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Planning Effective HCI to Enhance Access to Educational Applications

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Abstract: Information and communications technologies (ICT) are widely believed to offer new options for Web-mediated courseware design. Multimedia and online courseware development accentuates a belief that highly graphical (or visual) delivery media will meet the individualised instructional requirements of diverse student cohorts. While most electronic courseware may allow the user to proceed at their own pace, two assumptions are commonly made by courseware designers. Firstly, to facilitate learning, all users are assumed capable of assimilating the graphical content with their current experiential knowledge. There is little or no consideration of different cognitive styles. Understanding learner attributes is essential to increasing accessibility to computerized information. Secondly, learning is assumed rather than demonstrated. To deal with this issue, data analysis techniques can be used to differentiate between what an individual knows from what they do not. This paper presents two research projects that demonstrate the importance of awareness for the human-dimension of human-computer interaction (HCI) in designing effective online experiential learning for special education.

Keywords: *Human-computer interaction, instructional design, courseware design, information and communications technologies, accessible information, learning design, knowledge management and effective learning design*

Introduction

Effective learning is often expressed in measures of knowing. These pieces of knowledge can represent explicit activities required to become an expert in something [1]. Rarely is the achievement expressed in qualitative terms. Quality may vary according to how a learner feels about a particular learning event [2]. At best, the results may take a broad view of cognitive performance that cannot be applied to individual learners experiencing learning difficulties. There are suggestions for learning orientation that involve dealing with emotions and intentions, along with cognitive and social factors [3]. Herein lies the first dilemma facing the design of effective learning environments, namely how to create appropriate educational environments for those people who require accessibility assistance.

The notion of effective learning design assumes equal access to instructional strategies. However, the ubiquitous nature of many online learning environments means that people who require enhanced instructional delivery modes cannot become involved. For instance, when decisions are made concerning appropriate training/education/reskilling needs for people after some type of traumatized event, it is important to differentiate what an individual knows, from what they do not. However, for this particularly sensitive group of learners there are currently no means of providing a skills/competency measurement tool that is efficient, reliable, and safe to administer.

This paper outlines two projects designed to manage this issue. The first of the two projects sought to enhance the evaluation of young peoples' potential to participate in appropriate educational programs following a mental health episode. As both the young people and their support workers require a specialized tool to determine possibilities for educational/academic performance, it was vital to adopt a customized approach for this type of cognitive skills' evaluation. The expected outcomes of this 1-year Telematics Trust funded research project were to provide a useful tool for young people and their Case Managers, called *carers*, to gauge correctly academic competency in order to offer appropriate skills building programs in the short term, and to enable planning for longer term personal goals. Therefore, it was crucial to determine individual capabilities in terms of intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes [4].

The second of the two projects sought to enhance the Web-based resources for finding work for disabled people who have never been employed, or for people suffering negative effects of long-term unemployment [5]. The research team received a small university grant to conduct a 1-year study. The short-term goal of this project was to develop a system that can deliver enough functionality to demonstrate the benefits of customizing a work-searching system to access relevant knowledge building skills in a vocational rehabilitation setting. On the other hand, a middle-term goal was to secure sufficient interest and funding from a community service provider or industry sector to attract more funding to build the complete system for the longer-term goal of providing a fully interactive specialist Web-portal, linking these job seekers with considerate employers.

It is understandable that this group of individuals may suffer lowered self esteem and lack of motivation to try new things. It was anticipated that this project would capture the efficiencies of HCI to enhance job searching outcomes for people undergoing vocational rehabilitation programs. In Australia, there are some Web-based employment services that claim to provide open, flexible and distributed access for people who may experience difficulty in returning to work after a long absence http://www.maxnetwork.com.au/. Therefore, an immediate challenge for the research team was to provide evidence of the effectiveness of a more specialized Web-mediated work searching system. The first difficulty presented to the design team was to identify the people who will benefit most from such a system. The environmental context of this research project remains unique. Low self-esteem is common amongst the unemployed [6]. Consequently, the system takes on an educative role in order to enhance the self-confidence of people (all age groups) who may have been out of work for many years, or may have never experienced paid employment.

