is problematic to create simple dividing lines between humans and the technologies that they use. In a research

scenario, this means that theoretically a software programme could be as capable of presenting and enacting a world view as a human computer operator. More significantly however, it means that the character of discourse and the rationales assumed to be governing activities are not preconceived as *naturally* belonging to a particular set of actors (Haraway, 1990). In this context, making claims that a work activity is 'purely functional' can be understood as political rhetoric whether speaking of a human or of a technology.

Initial inquiry has led to the identification of two universities which between them exhibit all three of the responses that Collier (2001) identifies. The researcher is acting as a participant/observer at both universities. Preliminary, semi-structured interviews with individuals identified as responsible for a particular area of development have taken place. Fieldwork will continue until December 2002, by which stage, each of the universities in question will hope to have reached a significant juncture in their attempts to promote and integrate on-line learning technologies.

THEMES FOR ANALYSIS

The following themes for analysis have been derived from the texts and transcripts gathered during initial fieldwork. Emergent issues have been brought together and encapsulated by titles which appear relevant at this stage of the analysis.

Local Blends or Global Relations

At the point at which research began there was evidence of two quite disparate sets of behaviours associated with integrating on-line learning technologies. The first involved local endeavours to introduce technologies where, in most cases, a single academic was developing or working with a particular software program in the context of a single course or unit of study (Learning Technology Support Officer). The other kind of activity taking place involved global developments where partnerships and consortia with private companies and other universities were formed. The focus of these consortia was to provide on-line courses that could be undertaken at a distance with little or no contact with the institution outside the on-line environment. The thinking at the time was that distance on-line learning would be the form that was most likely to generate extra revenue for institutions. However, the crash in technology shares which took place in 2000 had a serious impact on the development of the on-line learning market and this particular form of course production and delivery has not proved as popular or profitable as was first expected. It is therefore the local activities and developments, which tend to place more emphasis on blending on-line learning with face-to-face teaching, which are now in the spotlight.

A Sense of Inundation

One of the themes which has emerged from preliminary analysis has been recurrent reference to a sense of inundation; of being overwhelmed by the implications of integrating on-line learning; of 'floodgates opening'. This sense of inundation is expressed in relation to a variety of different activities, not simply in terms of increased workloads. From one angle, it is seen as a need to shape the expectations of staff and students during the first stages of integration. Given the varying levels of readiness across departments and faculties there is concern that this 'tidal wave' will overtake infrastructural capabilities.

From the pedagogical angle there is a feeling that the capacity to link course materials to the internet from within the on-line learning environment opens up such a wealth of resources that teaching itself will need to take on a new dimension. Last, but not least, is the task of integrating the universities' existing infrastructural and informational systems with the chosen on-line learning technology. Although this area is not central from a learning and teaching point of view, it is central to the institutions' successful integration of these technologies.

Politics of Precision

Embedding teaching practice and course materials in technologies requires a certain level of articulation and precise definition that many teachers feel confronted by. This is not purely an issue to do with intellectual property rights and the ownership of intellectual materials. There is a discomfort with the act of fixing, encapsulating on-line learning into course activities and processes in such a way as to freeze a new order into routines. This manifests as a reluctance to open up complex activities and reduce them to definitive explanations. There is an element of distrust in this, a feeling that once defined, these activities could be completely disembedded from face-to-face teaching. In addition, there is distaste for the monitoring and surveillance capabilities that are opened up by such apparent transparency. On the other hand, there is a sense that greater capacity for equality and democracy is made available when processes are made explicit. Particularly with regard to admissions, assessment and treatment at exam boards the new technology is viewed by some as a positive move to disconnect 'student data' from students themselves.

RESEARCH CONTRIBUTION

In this research it is argued, on the basis of preliminary fieldwork, that the integration of on-line learning technologies into UK higher education will hold implications for both organisational practices and for understandings of educational and academic values. The practical requirements of the institution, the work of designing and maintaining its administrative and technical systems, is generally understood to be something which stands apart from 'the real work' of teaching and learning. However, with the integration of on-line learning technologies the interrelatedness of these areas of work is brought to the foreground and the tension between values and their practical manifestation is highlighted. In order to promote understanding of how on-line learning technologies are being integrated and to consider the emerging issues associated with academic autonomy, dissemination and professional identity, the case for an organisation-wide approach to empirical work has been put forward.

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Supporting the effective implementation of asynchronous computer conferencing in a campus-based HE environment.

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Abstract

The rapid expansion of networking capabilities and growing potential of access to such facilities is stimulating an exponential growth in the interest to develop technological resources to facilitate and enhance the learning experience within Higher Education (HE). Thus, educational institutions are increasingly being encouraged to experiment with tools which promote collaborative working which are, in turn, perceived to help in the development of more autonomous, responsible learners. The research that I am undertaking therefore seeks briefly to explore the theoretical underpinnings that usually prompt the adoption of such tools as asynchronous computer conferencing (ACC) technology for collaborative working in an educational environment. The research will then go on to question the traditional approach of the "moderated" implementation of such technology with the campus-based student and then report on some of the issues actually encountered in implementing the use of particular tools - WebCT and Blackboard - as an integral part of the learning experience within the teaching of two final year undergraduate modules concerning professional issues and computer ethics. Such modules are being delivered collaboratively to students based on two campuses within the UK (Milton Keynes and Leicester) as well as to those located in other universities elsewhere in Europe (Ireland and Denmark) and the USA.

The focus of my research lies, therefore in developing a theoretically sound framework for the integration of ACC within a campus based HE environment. As such there are a number of areas that need to be examined in terms of education, psychology and the media itself. Initially, therefore, a literature review has been undertaken in order to gain a thorough appreciation of current trends and influences upon educational thought and practice. Through such research it has become very apparent that there are a number of concepts that, despite years of discussion, still remain highly contentious. For example, perhaps one of the most fundamental problems within the literature seems to be with the term "learning" itself and what it actually means. For example, "learning" is frequently referred to as "that which has been acquired by a learner" as well as being used to refer to the learning process itself.

However, further difficulties then arise regarding the learning process itself and what this is deemed to be. For example, Sfard (1998) argues that there are two metaphors for learning – the "acquisition metaphor" and the "participation metaphor". Koschmann (1999), on the other hand, believes that such a dichotomy is too restrictive and proposes a "transaction metaphor" that encompasses both acquisition and participation. Thus, the actual process of what constitutes "learning" seems to be open to a variety of interpretations and there have been numerous attempts to define various models of learning based on these different philosophical underpinnings. Each of these models has then variously had its impact upon HE.

However, a recent attempt to define dimensions of such learning theories, undertaken by Leidner & Javernpaa (1995), has initially been used as a framework to examine these various theoretical models. This framework was adopted because it provided a comparison between the different models in terms of context, knowledge, learning and control. Conclusions drawn from such examination, however, suggest that the work of Vygotsky (1978) and the socio-cultural/constructivist/collaborative models of learning would seem to support the use of ACC as they, by definition, underpin the thesis that learning is emergent, non-deterministic and contingent – i.e. developed as a result of a "situated" process rather than as a discrete achievement. Thus the traditional didactic mode of transmitting information in de-contextualised settings is seemingly rejected as a model for learning.

There is, however, a growing concern amongst pedagogists regarding the widening gap between educational theories and existing learning environments as much recent development has been driven mainly by technological advances rather than educational objectives. For example, as noted by Currier, et al [2001], "professional uncertainty is clearly a major problem for institutions to address. For teaching staff, part of this concern is over the issue of pedagogy". How academics approach the new teaching possibilities that emerge is, therefore, important if the learning experience is to be enhanced. It is also important to them that they do not have their pedagogical approach dictated by the technology. Lee and Thompson [1999] also emphasise a focus on education needs rather than on the technology and that "staff needed to identify how they want to teach before selecting the technologies". Whilst it is also recognised that, as Wintlev-Jensen [2000] note, "there are some technological developments which have the possibility of radically shifting the established paradigms of learning" it is this potential gap between pedagogy and technology that my research seeks to address. Specifically, to date, this has been to:

- Conduct an analysis of theories of learning, group working, learning styles and discourse with regard to their relevance to, and impact upon, the development of learning communities.

- Undertake a literature critique related to the use and evaluation of ACC within different models of learning. A number of models currently exist (Laurillard (1993), Salmon (2000), Britain & Liber (1999)) and these have been examined in relation to how ACC is actually being implemented.

- Conduct a series of experiments using ACC with geographically dispersed campus-based undergraduates in order to identify patterns of interactions, mapped to such things as backgrounds, group behaviour and learning styles as well as to identify the various factors that might influence use of ACC in, for example, the development of moral judgment and learning communities. Techniques used here include application of Transaction Analysis, the Community of Inquiry Model (Garrison et al, 2001) and the Moral Judgment Test (Lind 2001)

Through this, a framework for integrating ACC [as an exemplar of technological implementation] is being developed and an intensive evaluation process will be activated to assess the workability of the framework and its attractions over more traditional modes of supporting the learning experience. It is expected the research will make a sound contribution in defining an effective pattern for supporting learning through the integrated use of ACC within a campus-based HE environment.

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The human-computer interface in higher education : does it meet the needs of *anyone* apart from the student? Do we know … and does it matter?

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Abstract

Introduction

The last few decades of the twentieth century have been a time of rapid developments in communication and information technology (C&IT) and its use in networked teaching and learning in universities. Much has been written on the subject of ***student*** satisfaction with this emerging style of pedagogy and how the learning experience may be enhanced through the use of technology. However, students are not the only stakeholders in higher education (HE) – others include HE institution managers, local and national government, the students' parents and potential employers and, most significantly where the use of communications and learning tools is concerned, the university teaching staff themselves.