The longer term goal of these research projects is to inform government policy and practice for young Australians with special needs, and reduce the burden for tax payer funded vocational training and rehabilitation programs.

Instructional design approach

In any instructional event it is important to identify the learning domain (the instructional content), and to specify the learning tasks for developing the necessary skills and knowledge to achieve the performance outcomes (the instructional goals). To this end, the term cognitive skill acquisition is used to refer to the set of cognitive skills associated with declarative (knowing what) and procedural knowledge (knowing how) [7]. This type of cognitive skill acquisition can be analysed in four discrete categories [4]:

1. *Verbal information* (knowing basic terms).
2. *Intellectual skill development* (basic rules, discriminating and understanding concepts and principles).
3. *Intellectual skill* (higher-order-rules, problem solving, the ability to apply concepts and principles in new situations).
4. Two different types of *cognitive strategies* (a) to identify sub-tasks, recognize un-stated assumptions, and (b) to recall simple prerequisite rules and concepts, integrating learning from different areas into a plan for solving a problem.

In Project-1, these categories of skill were embedded within the learning content. However, this type of framework was unsuitable for Project-2. Instead, the learning domain concentrated on the intellectual skills associated with problem solving (e.g., deciding which form of public transport to catch to work).

The literature reveals research which distinguishes human ability to process information, as a combination of mode of processing information, and the way people represent information during thinking (see Figure 1) [8].

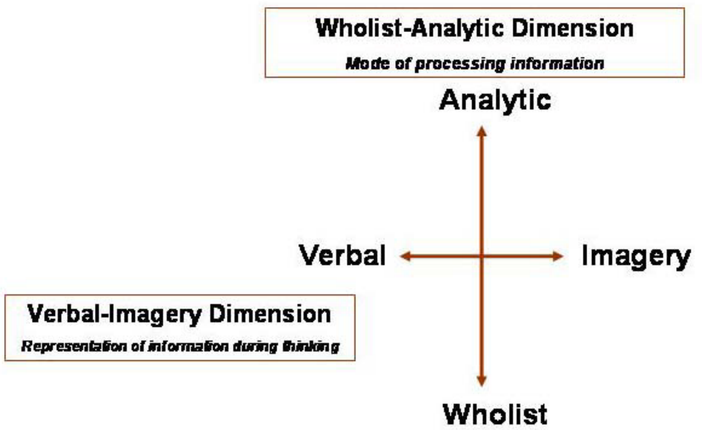

Fig.1 Cognitive style construct

Moreover, there are two fundamental cognitive dimensions, Wholist-Analytic and Verbal-Imagery, that affect performance in two ways. The first relates to how information is perceived and interpreted, while the second relates to how already memorised related information is conceptualises [9]. Cognitive style is understood to be an individual's preferred and habitual approach to organizing and representing information. Measurement of an individual's relative right/left hemisphere performance and cognitive style dominance has been a target of researchers from several disciplines over the last decade [10]. Different theorists make their own distinctions about cognitive differences [11]. According to Riding and Cheema, for example, the Wholist-Analytic continuum maps to the cognitive categories used by other researchers (see Table 1).

Table 1 Researchers' terms for processing information – Mapped to Riding's WA continuum

Terms describing cognitive differences	**Researchers**
Levellers-sharpeners	[]12]
Field dependence-field independence	[13]
Impulsive-reflective	[14]
Divergers-convergers	[15]
Holists-serialists	[16]
Wholist-analytic	[11]

These well known terms are used frequently throughout the literature in a number of different research disciplines.

The Wholist-Analytic dimension defines that Wholist learners are able to understand a concept as a whole, but may find difficulty in disembedding its separate components [17]. On the other hand, Analytic learners analyse material into parts, but find difficulty in understanding the whole concept.

The Verbal-Imagery continuum measures whether an individual is inclined to represent information verbally or in mental pictures during thinking [10]. Verbalisers prefer and perform best on verbal tasks, while Imagers are superior on concrete, descriptive and imaginal ones. When there is a mismatch between cognitive style and instructional material or mode of presentation, performance is deemed to be reduced [18].

Both Projects illustrated this variation in cognitive style, with participants demonstrating preference for verbal or visual representation. For this reason, it is critical to create an instructional environment which caters for the full range of cognitive style preference with delivery options for users to choose from. The Meta-Knowledge Processing Model is proposed here as an effective and robust learning systems' design tool (Figure 2). This Model provides an adaptive cognitive dimension design-framework, which reflects the user's preference for thinking mode (verbal/imagery), while also providing both wholist/analytic instructional strategies to capture the user's inherent information processing mode.

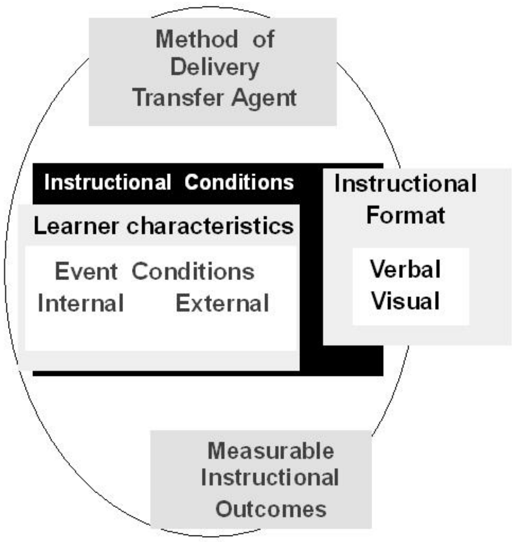

Fig. 2 Meta-knowledge processing model

Every component was described fully to provide detailed system specifications. This was especially important with the production of the visual resources. Each picture was logged with the associated interactions/audio and access location. It was important to keep track of the inter-relating resources to ensure a seamless approach that would reduce stress. Contemporary approaches to instructional design often lack an ability to recognise and accommodate the dynamics of cognitive processes necessary for online learning (see Figure 2). This systems' design modelling tool identifies interactive relationships between cognitive style and instructional format, and the need to adapt the instructional format dynamically. It requires a concurrent acquisition of meta-knowledge relating to the learner's cognitive performance with a knowledge-level-analysis of task difficulty [19].

The instructional environment was described in detail using the Meta-Knowledge Processing Model to define each facet of the system. Consequently, the *method of delivery* chosen to achieve the *measurable instructional outcomes* (readiness for study or skills development) utilized touch screen technology. In keeping with the design brief to ensure that the systems were fun to use, the navigation was kept simple. Users were only required to press the screen to navigate forward, backward and exit. The *instructional conditions* (the learning content) underwent a comprehensive development with subject matter experts and case managers to identify the basic knowledge management issues that surround everyday life-skills. The following were obtained: identification skills (e.g., touching part of a photo that shows a best before date), food preparation (like picking out where the packet of rice was grown), safety (like choosing which extinguisher to use for an oil fire in a kitchen), communication (watching the video that involved a young person being interviewed for a job), magnitude (picking the flower that is closest) and consumer awareness (deciding which advertisement was suitable for outdoors work).

The presentation mode or *instructional format* was pictorial with associated text captions to assist comprehension, and ask questions. Video vignettes with audio explanations were available for demonstrating examples, maintaining the Merrill [20] 5-star principles of instruction (Problem recognition, Activation, Demonstration, Application and Integration). All these principles were designed into the prototypes, including: showing real world problems associated with looking for work, encouraging memory recall by activating some examples of prior experience and integrating new material into everyday life). The vignettes provided examples of everyday activities related to: health and safety, organizing study papers, and preparing for an interview (Figures 3 and 4).

Prototypes

Project-1: EASY

In the first project, the participants were young people who were deemed to have learning difficulties in basic literacy skills (written and oral comprehension and expression), numeracy skills, problem solving and organization, memory and concentration levels. This prototype was built to include a range of tasks that would involve the participants in identifying instances of key elements from safety symbols, diagrams, pictures, tables, or written passages. In addition, the prototype would pose questions relating to magnitudes such as length, width, distance and temperature, aspects of food purchasing, safe storage of food, interpreting recipes, and calculating purchase prices. The design brief was to make access to the computerised information simple and fun to use. Consequently, the Home Page displayed only the acronym EASY which represents the full name Educational / Academic Skills Evaluation. The six-option menu consisted of 6 large buttons (Identification, Magnitude, Food, Consumer Awareness, Safety and Communication). Pressing these buttons took the participant through the series of cognitive assessment tasks. Pressing the Communication button displayed 2 smaller sub-level buttons; these smaller buttons activated the video vignettes (Figure 3). These videos were produced using young people preparing for an interview, and a day at work.