Some research into faculty satisfaction levels with C&IT is emerging from the US but there seems to be little equivalent data from the UK at present. However, tutor satisfaction levels could significantly affect the take up of ICT within the sector, in terms of how the technology is used and how swiftly and effectively it is deployed (Jaffee,1998). Conversely, a greater understanding among C&IT designers of how teaching and learning technologies, and the related human-computer interfaces (HCI), can contribute to the satisfaction of teaching staff might lead to design changes in the tools concerned. This paper addresses the question of whether teacher satisfaction can and should affect learning technology and HCI design, whether enough is currently known about the subject to enable it to do so and whether (and how) the matter should be researched more fully.

Topics

The paper will begin with a clarification of the concepts and terms which will be employed: which HE stakeholders are concerned and why the satisfaction of each affects that of the rest; what is meant by 'satisfaction', its relevance in terms of learning and teaching, and how it might be assessed; and what aspects of interactivity are or might be affected by stakeholder satisfaction with the tools. The reported results of research into tutor satisfaction in the US (e.g. Almeda and Rose, 2000; Arvan and Musumeci, 2000; Fredericksen, 2000; Hartman *et al*, 2000; Warschauer 1999) and in the UK (e.g. Deepwell and Syson, 1999; Haywood *et al*, 2000; Sosabowsky *et al*,1998) will then be discussed, in the context of how this affects HCI and the manner, speed and effectiveness of learning technology use. The satisfaction of other stakeholders (Bacsish and Ash, 2000; Kashy *et al*, 2000; Noble, 2002) will be touched on in terms of their individual objectives and how these may be met, or threatened, by the use of interactive learning technology, and how this might affect the design of that technology.

Conclusions

A number of conclusions will be drawn from the matters discussed in the paper. At the simplest level, it can be deduced from the research described here that different stakeholder types have different preferences in their choice of interactive tools and how to use them, arising out of their different objectives and levels of satisfaction with the tools. For example: students tend to favour tools which enable easy access to the internet, their colleagues and their tutors; tutors value on-line assessment, course material distribution and asynchronous communication tools; whereas management and government are more interested in managed learning environment tools and distance learning facilities, to reduce administration costs and increase student numbers. In each case, the preferred characteristics of the favoured tools are also heavily affected by the objectives of, and satisfaction of, the users concerned.

At a more thoughtful level, the paper draws conclusions about the kinds of assumptions underlying the literature and the questions which do not seem to have been addressed by the research being reported. It seems clear, from the research so far, that stakeholder satisfaction does indeed affect choice, and manner of use, of C&IT tools. However, without establishing what relationship might exist between 'stakeholder satisfaction' and learning (or indeed teaching), and to what extent such satisfaction is an aim, or even an important feature, of higher education, it seems premature to be drawing conclusions on which technologies to implement in the field, how to deploy them and how to improve them.

The final conclusion to be drawn from this discussion paper might be deduced from the conditionality of many of the words used within it – there seems to be a shortage of research into this important topic, and in particular a lack of research which answers some of the critical questions outlined here. Huge sums of money are being spent on C&IT in UK higher education, a vast number of teachers and learners are being radically affected by the application of this technology to university teaching, and most of the rest of the population has a significant interest, one way or another, in this application of technology. It would therefore seem prudent for more research to be done into the matters discussed in this paper before trying to mandate the 'best' application of networked teaching and learning in UK HE.

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GENERATING COMPUTER-BASED ADVICE IN WEB-BASED DISTANCE EDUCATION ENVIRONMENTS

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1- Introduction

Although Web-Based Distance Education (WBDE) offers many attributes that benefit the learning process over the traditional methods, many barriers still remains, e.g., student's sensation of isolation from the educational environment, their feelings of disorientation and becoming lost in course hyperspace, and the resulting communication overhead required from faculty members are some of these barriers. Enabling Web-based distant courseware to play the role of the advisor and provide students and course facilitators with the appropriate feedback is the way to solve these problems. The Implementation of Web-Based Intelligent Tutoring Systems (WBITS) (Brusilovsky, 1999, Capuano et al., 2000; Mitrovic, 2000, Virvou & Moundridou, 2000; Peylo et al., 2001) facilitates the development of effective distance learning environments. Incorporating student-modeling (King, 1998; Mitrovic & Ohlsson, 1999; Self, 1999) techniques into Web-based courseware allows students' actions and behavior to be monitored and the needs of each individual to be addressed. Student models can also be used to generate advice to course facilitators in order to improve the effectiveness of WBDE.

The goal of this project is to exploit student modeling techniques in order to provide course facilitators with appropriate advice and help them manage, assess, and advise their distance students. Models of students who work with Web-based courses maintained by a Course Management System (CMS) will be extracted based on information provided by the CMS. The resulted models will then be used as a basis for generating computer-based advice to the course facilitators. It is expected that such advice will enable the facilitators to keep close to their distant students and will make possible the students to receive more effective guidance.

2- The Research Problem

Problem Definition: There are three key motives behind this project. The first is the distant students' feeling of isolation from the educational environment and their belief that it is difficult to support a position in the absence of the teachers and supervisors (Smith, et al., 2000; Gratto, 1999; Galusha, 1997; Wood, 1996). The second motive is the students' willingness to become disoriented in the course hyperspace, especially when a large number of links are presented (Galusha, 1997; Carro, et al., 1999). Many researchers in the field of WBDE consider this problem a main reason for increasing drop rates in such courses. The third motive is the increased communications overhead required from course facilitators to interact with distance students and answer their questions (Smith, et al., 2000; Gratto, 1999). In fact, it is difficult for academic staff to play their new role as facilitators and try to keep track of each distance student, i.e., to know what the student knows, what he does not know, what misconceptions student falls in, what feedback should be provided, or answer questions prompted by each student. Often, course facilitators do not have the necessary knowledge required to manage and assess their classes.

The main idea in this project is to investigate how information generated about students attending web-based courses maintained by CMS can be used to construct suitable student models that can be exploited for generating appropriate advice/help to course facilitators. The facilitators can then become more knowledgeable about their distance students as individuals and as a group and can keep themselves close to their students by appropriately addressing the needs of each individual.

Research Objectives: The main objectives of this research are:

1- To develop a **Student-Model Builder (SMB)** that will use the information generated about distance students in a WBDE environment designed with a CMS to build student models that will **facilitate appropriate computer-based advising**.

2- To build an **Advice Generator (AG)** that will use the created student models to intelligently **generate appropriate advice that will be delivered to the course facilitators.** Advices will be based on the status of individual students, group of the students or the overall class.

The expected benefits are **minimizing the student's feeling of isolation and disorientation** and **reducing the facilitators' communication overheads**. It is also intended to **early discover and solve the problems** that might be generated to the distant students on individual or group levels.

3- The Proposed Model

An advice generating system will be designed to deliver certain types of advices, such as: the names of the students who do not understand a specific part of the course, why, and possible solutions, the parts of the course in which most of the students suffer problems and why, overall class evaluation in a part or some parts of the course, the usage rates of the available collaboration tools e.g., mail utility, chatting rooms, and bulletin boards, etc. Advices will be delivered to the course facilitators along with some recommendations to the students. The course facilitator have the options to redirect these recommended advices, as it is, to the students or change it to a more suitable advices decided by himself.

Figure (1) shows the architecture of the proposed advice generating system. There are two parts: the first part (with the gray background) represents the conventional structure of an educational course maintained by a CMS, while the second part (with white background) represents the addition we propose to generate computer-based advice following the project objectives. In the first part, the course designers are responsible for preparing the material and organizing it in a way they believe is effective for the potential students. This material is incorporated in the Domain Knowledge Base (DKB), and may contain HTML pages, presentations, glossary items, supplementary papers, quizzes, etc. The course designers are also responsible for registering the student. During registration, appropriate information about the students is collected in a Student Database (SDB). The CMS records information about the students' interactions with the course. SDB is the main input for the advice generating part. The components of this part are described shortly in the next paragraphs.

The Domain Knowledge Base Module (DKB): The proposed DKB depends mainly on pre-stored materials. There will be no expert model for the selected course. The instructional materials are represented by a set of HTML pages that contain the body of the course knowledge. DKB will constitute quiz problems designed especially to help diagnosing and evaluating students. Most of the quiz problems will be in the form of multiple-choices. The choices will be designed to help evaluating student understanding of a certain concept.

The Domain Meta-Knowledge Module (DMK): contains information about the content and the structure of the course material. A list of the concepts studied within the domain represents the ideal domain model. Fuzzy relations (Strong, Moderate, or Weak relation) among the domain concepts will be represented in DMK to show the necessity of other concepts to master a specific concept. DMK also relates each domain concept to the appropriate course material in DKB. Information about each domain page from DKB is stored in DMK (for example, the time required to read the page and the confidence levels by which reading of this page guarantees student understanding).

Student Model (SM): incorporates: a Student Profile (SP), the Student Behavior Model (SBM), the Student Material Model (SMM), the Student Quiz Model (SQM), and the Student knowledge Model (SKM). The knowledge required for student modeling will be extracted by Student Model Builder (SMB) from CMS's student database which contain information about student's actions.

The system will rely upon two main sources of information to build SM: the analysis of the students' performance recorded by CMS and a human-teacher's judgments either represented in DMK or embedded in Advice Generator (AG). The student-modeling component will be maintained using certainty theory and fuzzy sets techniques (Derry & Hawkes, 1992; Katz et al, 1994; Capuano et al, 2000).

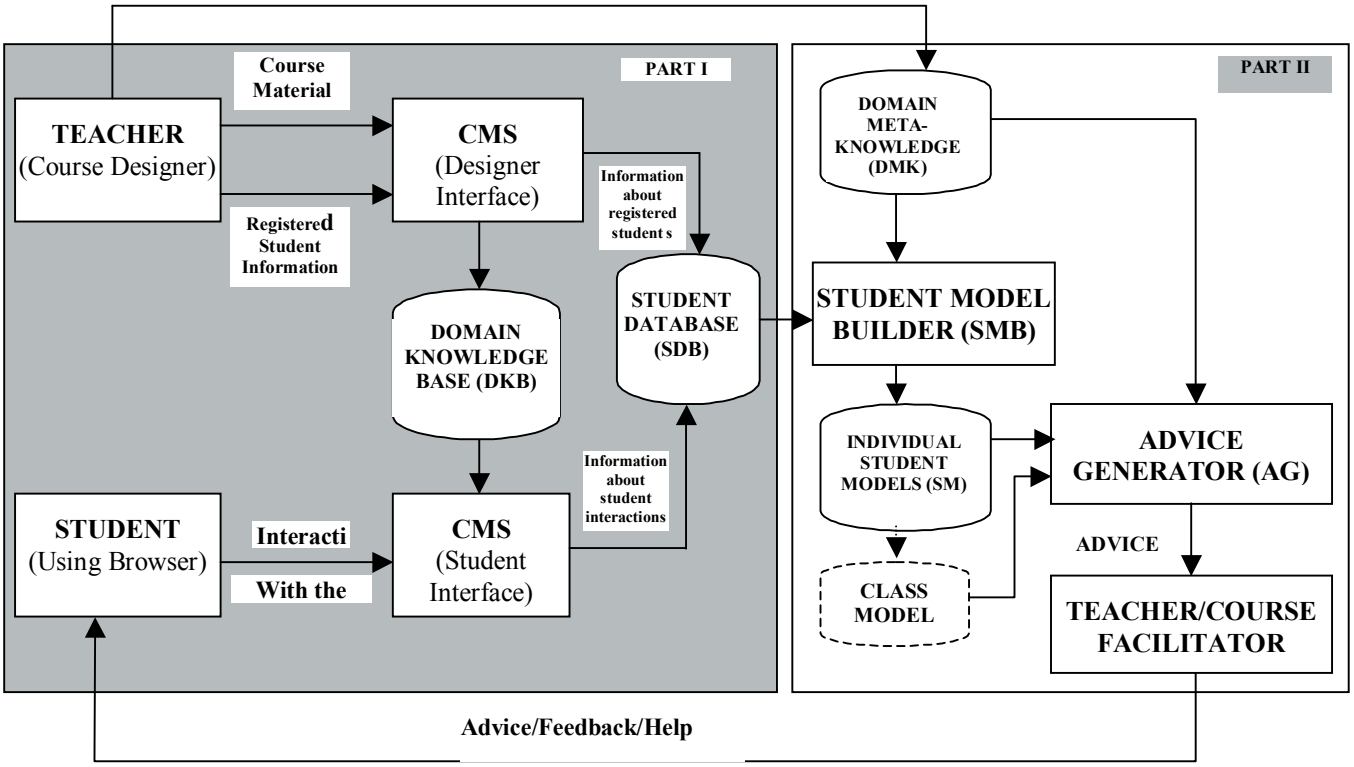

Figure (1): THE PROPOSED SYSTEM MODEL

Student Model Builder (SMB): SMB will be designed to read the student information generated by the CMS and process it to be ready for storing in the appropriate locations in SM modules.
Advice Generator (AG): AG produces appropriate advice and/or help based on information in the SM and the class model. The AG uses the SM to judge about the individual student's status and the overall class status, which will be used for generating appropriate advices to the course facilitator. SKM will contain several measures of belief that represent system's confidence levels regarding some student modeling variables. These measures can be used to assign the student to a fuzzy set that coincides with the student status.

4- Research Methodology and Current Status

Our research methodology includes the following steps:

1- Conceptualization of the research problem, objectives and related issues.
2- Studying and selecting one of the available CMS.
3- Designing a web based course using a CMS and implementing this course in a real educational environment to collect genuine data to work with.
4- Developing a formal description of the student model and advice generating criteria.
5- Designing the Student Model Builder and the Advice Generator.
6- Validating the proposed architecture in a computer prototype.
7- Formative evaluation - testing the prototype with users (students and course facilitators)
8- Refining the prototype and identifying possible extensions to the model.
9- Summative evaluation - Evaluating the system in a genuine distance education environment.

Currently, we are working on steps 3 and 4, steps 1 and 2 have been completed.

5- Conclusion

There are several contributions expected from this research project

1- This work is expected to enhance the effectiveness of WBDE through advising course facilitators. Differently from the previous researches, who are trying to enhance the effectiveness by directly advising the students, our research is directed towards helping the course facilitators.

2- The novelty of some advice types used to be generated is expected to be a contribution to the field of computer-based education.

3- The work may be considered as a framework by which it is possible to use the information generated by CMS to build effective student models.

4- There is expected contribution to the area of using Artificial Intelligence in education through building an Advice Generator that will employ student models to intelligently generate advices to the course facilitators.

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Title: Learning Through Learning Content Management Systems

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Abstract:
New learning technologies have promoted the notion that ICT has the potential to allow people to learn more easily and flexibly through or with this medium. This awareness is reflected in the current widespread utilisation of the web for training and learning, in commercial and university enterprises. One such learning technology is that of the Learning Content Management System (LCMS). This paper looks at the LCMS and evaluates its effectiveness. The evaluation is based on a two-pronged approach. Firstly, the key characteristics of the media are surveyed along with the technology that has facilitated its development. Secondly, this paper will examine the interactions that take place between authors, learners, content and technology. This second analysis will focus on the types of learning activities that take place based on current learning theory (Mayer, 2000; Jonassen Peck & Wilson, 1999). It is hoped that this dual approach will help develop a theoretical understanding of the issues relating to the appropriate pedagogical use of LCMS and may inform future design and development.

Introduction to Learning Content Management Systems

ELearning initiatives are frequently driven by an awareness of knowledge as an important source of wealth creation, along the quickening pace of environmental change and the rapid development of information technologies. However, various criticisms have been raised about the marginal benefits that arise from using technology in education (Hokanson & Hooper, 2000). Despite these concerns learning technology is continually advancing and new initiatives are underway to standardise eLearning tools, technologies and content.

In an attempt to take advantage of developments in learning technologies some companies have adopted the approach of purchasing once-off eLearning courses off-the-shelf, or slightly customised courses. These courses are instructionally sound and usually general enough to enable content developers to exploit a large customer base. A similar model is employed by universities whereby course material is delivered on-line by lecturers utilising their own web sites or via campus intranet systems that similarly enable publication. It allows subject matter experts, with little technical expertise, to design, create, deliver and measure the results of their eLearning courses.

However, recent advances in learning standards (such as SCORM and IEEE) and in using XML to classify content now make it possible to create learning content management systems. This paper will focus on these standards and the technologies behind the development of a Learning Content Management System (LCMS). In essence a LCMS manages content or learning objects at a much smaller unit level than traditional content management systems. It supports an environment where authors can create, store, reuse, manage and deliver learning content from a central object repository. It also may contain traditional Learning Management System

functionality such as the ability to monitor student participation, and assess student performance along with interactive features such as threaded discussions, video conferencing, and discussion forums. But ultimatelty the novelty is the ability to deliver and reuse granular modules of instruction. This is a much different concept than the conventional approach of purchasing eLearning courses that do not enable any reuse of atomic fragments of courses, but instead create and deliver the entire course as one technically indivisible organism.

Interactions Between System Users

The second approach adopted by this paper looks at the interactions between the system users. Investigating the effects of a LCMS on learning and performance requires a solid foundation in learning theory. A theoretically grounded investigation of the system allows one to draw conclusions relative to the learner, rather than attempting the slippery slope of a media comparison (Doolittle, 2001). The technical components discussed above form the backbone of the LCMS. But this technology relies on more than the hardware and software that it is made of. It also makes underlying assumptions on the nature of learning, and the methods it utilises to engage learning, such as cognitive learning strategies and critical thinking skills (Jonassen, Peck & Wilson, 1999).

Therefore this paper will examine the most recent research on learning theory. Learning theory has developed in recent times from a behaviourist approach through to modern cognitive information processing perspectives and constructionist approaches. This will form the foundation of investigation into the use of sound LCMS instruction.

Examples of other similar technological investigations that are grounded in cognitive theory include the work of Richard Mayer (see Mayer, 1997, 1999), Laurillard (1993, 1998) and Jonassen, Peck & Wilson (1999). An effective synthesis of cognitive information process theory can be seen in the work of Jonassen et al. (1999). These researchers describe the interaction of five interdependent attributes of meaningful learning. They claim that if technology is to be used to support meaningful learning, then it needs to engage the learner in active (manipulative/observant), constructive (articulative/reflective), intentional (reflective/regulatory), authentic (complex/contextual), cooperative (collaborative/conversational) learning. These five attributes are helpful criteria for evaluating the LCMS technology. Each of the components of the system will be examined under this matrix.