Fig. 3 Prototype-1 sub-level menu

Project-2: eWRAP

The target learners in the second project were youths and adults who were suffering the negative effects of long-term unemployment. As such this second project takes on an educative role, utilizing ICT to enhance the self-confidence of people (all age groups) who may have been out of work for many years, or may have never experienced paid employment. It was very important therefore to design a tailored learning experience that caters for the special needs of this target audience (people requiring enhanced accessibility to information).

It was important for this project to make access to the information easy. Once again this system utilized touch screen technology with both keyboard and mouse removed during the experiment. Therefore, the *method of delivery* implemented a Home Page to welcome the user through an audio greeting that is toggled to a textual description as an alternative (Figure 4). The learning content (*instructional conditions)* consisted of five key job seeking options (Looking, Applying, Starting, Keeping, and Surviving). The navigation was kept simple. Once again Video vignettes offered typical examples of everyday activities that included young people in role play performances to depict: health and safety issues, preparing for an interview, typical job environments, and benefits of socializing at work.

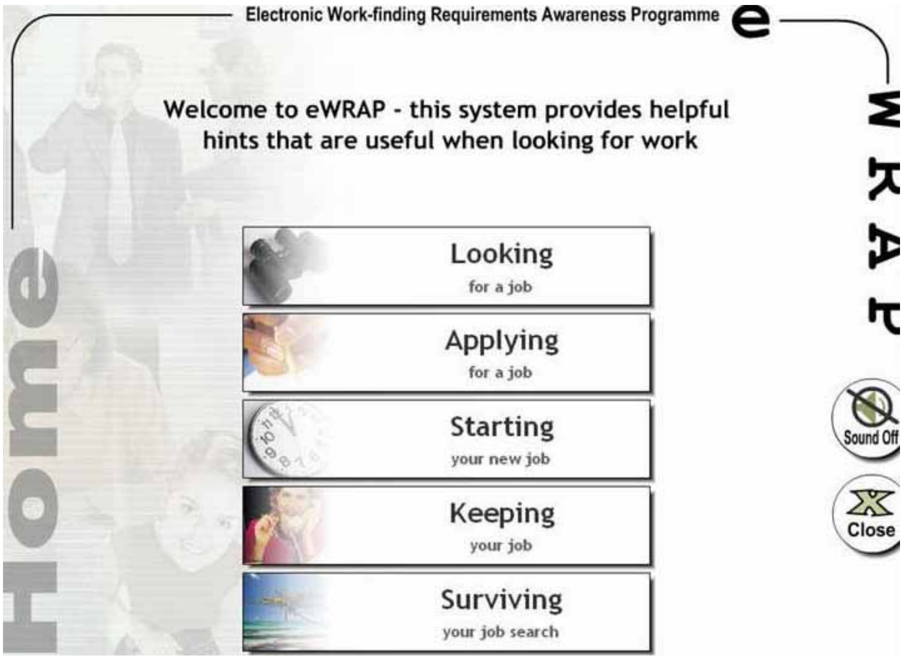

Fig.4 Prototype-2 login screen

Evaluation

The primary aim of this research was to find ways to enhance the interactive effective of instructional strategies and cognitive style for young people wishing to return to study or work, following a mental health episode. The objective was to develop interactive ICT tools that are safe, accurate and easy to use. At the core of this work is the ability to provide adaptive technology that can differentiate users' expectations. In particular cognitive preferences, motivation levels towards the task at hand.

Participants

The 25 participants were attending a special education unit or community-based centre offering vocational programs. They aged between 15-25 years and represented a range of scholastic experiential awareness. The sample was grouped according to Project. The Project cohort varied in their catchment areas from suburban to poor urban. There were more school aged participants attending the special education unit than the community-centre, while the number of participants with a working background was low compared with the number of those attending the community-centre. In each Project, all the participants were given the opportunity to decide whether to participate or not. Many of them of them had no previous computer related experience.