As part of the user analysis the roles of learner and author users of the system are investigated, along with their interactions with the system. The first user under investigation is that of the author. The author performs tasks within the LCMS environment ranging from creating content in the form of fragments or larger chunks of topics, lessons, modules, courses or curricula. The main features that the author employs are that of creating and publishing content and searching for learning objects to reuse. Questions are asked as to the nature of thinking skills these authoring activities require. Also the implications for instructional design need to be deciphered as the as the author has no control of the topics once published. Does this allow the learner greater autonomy and self-directed learning or create a chaotic web of content with any contextual meaning?

The second user of the system is that of a learner who may assume two distinct roles. They may be trying to find something out as quickly as possible (i.e. a chef may need an instant recipe for cranberry sauce to save a burnt turkey, or an engineer may require a immediate pin layout for a male serial connector for on-site repairs). Secondly, the learner may wish to take a course over time with additional reading, assessments and practical sections. The LCMS allows the learner to assume either of these roles. It does this by building search functionality, the option to take a full course, to find an answer to a specific query and to collaborate in a shared space into the interface portal.

Again questions arise as to the nature of the learning process taking place between the learner and the system. Does the system adopt a learner centric approach, both in terms of content and delivery format (using a bottom-up approach, starting with the needs of the individual learner, as opposed to the top-down approach of the traditional classroom model)? Dynamic delivery of content is based on assessed needs. As learning needs may be difficult to predict, how will this new approach enable just in time and just-for-me learning? Can smaller units of learning and moments of understanding tailor content to the assessed needs of the learner, delivering only what are required?

Conclusions

Finally, both the technical description and the user analysis of the learning activities and processes inherent in the system, will lead to a deeper understanding of the issues relating to the use of LCMSs. It is hoped that this will guide future research and inform the design and use of the LCMS as a medium to support meaningful learning and enable easy authoring of propriety content.

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Meeting the needs of the online researcher: an investigation in virtual autonomy

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This paper addresses the conference question: "What is digital technology and how is it changing?" Digital technology, in the context of this investigation, is seen as a virtual learning environment (VLE). The JISC-UCISA management and implementation of VLEs report provides insight into UK Higher Education activity [1]:

- VLEs represent a cultural challenge for academic staff and students in the way they engage with learning and teaching,
- VLEs are generally stated to be important in institutional learning strategy (e.g. efficiency, pedagogy, increased flexibility, etc.), but are poorly matched by delivery. Accessibility is still a factor.
- Mature support mechanisms have yet to be comprehensively developed across the HE sector due to limited development time for staff and students.

For this study, VLEs are categorised into two major groups: commercial and independent. A number of studies compare the features and tools of commercial VLEs (e.g. WebCT [2], Black Board [3]) have been done [4], but emphasis should also be placed on the pedagogical issues related to online teaching and learning (Stephenson 2001). Independent groups developing VLEs and MLEs (managed learning environments) may be universities or funded projects. Several U.K. universities have developed VLEs (e.g. Comentor, et al [5]). Two major funded projects have emerged recently in the UK:

1) **Learndirect / learning through work** [6]: A key feature of this VLE is that learning is relevant and beneficial to the learner and the employer. The scheme helps to; gain a university qualification, without taking time off from work, enhance capability and individual effectiveness at work, develop planning and reflection skills. The learner has use of specially designed online resources to; evaluate prior experience/knowledge and current circumstances, identify immediate and long term needs and aspirations, formulate a unique learning programme specified in an online learning contract with a partner university, organise learning activities, record progress and achievements, access a range of learning materials and professional help, and share ideas/problems with other learners in the scheme.	2) **The UK eUniversity** is a HEFCE funded project that acts as a portal for e-learning to access HE institutions online. Still under construction, the UKeU VLE is custom made by its partner SUN Microsystems [7].

Table 1 A sample of UK VLE's - independently funded

The second part of the question addresses how VLEs are changing. Laurillard (2000) sees conventional VLE models for instruction adapting to those supporting research. Mason (2002) observes a paradigm shift towards VLEs to support work-based projects. Examples of instructional VLEs are evident in undergraduate modules using a content-driven approach [8]. In a work-based training context commercial enterprises use a didactic approach to train employees in basic ICT skills (i.e. European ICT Driver's Licence) [9].

A research-based VLE is a new emerging paradigm (ESCelate workshop 2002). Undergraduate [10] and postgraduate [11] VLEs can embrace this model. The potential to support online research by developing VLEs based upon web-based pedagogical models in relationship to virtual autonomy is core to this study (e.g.- PROS (Promoting Researchers Online Supervision) project [12]).

As part of this paradigm shift, tutors and learners will need of re-evaluate their roles in the VLE. A research-based VLE model sees the online tutor, in some cases, taking the guise of 'project supervisor', not the knowledge expert common to instructional models. Online tutors for research-based VLEs assume a facilitator/moderator's position [13] (Allinson A. 2002). The learner also has a changing role. In a research-based VLE there is a shift to the learner becoming a virtual autonomous researcher. The initial research proposal must solve a problem, test a hypothesis or answer a research question. This is done by independently finding the resources to construct a solid literature review, deciding an appropriate research method that takes advantage of effective on/offline data collection/analysis tools. Next, they present and defend their arguments via online discussion/collaboration tools and media. These steps are supported by the findings discussed in a needs analysis conducted at Middlesex University (Basiel A. 2002). The online researcher must be able to learn and adapt with the VLE. To master the online system and tools they need to identify support mechanisms and communication protocols (Basiel 1999). The online researcher, thus, has an additional responsibility compared to their analogue counterparts.

What methodology can be employed by the VLE architect (online instructional designer) to better design the system to meet the online researcher's needs? Checkland (1999) offers a solution with the Soft Systems Methodology (SSM). Briefly, the inquiring/learning cycle can be summarised by these principles:

- The real world is a complexity of relationships that are explored via models of purposeful activity based on explicit world-views.
- The inquiry process is structured by questioning the perceived situation using the models as a source of questions.
- 'Action to improve' is based on finding accommodations (versions of the situation which conflicting interests can live with).
- The inquiry cycle, in principle, is never ending.

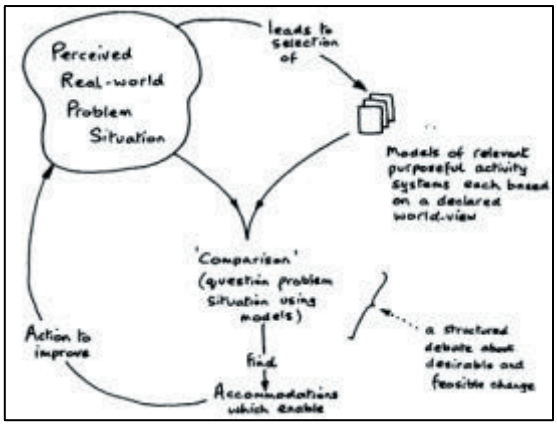

Figure 1 Soft System Method (Checkland p. A9)

In addition to SSM, this research offers an adapted Popperian approach to gaining valuable feedback from the VLE stakeholders (Popper K 1989, Ellington H. 1995). This methodology suggests a rigorous testing of the VLE to identify, not where it succeeds, but where it fails. By building into the system an explicit understanding of the VLE protocols and supporting online tools valuable formative evaluation can be collected. Networked surveys can gather quantitative data, while interviews can be conducted via web-based video conferencing for reflective data. Information analysis is conducted at a macro and micro level (McAteer E. 2002). This process can be briefly summarised by table 2.

[Pre-Stage] => (define user/system requirements)	[P_1/S_1] => (initial problem situation or system state)	TS => trial solution	EF => error falsification/ elimination	[P_2/S_2] => new problem situation	[Pn/Sn] ongoing revised problem/ system state
Needs analysis and system usability study identifies stakeholder's gaps	Identification of the instructional system objectives and learner's needs	Development & operation of the instructional system	Identify ways the system fails to meet researcher's needs	Identify ways system is improved to meet user's needs	Maintain feedback loop to support system changes

Table 2 Adapted research method for VLEs

PROS (Promoting Researchers Online Supervision) is a PhD/DProf. pilot study investigating a research-based VLE design called ViPER (Virtual Project-based Environment for Research) [12]. Its design is based upon the Transitional Autonomy Model (TAM) (Basiel A '00) presented at HCT'00. The underpinning theoretical basis of this model combines and adapts the following to VLEs:

- Web-constructivism – the adaptation of Constructivist learning principles to the web-based learning environment (Hein G. 1995, Basiel A. 1999),
- Transactional Distance Theory – the relationship of learner autonomy to dialogue and structure as applied to VLEs for this study (Moore M. 1983),
- Human Computer Interaction (HCI) - the principles guiding the design process of a computer interface interaction for learners to engage with content and communication in the VLE.

In summary, the nature of VLEs is shifting from an instruction to research-based paradigm. A greater burden is placed upon the online researcher to become a virtual autonomous learner/researcher. Design principles are needed to aid the VLE architect, rooted in sound pedagogical models. This paper offers an adapted Soft Systems Methodology as a guide. Supporting evidence is currently being gathered through the PROS project for validation of these models [12] designed by the underpinning online pedagogical principles of the transitional autonomy model (Basiel A '00).

References - Located at:
http://www.iclml.mdx.ac.uk/research/HCT'02references.htm

A computer supported approach toward collaborative and creative musicality in the classroom: concepts and framework

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Abstract: Traditionally, music education focused on the assimilation of fundamental music concepts by individual students. In contrast, this paper outlines a study, which proposes to utilise students' creative musical potential, collaboratively within the classroom. This work extends upon MOLE (Music Oriented Learning Environment, Truman, 2001; Badii & Truman, 2001), a computer-based environment designed to support individual student's acquisition of music concepts. This paper outlines the new Creative Collaborative MOLE (CC-MOLE) which aims to support music learning through collaborative composition and interpretation. This is motivated by a framework, illustrating how music learning through creativity can be facilitated in the classroom.

Keywords: music learning, creativity, constructivism, collaborative learning.

1. Introduction and background motivation

Traditionally, learning was perceived as the assimilation of concepts presented to the student by the teacher, viewed as providing students with the ability to comment intelligently on the subject domain. In music learning such concepts include musical scales, keys, chords and instrument training. However, from a contemporary perspective, the constructivist paradigm accentuates that learning is most effective when the student is an active participant as opposed to a passive receiver of knowledge (Lave & Wenger, 1991). It is also suggested that learning is a social activity in which interactions with others are an integral part of the process (Vygotsky, 1978). Similarly, creativity also involves the active construction of ideas within social settings. This paper argues that collaborative creativity can be a route to learning core concepts, and that creativity is an effective form of learning (Guilford, 1950), which requires students to form multiple perspectives of the learning scenario (Gero, 1996). Thus, enabling students to construct their own understandings via a process of social participation and creative exploration.

This paper outlines the preliminary MOLE study, along with revisions in the form of Creative Collaborative MOLE (CC-MOLE), which draws upon a fresh conceptualisation of creativity as an effective form of learning commencing at the earliest stages of classroom creativity. CC-MOLE supports music learning via collaborative construction and peer evaluation of musical compositions. The associated framework for classroom creativity in music learning is also presented.

2. Discussion of pedagogic dimensions of MOLE and CC-MOLE

This study extends upon previous research conducted using MOLE, an e-learning system to support individual GCSE music students with the accumulation of music theory concepts (Truman, 2001; Badii & Truman, 2001). The study investigated situated learnability effects of different media mixes of text, colour, voice and animation within the presentation flow with regard to the transfer of accumulated knowledge from short term to long term memory (knowledge modulation). The study also investigated the effects of different learning protocols (i.e. single versus multi-session learning trials) upon knowledge modulation. Participants worked through six interactive lessons in which they were presented with formal music concepts and multiple choice comprehension tests. Results indicated that multi-session trials were most effective and that the deployment of mixed media for learning is an effective multi-modal reinforcement strategy. In contrast to MOLE, CC-MOLE focuses upon

social learning and the probabilistic presentation of information as opposed to factual. This draws inputs from studies pertaining to the effects of language on instruction upon learning (Langer, 2000). CC-MOLE encourages students to learn via constructing their own representations of what is learned as opposed to acquiring facts for comprehension tests. Similarly to MOLE, CC-MOLE also incorporates different media streams. However, it also encompasses a collaborative compositional environment unconstrained by traditional stave notation in which students work together in pairs to compose short melodies. Students will also have the capability to assess the work of peers via a music-sharing forum.

3. Overview of experiments to be conducted and research hypotheses

CC-MOLE will be used in experiments as a vehicle to test the following hypotheses:

H1.	The way in which preliminary instruction is provided prior to the compositional task will have a direct influence upon creativity.
H2.	The deployment of alternative representations of musical notation, devoid of traditional stave notation will have a direct influence upon creativity.
H3.	Collaboration with peers during music learning and exploration will have a direct influence upon creativity.

Experiments will be conducted with secondary school children, who will be presented with instruction concerning musical scales. Subsequently, students will work in pairs to compose a piece of music utilising the collaborative composition environment. This will occur across two sessions due to the importance of incubation for effective creativity to occur (Claxton, 1998). Following the completion of compositions, students will assess the work of peers according to certain criterion. Effects of collaborative creativity will be assessed via video observations and students will also be interviewed to attain feedback pertaining to their learning sessions.

4. Collaborative and creative musicality in the classroom: a framework

Following the preliminary MOLE study, a fresh conceptual framework illustrating how creativity can support classroom learning has been devised. The design of CC-MOLE was guided by this framework to ensure the software and associated learning tasks account for necessary social and personal processes. The generic framework for classroom creativity and the specialised framework for music learning using CC-MOLE are illustrated in figures 1 and 2 respectively.

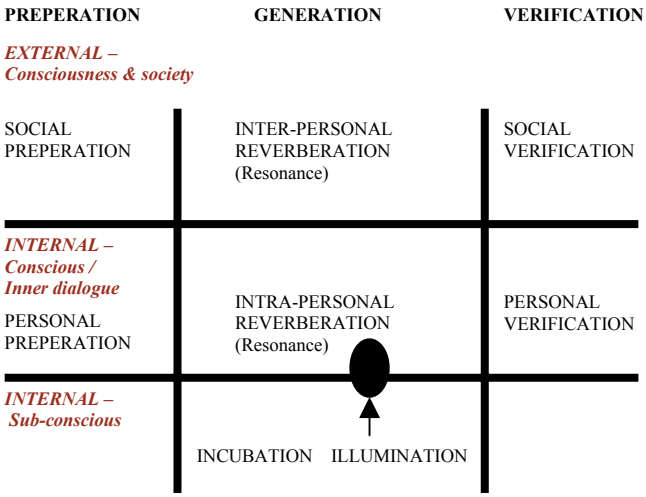

Figure 1 – General creativity framework

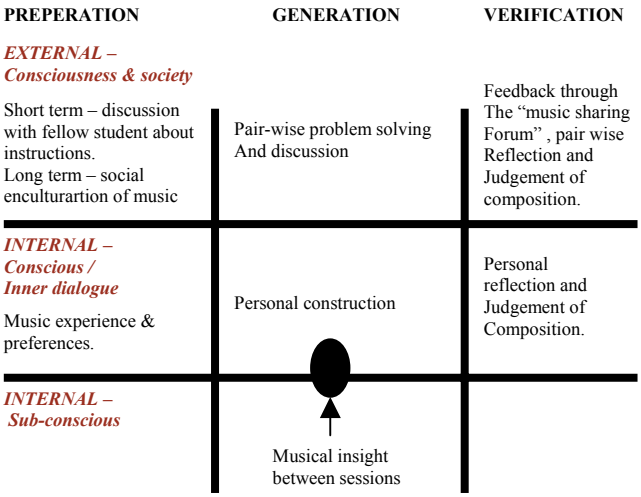

Figure 2 – Specialised framework for CC-MOLE

Figure 1 illustrates how creativity can support classroom learning. Laterally, the framework is divided into three phases of creativity: preparation, generation and verification (adapted from Wallas, 1926). The vertical dimension illustrates individual and social components of creativity. It is important to note that the framework does not commit to any strict linear route and generation may be followed by further preparation. Similarly, generation may consequently lead to further preparation.

With reference to figure 2, when using CC-MOLE, social preparation processes are both short and long term. Long term, students acquire knowledge concerning music and musical styles dominant in their culture. In the short-term, students working in pairs are given time to explore the background materials and instructions for the classroom activity. The generation phase comprises both pair-wise discussions and personal construction. In order to allow time for incubation the task of constructing a melody is divided into two classroom sessions. Verification occurs on three levels: personal, pair-wise and within a larger student group. Wider group verification is supported by the "music-sharing forum", in which compositions are shared and discussed across the class. Overall, CC-MOLE is designed as a vehicle, which will be utilised for future study to test the above hypotheses and also, to test components of the conceptual framework.

5. Conclusions

This paper has addressed the role of creativity for learning in the classroom context. This work extends upon MOLE, an e-learning system for music learning. The revised system CC-MOLE seeks to facilitate collaborative creativity in music learning in accordance with the conceptual framework for collaborative creativity in the classroom for which CC-MOLE will act as a demonstrator. A number of further studies are planned.

MOLE can be accessed on-line at: http://www.mole-online.co.uk

6. Acknowledgements

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WORKSPACES THAT WORK
Towards More Effective Personal Information Management

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ABSTRACT

Support for personal information management in today's computer workspaces is compartmentalised due to poorly integrated, inconsistently designed software. This adds to the complexity that users have to deal with as they carry out their day-to-day tasks – impacting learnability, productivity and satisfaction. Our research is aimed at understanding how compartmentalisation affects users, and proposing a set of guidelines for the design of simpler, more effective workspaces. We have carried out a series of user studies focused on the desktop workspace. The study findings have motivated the design of two software prototypes that are aimed at improving workspace integration and consistency.

INTRODUCTION

The personal computer has been conceptualised as a *workspace* within which a user carries out their roles and tasks [8]. The workspace is populated by the *tools* and *resources,* which facilitate activity, and the *constraints* that limit it. Individuals customize this environment by gathering collections of resources that are relevant to their ongoing roles activities. Typical collections include document files, email and web bookmarks. *Personal information management* (PIM) is the term used to describe the handling of such collections [9]

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It has been argued that PIM support in today's computer workspaces is compartmentalised [3, 4, 6]. The different types of information that users work with are managed within distinct tools, even though they often relate to the same user activity. For example the authoring of this paper involved the management of files, email, web bookmarks, contacts, notes, reminders, references and scheduling information, within many different applications. Integration and consistency between tools is haphazard, even between those developed by the same manufacturer. The consequences of compartmentalisation are far-reaching. As well as impacting productivity [4], users often feel guilty about the state of their workspace [3]. In terms of the conceptual framework outlined above, compartmentalisation generates a set of constraints within the computer workspace. Such constraints limit the effectiveness of the workspace and the productivity of users within it [8].