Materials

Both Projects involved a computerized prototype system, preloaded onto one standalone IBM compatible computer. Each prototype employed a touch screen to reduce the likelihood of reluctance to access a computer [213]. The participants were not expected to access the prototype using a mouse or keyboard; the processing unit was placed away from the screen. Due to the need to respect the privacy of the participants, the prototypes were not designed to capture and store any data. The cognitive performance data-capture instruments were hard-copy. A performance coding sheet was used to collect the data for Project-1, while a simple feedback sheet was used for Project-2.

Procedure

The research team conducted a thorough task analysis of the knowledge acquisition environment relating to young people wishing to return to study or participate in community-based vocational rehabilitation programs.

For Project-1, the experiment tested the participants to determine the level of remedial intervention required for vocational re-training/rehabilitation. The Australian benchmark, Curriculum and Standards Framework (CFS) [2~~2~~1], was used to devise the learning outcomes as key English literacy learning areas/strands (speaking and listing, reading and writing). The CFS is structured in key learning areas, strands and levels, describing what students should know and be able to do in eight key areas of learning at regular intervals. Each strand was divided into sub-strands (texts, contextual understanding, linguistics, and strategies). A cognitive performance matrix was developed by the lead researcher to fill the gaps found in existing systems, which currently adopt the CFS framework [23~~2~~]. This matrix identified educational and academic tasks in terms of basic to complex (see the left-hand, vertical rows in Table 2), and measurable cognitive performance outcomes in terms of declarative (*knowing that* – verbal information) to procedural knowledge (or *knowing how* – a cognitive strategy) [21~~3~~]. These categories are shown on the horizontal rows in Table 2. This framework formed the basis of the educational/academic skill’s performance testing instrument, along with a series of visual (pictorial) and text-based information sequences to depict everyday life experiences, including: identifying factual detail, examples of magnitude, food preparation, consumer awareness, safety and communication. In order to evaluate the cognitive performance of each participant, the QUEST Interactive Test Analysis System was used. The QUEST software application was written by Raymon J.Adams & Siek-Toon Khoo, and published by The Australian Council for Educational Research Limited in 1993 [24]. Central to QUEST is a measurement model developed in 1960 by the Danish statistician George Rasch. QUEST develops a uni dimensional scale with equal intervals along each axis, to measure individuals' performance and test items together [24]. The resultant cognitive performance measurement instrument was calibrated to ensure validity [25].

Table 2 Cognitive performance capability matrix

<table>
<tr><th colspan="7">Instructional Objectives : Measuring Academic Performance : Concentration and Attitude</th></tr>
<tr><td rowspan="6">Automated Educational/ Academic Skills Evaluation for Young People: (EASY) system Proof-of-Concept</td><td colspan="2">Declarative Knowledge</td><td colspan="3">Procedural Knowledge</td><td rowspan="6"></td></tr>
<tr><td>Band-A</td><td>Band-B</td><td>Band-C</td><td>Band-D</td><td>Band-E</td></tr>
<tr><td>Verbal information skill</td><td>Intellectual skill</td><td>Intellectual skill</td><td colspan="2">Cognitive strategy</td></tr>
<tr><td>Concrete concept</td><td>Basic rule</td><td>Higher-order-rule</td><td rowspan="2">Identify sub-tasks</td><td>Knowing the “how”</td></tr>
<tr><td>Knows basic terms</td><td>Discriminates</td><td>Problem solving</td><td>Recall simple pre-requisite rules & concepts</td></tr>
<tr><td>Knows “that”</td><td>Understands concepts & principles</td><td>Applies concepts & principles to new situations</td><td>Recognizes unstated assumptions</td><td>Integrates learning from different areas into plan for solving a problem</td></tr>
<tr><td rowspan="2">Learning Domain Task Code = R</td><td rowspan="2">Texts</td><td colspan="4">Aspects of Language</td><td rowspan="2">Totals</td></tr>
<tr><td>Contextual understanding</td><td colspan="2">Linguistics</td><td>Strategies</td></tr>
<tr><td>Reading (constructing meaning from print & non-print)</td><td>Literature (books, etc)</td><td>Everyday texts (telephone conversations, notices)</td><td colspan="2">Media texts (newspapers, Internet, TV, Video, CD-ROM)</td><td>Workplace texts (letters, resumes, reports, etc)</td><td></td></tr>
</table>