Although the literature contains many PIM user studies that focus on specific types of information [e.g. 2], most do not deal with integration between different types of resource at the workspace-level. One exception is Bellotti and Smith [3] who describe the user-centred design of an email tool that integrates support for contacts and scheduling. Other work, motivated from a technological perspective has aimed to unify PIM at the workspace-level [e.g. 6]. Although many interesting techniques have been proposed, these more ambitious systems can be criticized for their lack of empirical foundation and evaluation. To design simpler, more effective workspaces, we need greater understanding of user needs. It seems clear that such understanding must come from user studies at the workspace-level. We also argue that compartmentalisation must be tackled at the level of the operating system rather than making piecemeal improvements to already bloated tools.

RESEARCH AIMS AND METHOD

Our main research aims are:

- Through user studies, investigate the problems users encounter whilst managing personal information in compartmentalised workspaces.
- Propose ways of enhancing workspace design to alleviate these problems, and implement them as extensions to a standard operating system.
- Evaluate the success of these prototypes in dealing with the specific problems, as well as their contribution towards simplifying the workspace as a whole. Making incremental changes will allow us to ask users to evaluate each design within a familiar context, that of their current workspace.

The evaluation results will contribute towards our overall research goal: a set of design guidelines for improving PIM integration in future electronic workspaces.

PROGRESS TO DATE

User studies

We have carried out a series of structured interviews to explore the effects of compartmentalisation. The fieldwork encompassed several resource collections: files, email, to-dos and web bookmarks. Qualitative analysis of the results has highlighted the impact of compartmentalisation on two features of the typical workspace, categories and reminders:

- All the subjects emphasised the effort involved in managing multiple types of information in parallel. For those users who chose to manage more than one folder hierarchy, a significant level of overlap was noted in terms of the categories used to label folders [4]. This was despite that the fact that each set of user-defined categories was developed separately as a result of compartmentalisation.
- Most of the subjects did not make use of dedicated to-do managers but instead relied on implicit reminders in the form of desktop icons, their email inbox, and ad-hoc lists. Incompatible mechanisms for marking items as reminders led to users developing ad-hoc strategies for creating working sets of resources. For example several users mailed URLs to themselves to create email reminders for tasks to perform on the web.

Prototype Design and Implementation

Each set of findings has motivated the design of a software prototype, as described below:

- *WorkspaceMirror* is an extension to Microsoft Windows that allows users to share organisational categories and structure between PIM tools. The software synchronizes three folder hierarchies: the user's "home directory" where personal documents are stored; (2) web bookmarks stored in the "Favorites" folder; and (3) email messages stored in Microsoft Outlook.
- *CWM (Common Windows Metadata)* provides support for labelling any file, email, web bookmark or tool as a reminder. Interaction, representation and metadata are consistent across all resource types. The prototype also allows reminders to be grouped together into a consolidated to-do list.

Initial feedback from prospective users has been positive. After completing the prototypes, we plan to evaluate them in the context of real user workspaces over an extended period.

OPEN ISSUES

Theoretical Foundation

To date, the work has mainly been of a practical nature – user studies and design – but our findings need to be analysed in terms of an appropriate theoretical framework. Distributed cognition [7] appears to offer a suitable perspective, providing a useful analytical framework without abstracting away the complexity of real-life workspaces.

Evaluation Process

The most pressing set of issues relate to prototype evaluation. PIM is an ongoing activity, interleaved with the production tasks that it supports. The complex, open-ended nature of PIM means that objective measures of efficiency and effectiveness are difficult to define. Instead we intend to focus on qualitative measures of user satisfaction. Data will be obtained via subjective feedback, in the form of questionnaires and interviews, before, during and after use of the software. Potential evaluation criteria include (1) sense of control over the workspace, and the extent to which production tasks are supported; (2) user frustration, for example the familiar PIM bugbear of wasting time; and (3) critical incidents such as losing data and other direct impacts on production tasks.

We are exploring the use of Grounded Theory to substantiate our analysis. This qualitative technique has been successfully applied in other HCI research where user perceptions and attitudes had to be modelled [e.g. 1]. We also acknowledge that great care must be taken in accommodating individual differences – PIM by its very nature is highly customized, and our criteria must be valid across multiple users.

ACKNOWLEDGEMENTS

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Can Navigation Aids Support Constructive Engagement with Hypermedia?

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1. Introduction

The rapid expansion of hypermedia on the web and on CD-ROM, has increased its potential as a course delivery platform for distance learning. Consequently, there has been a significant push for universities to develop online courses [1]. It is important that the design of hypermedia meets its educational needs, as it has not always been shown to have advantages over traditional texts (e.g. [2]).

One approach to this problem has been to design educational technology as constructivist learning environments (e.g. [3]). The central claim of the constructivist approach is that knowledge or meaning is not fixed, but rather is constructed through experience [4]. 'Constructivism', as an umbrella concept, embodies many ideas found in current popular learning theories [5], and we can define the associated notion of constructive engagement as engagement in activities suggested by constructivism to facilitate learning. Examples of activities that constitute constructive engagement will be discussed in sections 3 and 4.

The focus of this research is on the potential of navigation aids to encourage constructive engagement with hypermedia. Navigation aids are techniques employed to support hypermedia navigation, and examples range from embedded links to menus, interactive maps and bookmarks. Since they have been shown to affect the usability of hypermedia, both in terms of navigation efficiency and ability to learn from it [6], navigation aids are important in determining how well users are able to engage with content information.

Examples of navigation aids designed from a constructivist perspective can be found in the web browser add-on, Nestor Navigator, created by Romain Zeiliger at CNRS, France. Nestor aims to encourage users to reflect on, structure, share and conceptualise the navigational experience [7]. It consists of a browsing window and an adjacent window displaying a graphical trace of the web space visited that is updated as the user navigates. The trace can be rearranged to create conceptual maps that show the conceptual structure of the hypermedia content. Creating the conceptual map involves reorganising the shape, and adding personal links, conceptual areas and keywords.

2. Research Aims and Objectives

The aims of this research are: to investigate the extent to which navigation aids can encourage constructive engagement with hypermedia content; and to produce a set of guidelines for the design of navigation aids to promote constructive engagement.

In an attempt to realise these aims some preliminary objectives have been set out. A first objective is to define a framework based on constructivist literature that encompasses the essential features of constructivism. This will then be used to predict the level and type of constructive engagement associated with given navigation aids. Following from this, a second objective is to empirically test these predictions by evaluating the level of

constructive engagement, and the level of deep learning, associated with the use of different navigation aids. Finally, a third objective is to compile the results of these empirical studies into a set of guidelines for the design of navigation aids to promote constructive engagement.

3. Predicting the level of constructive engagement for a given navigation aid

Constructivist literature suggests activities that constitute constructive engagement. The following set of constructivist principles, put forward by Cunningham et al (1993) [8], are an example of a framework that suggests such activities. The principles are as follows:

1. Provide experience with the knowledge construction process
2. Provide experience in and appreciation for multiple perspectives
3. Embed learning in realistic and relevant contexts
4. Encourage ownership and voice in the learning process
5. Embed learning in social experience
6. Encourage the use of multiple modes of representation
7. Encourage self-awareness of the knowledge construction process

The conformity of a given navigation aid to these principles may be used to predict the level and type of constructive engagement associated with the given aid.

4. Example: Creating a conceptual map

An example shown below demonstrates how the creation of a conceptual map may conform to a selection of Cunningham et al (1993)'s principles. The creation of a conceptual map should involve reshaping, adding personal links, keywords and conceptual areas. Note that these activities are considered when undertaken by a single user. Only activities associated with the use of the navigation aid are considered, rather than activities associated with other aspects of the hypermedia content.

Provide experience with the knowledge construction process- Learners are able to construct their own understanding of hypermedia content through the creation of a map. They are not issued with an expert model, so must experience the knowledge construction process for themselves. This suggests high conformity to this principle.

Provide experience in and appreciation for multiple perspectives- Creating a conceptual map may lead to appreciation of different views on the same material. The learner may become aware that there are several perspectives on how they could organise and view content information in a map. However, to reach a higher level of conformity to this guideline, users may share maps with others and consider different perspectives on organising the content. This suggests that when the user is working alone there is a medium level of conformity here.

Encourage ownership and voice in the learning process- As the learner is responsible for what is included in the map and how it is organised, they are considered to have high ownership of their learning. Consequently, this suggests high conformity to this principle.

Embed learning in social experience- As the learner is creating the map alone in this example, it appears that there is a low level of social experience associated with the creation of the conceptual map. This implies low conformity to this principle.

Encourage self-awareness of the knowledge construction process- The act of creating a conceptual map encourages users to reflect on the meaning of links and groupings in the map. A completed map may also show a trace of how a user may come to understand concepts presented in the hypermedia content. This suggests high conformity to this principle.

This examination demonstrates that the activity of creating a conceptual map shows a high degree of conformity to the following three principles: 'Provide experience with the knowledge construction process'; 'Encourage ownership and voice in the learning process'; and 'Encourage self-awareness of the knowledge construction process'. As such, this will lead to the hypothesis that creating a conceptual map of hypermedia encourages a high level of engagement in activities associated with the three constructivist principles listed.

5. Future work

Work in progress involves the development of a more detailed constructivist framework. Accordingly, this will involve the definition of what constitutes high, medium and low levels of adherence to themes in the framework. The framework will then be employed to generate hypotheses about the level and type of constructive engagement associated with given navigation aids. If a given navigation aid shows high levels of conformity to a particular theme in the framework, high levels of that particular type of constructive engagement will be predicted.

These predictions will then be tested through empirical studies of the effects of navigation aids on engagement in constructive activities and on deep learning. The findings will then be compiled into a set of guidelines for the design of navigation aids to promote constructive engagement.

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Interactions between the spatial location of information and interactivity in a safety training virtual environment

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Abstract. This paper addresses the issue of whether co-located information in a virtual environment aids recall and learning. An experimental design to compare two ways of delivering information (co-located/non co-located) and two levels of interactivity (active/passive) in the domain of safety training is reported. The research question concerns identifying the nature of the interaction between co-location and degree of interactivity and assessing its effect upon safety knowledge and skills acquisition.

Introduction

A substantial amount of research has shown the effectiveness of virtual environments (VEs) for learning in particular applications and specific situations. VEs enable users to interact with three-dimensional scenes of real and artificial worlds. Unlike other desktop-based applications, VEs offers the opportunity to exploit spatial metaphors for learning and recalling information.

Providing exposure to good practice in laboratory safety is fundamental for the prevention and avoidance of accidents. Laboratory users must know what to do, where to go, and where safety equipment is located in the event of an incident. At the University of Sussex, new students are informed about the general laboratory regulation in an induction lecture. However, this method is rather informal and does not test retention of declarative knowledge or the acquisition of procedural knowledge by students [1]. Using a different approach to text-based instruction and the traditional classroom lecture, VEST-Lab (Virtual Environment for Safety Training) aims to heighten laboratory safety by involving the learner in a contextual and interactive training environment. In order to facilitate recall and learning, textual and auditory description of safety information is associated with entities in the virtual lab.

Place and Location

The effect of place and location for recalling information has been investigated in cognitive psychology. Place refers to the inhabited environment during learning and location to the positions of objects in the space around the learner [2]. It has been argued that during learning, these factors provide substantial cues for retrieval of information [2,3]. Regian et al [4] claim that in procedural tasks, responses are associated with spatial location.

These principles have been applied to designing user interfaces and computer-based applications. For example, Ark et al [5] showed that subjects had better performance for locating targets in a GUI based on 3D realistic objects and ecological layout than with 2D icons in a traditional interface. They suggest that this design is most useful for tasks which require identifying and learning the places of objects. It can be expected that this improvement in performance associated with GUIs also happens with desktop VR applications, not only in terms of performance, but also as associative information.

Tan et al. [2] have explored the importance of providing cues at the time of learning to facilitate recalling information. They have developed a system, called Infocockpit, that surrounds the user with panoramic image and ambient sounds in addition to multiple monitors. Their study shows that people were able to remember more pairs of words under the Infocockpit condition than using a conventional desktop. The experimental task was to remember three lists of ten word pairs. In Infocockpit training, people learned lists of words while contextual images were displayed along with ambient sounds. Participants were tested for retention one day after. Results show a high correlation between the remembered word-pair and location. They have interpreted the outcomes as suggesting that the learning environment provided contextual cues that the learner inadvertently encoded, and later used to facilitate recalling.

Overlaying virtual information on the user's view of the real world that surrounds her/him, is the main component of augmented reality. Neumann and Majoros [3] have analysed the potential benefits of this technique for manufacturing and maintenance tasks training. They argue that incorporating virtual information (images, text) into the user's view of the real context creates a framework of association that aids recall and learning.

Interactive participation

Many studies in computer-based instruction have shown that interactivity affects learning positively. Interactivity in VEs also enables active navigation and learning by doing. According to Brooks et al [6], the navigation process allows better spatial acquisition. Cheesman and Perkins [7] point out that interactivity is better than passive participation because the user "encodes information in more automatic, elaborated form, with multi-modal components, that include conceptual, visual, sensory and motor components." (p. 375). This finding is particularly interesting for safety training in VEST-Lab because it promotes interactive training.

"Learning by doing" suggests that learning entails the proceduralisation of declarative knowledge through action or performance [8]. That is, theoretical knowledge can be easily acquired, but it has to be manifested in performance to acquire skills. Doing, or taking actions, in safety training can be crucial for developing a mental model to cope with emergencies. However, performing the actual doing in desktop VR is not feasible with conventional input devices, for instance, the operation of a fire extinguisher. According to Brook et al [6], motor information does not have to be gathered by the actual "doing", but encoded in more symbolic way. Performing a task in a VE, therefore, may not have to have a strong verisimilitude with the real world.

Tying information to virtual entities

VEST-Lab has capitalized on the principles and techniques aforementioned. Annotations are associated with entities in the virtual lab. Annotations provide textual and auditory descriptions of laboratory precautions and emergency procedures. Entities are virtual objects, pictures, video-clips and animations. Specific information is related to the graphical semantic of entities. For example, a cylinder lying on the floor is associated with lab housekeeping information for storing cylinders; a picture of a person without eye protection with safety gear equipment; and animation of a fire on the bench with fire emergency procedure. This approach can be seen as a graphical version of the mnemonic technique called "method of loci" [9], an ancient method used by Greek orators for remembering a long speech. The orator relates part of the speech to be remembered with objects along an imaginary or real path. The orator mentally visualizes the path and moves along it to retrieve the information associated with each object [10]. Instead of an imaginary building, a concrete representation of an actual laboratory is depicted. Virtual entities substitute for imaginary landmarks.

The training strategy consists of two phases. In the first phase the trainee is able to explore the virtual lab and spot safety violations. Annotations of lab precautions and emergency procedures are presented when clicking on entities. The second phase gives multiple-choice questions all the way through in the lab. Immediate evaluation of the trainees' answers is provided by the system. It is important to note that VEST-Lab is not intended to substitute for any other form of safety training but to augment the knowledge about laboratory safety in a way that other media cannot.

Research question

This research has focused on how interactivity and co-located information actually help learners to acquire knowledge and make it more memorable. As VEST-Lab is interactive and offers a high degree of visual fidelity with an actual chemistry laboratory, it can be postulated that (a) interactivity would encourage the learner to externalize declarative knowledge in situations, and (b) co-located information would facilitate recalling information and hence learning.

The hypothesis is that trainees who have supplementary training through interactive and co-located information will have better learning outcomes and achieve longer retention of knowledge. If this is true, therefore, these trainees will have higher scores in a safety assessment and the results will have important implications for the design of laboratory safety training programmes.

Experimental design

The study has four experimental conditions; two defined by the method for presenting information in the VEs and two determined by the level of interactivity. Two versions of VEST-Lab for delivering training will be used providing co-located information and non-co-located information. The former displays context dependent annotations (see Fig. 1). The latter presents information in a separate window (see Fig. 2). The level of interactivity determines the type of training. Interactive training will be delivered by both versions of VEST-Lab. Passive training will be a playback session of VEST-Lab, with a paper-based quiz question session. Table 1 shows the four experimental conditions.

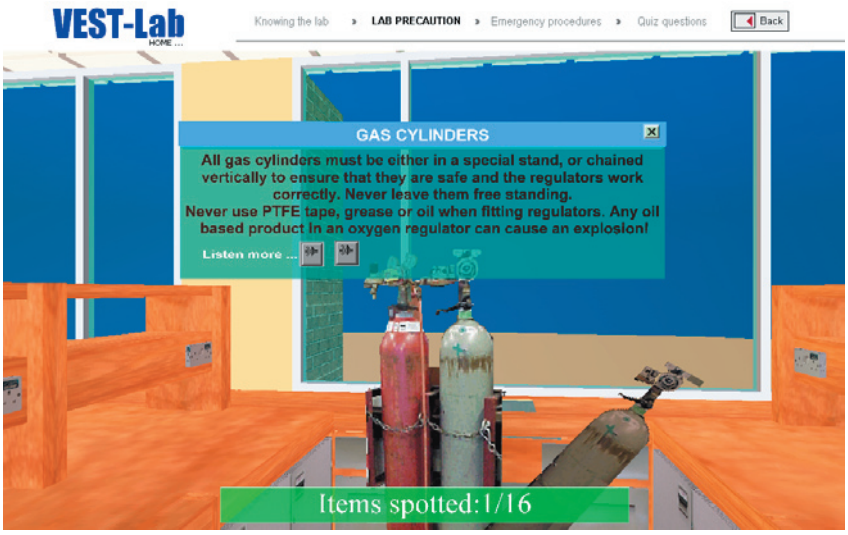

Figure 1. Context depend annotations are tied to entities in the virtual lab.

	Context dependent information	
Training	Co-located	Non-Co-located
Interactive	C1	C2
Passive	C3	C4

Table 1. Experimental conditions.

Supplementary training will be provided to new chemistry students after they have attended the safety induction talk. The reason for this decision relies on three facts: VEST-Lab does not cover all safety issues, as the safety induction does; previous research indicates that VEs are less effective for a learner who does not have prior knowledge of the task at hand [11]; finally, it will establish a knowledge base-line and ensure that the all participants have received the same information prior to the experiment. The evaluation method consists of pre-test, training, and post-test. Pre-test and post-test questionnaires have been designed to test different aspects of recalling information. The questionnaire consists of twelve questions. Four questions can be answered with information provided in the induction lecture; four questions with information provided in VEST-Lab; and four questions with information provided in both induction talk and VEST-Lab. This will help to determine the effect of VEST-Lab training. This questionnaire will be administered to measure learning outcomes. A similar questionnaire will be used to test retention a week later.

Summary

VEs by definition offer the potential of spatial metaphor for learning. Placing together entities and annotations in a contextual environment not only may provide an effective memory retrieval cue, but also a method to encode spatial information and, hence facilitate learning. The extent to which interactivity also plays a role in this encoding will be explored. Results from this research can contribute to and inform the design of effective training environments.

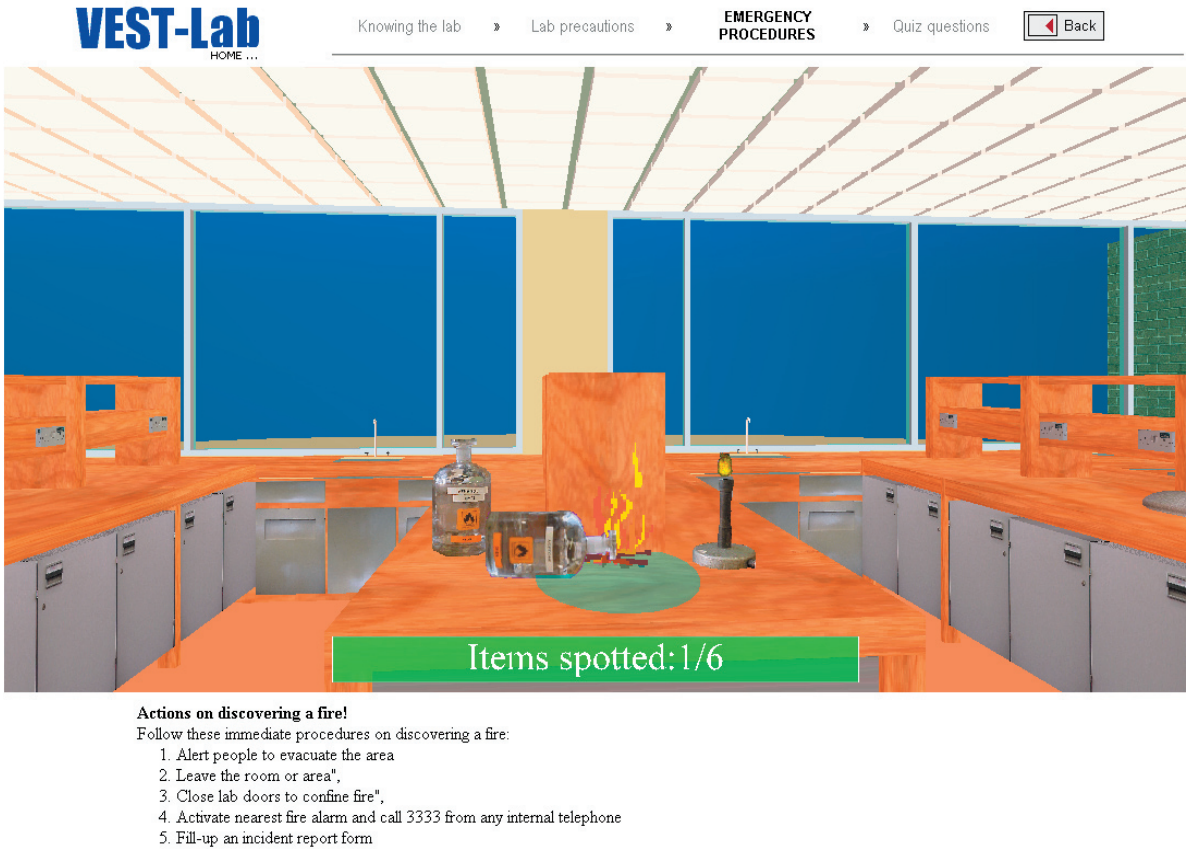

Figure 2. Non-context dependent annotations are displayed "outside" the scene.

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MINIMAL ECOLOGICAL SOUND DESIGN FOR A SENSE OF PRESENCE IN DIGITAL VIRTUAL ENVIRONMENTS

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Abstract
Virtual reality is one of the ways that designers and game programmers are seeking to change the way user's experience digital technology. This paper detailed a minimal approach for providing an effective sense of presence in digital virtual environments. Instead of reproducing realistic sounds, we are finding minimal sound objects and sound events. The user studies of people's imagination of sound identified expectation and discrimination as two important constructs to be considered in designing minimal yet effective ecological sound. Our ongoing research into investigating these constructs is described, along with future avenues for research.

1. Introduction

Most auditory research for virtual environments is based on the rationale of reproducing reality in virtual reality. We suggest another possible approach to auditory design in digital virtual environments. Instead of designing a realistic auditory acoustic virtual environment, a minimal auditory design that holds minimal information (but enough to provide the sense of presence and characteristics of a virtual space) is, we suggest, users need for a successful interactive experience in virtual environments. Looking at sound from the ecological perspective [2,4], the research aims to identify ecological sound source/events that are expected in a virtual space and discriminated over several virtual spaces [1] and to evaluate these with presence measurements, including questionnaires and physiological readings. The end goal of our research will be to design a virtual sound scape – with just enough sound cues for users to identify a virtual place and experience a sense of presence.

1.1 Sense of Presence in Virtual Environments (VEs)

A user's engagement in a virtual environment (VE) is largely a function of the user's "sense of presence" [6]. This perceptual illusion of "being there" in a mediated environment [7,10] involves continuous responses of the human sensory, cognitive and affective processing systems to objects and entities in an environment. Although vision tends to be the dominant sensory channel [9], it is reported that auditory cues are important to the establishment of a 'full' sense of presence in VEs [5].

1.2 Ecological approach to auditory perception

The ecological approach to auditory perception suggests that, phenomenally, we don't 'hear' acoustic signals or sound waves, we hear events [2,4]: the sounds of people and things moving, changing, beginning and ending, forever interdependent with the dynamics of the present moment. We hear the semantics of sound producing objects, events and the environment. The ecological approach has become increasingly popular for sound design in spatial oriented virtual environments and is the one taken in this project.

1.3 Perceived affordances of sound producing objects

In the 'real' world, we have rich auditory information, but, as yet, it is not known what level of realism is needed for ecological sound design in order to achieve a sense of presence in

VEs. The importance of designing everyday things with an accurate affordance for action and functionality is well accepted [4,8]. We wish to explore the factors influencing the perceived affordances of sound producing objects. We highlight the importance of designing sound producing objects with sufficient semantic information to convey the characteristic of a virtual space.

2. Initial Work

2.1 User studies of expectation and discrimination

Results from our initial study [1] show two constructs - expectation and discrimination appear promising mechanisms for designing sound to convey a sense of presence. Expectation defines the extent to which a person will expect to hear a sound in a particular location; discrimination is the extent to which a sound will help to uniquely identify a particular context. We predict that the most useful sounds are those that either elicit high expectation or high discrimination from the listener. By manipulating the expectation and discrimination of sound events of a location, we aim to be able to design a minimal soundscape for a VE.

2.2 Experiment of manipulating expectation

Our second study investigated users' sense of presence by listening to audio clip recorded from real life places, together with matching and mismatching visual image captured to prompt participants' existing mental models. Results shown that the user's sense of presence increase with high expectation (matching stimuli). Low expectation with mismatched audio and visual stimuli resulted in a lower sense of presence.

3. Research Aims

The aims of the present research are:

- To investigate the effects of ecological sound on the development of a sense of presence in VEs.
- To identify aspects of the psychology of ecological sound that will lead to an increased sense of presence.
- To evaluate the effectiveness of minimal ecological sound design in VEs that will achieve enough sense of presence for an effective user experience.

The main contribution to knowledge made by the research will be to provide VE designers with guidelines for designing minimal ecological sound in the development of advanced interactive virtual environments.

4. Current and Future Work

Future work will extend our intial investigation into the role of expectation and discrimination in contributing to minimal ecological sound design. The investigation involves manipulating and evaluation of these two constructs. By the end of this year, we aim to finish a few experiments: 1) manipulating discrimination, 2) manipulating expectation and discrimination of sounds, and 3) the evaluation of sound design for VEs in which sounds are designed with affordance to be highly expected and discriminally perceived.

4.1 Manipulating discrimination

This is an experiment of manipulating discriminated sound of places. A combination of synthesized sound source/events will be added one by one into a soundscape to playback to participants. Presence questionnaire and physiological measurement will be presented. Result from the experiments will determine how many and how much sounds are needed to achieve sense of presence.

4.2 Evaluation of expectation and discrimination

A combination of the above discriminative sounds of each place coupling with some highly expected sound events are presented. The experiment will manipulate the level of volume and resolution of highly expected sound which are low in discrimination, to investigate the minimal sound provision required for effective presence.

4.3 Evaluation of minimal ecological sound design in VEs

We will evaluate the sounds needed for sense of presence in this experiment. An auditory virtual environment will be built using spatial sound as a base for the experiment.

5. Interim Conclusions

Higher expectation clearly promotes users' sense of presence in a VE. The concept of designing minimal ecological sound into VE to achieve just enough sense of presence seems feasible as a research subject. More over it offers a way forward for allowing users of VE in low bandwidth environments - such as those using mobile devices and wide area network multi-users virtual environments - to experience a sense of inter-connected place in chat-rooms and when playing games. By tackling this research from the angle of primary human auditory perception instead of technological driven research we can ensure that the user experience is optimised, while the design of bandwidth hungry technology is avoided.

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