However, for the job search prototype (Project-2), the performance matrix had limited value. Instead, a series of meetings were held with subject matter experts to develop a typical user profile [26]. A number of characteristics were identified by the involved experts, including: confidence and self esteem, revaluating personal goals, experienced some break from employment, education and training (can be several years), last experience of employment education or training may have ended negatively. Consequently, a list of key work-seeking skills were identified: finding appropriate work (indoors/outdoors), preparing an application, dealing with rejection, planning for the first day (travel/food/clothing), how to stay employed, and what to do when the work ended. Visual (pictorial) metaphors were devised to facilitate the learning content to include: self-confidence, motivation, managing food, travel, personal budgeting and managing social welfare benefits. Textual representation was kept to a minimum; instead, voice clips were available to provide appropriate information. Not enough is known yet about how people respond to hypertext in a Web-based instructional environment. Research is needed to establish a taxonomy of tasks to analyse and compare usability issues [27]. -Video vignettes were used to depict examples of real world instances of deciding on which type of public transport to catch, preparing food and clothes, and a sample job interview (both examples and non-examples). It is sound instructional design practice to contrast the good example (of a concept of thing) and show the non-example to increase the effectiveness of the demonstration [20].

The data gathering process was different for each Project. The data gathered for Project-1 occurred during a pre-arranged consultation session. This session was facilitated by the participant's regular teacher. The participant's performance was recorded by the teacher on the performance coding sheet during the session. Project-2 captured participants' answers on the feedback sheet that they were asked to complete at the end of their session. In addition, in Project-2, a research team-member sat in the room while the participant used the prototype, to answer any questions from the participant.

Results

Analysis of the test item data for Project-1 used the QUEST interactive test software [24] in order to avoid measurement errors in the testing instruments. The QUEST estimate allows for improved analysis of an individual's performance relative to other participants [28], and relative to the test-item difficulty [29]. This analysis was able to calibrate the responses to the cognitive performance measurement instrument, providing a basis for assessing the participants' progress towards returning to study or vocational training. The analysis of the data showed a clear differentiation of test-item difficulty and user skill levels [23]. The QUEST tool, combined with the teacher's observations, was also able to identify that some participants performed well with visual tasks (select the closest flower, pick the largest building block, etc), where they had difficulty with text/numeric test-items (find an ingredient from a recipe, calculate the cost of several grocery items, etc). Conversely, those participants able to quickly calculate purchases, often pondered over visual perception tasks. In summary, an analysis of the test item data reveals there were 56 right/wrong and partial credit test items (with a maximum possible score of 64), suitable for the evaluation of educational and academic skills of young adults, were able to be calibrated to form the basis of assessing progress made towards returning to study or vocational training [23].

Testing of the systems for Project-2 was executed over a four month period during 2003. Preliminary qualitative feedback, including that of several non-computer users, was very positive. The users found the system easy to use, informative; they could relate to the characters in the various video vignettes. An example of the comments from the participants included: "*the person applying for the computer position reminded me of people I know, it made me think that* *behaving like that is not good*" and "*I can see that wearing suitable clothing is important for an interview*". As with Project-1, there was differentiation between participants' usage of the system. Some participants preferred listening to the verbal descriptions of menu items, whereas others turned the voice toggled option off, and read the textual descriptions. Many of the participants enjoyed the videos and comic metaphors. However, a few preferred just to read through lists and descriptions.

Access to Information

There can be no doubt that interest in learning has shifted from an insular approach to school-based education to participation in a global knowledge sharing environment. As a result, a turning point has been reached in the design and development of multimodal courseware. For instance, within the context of online asynchronous learning platforms, there is a noticeable shift from traditional teaching methods, which provide for a sole learning-content provider (class-room teacher) [30], towards a multiple mentor-guiding approach (multiple facilitators on duty to answer questions) [31]. However, in adopting this newer approach, it is assumed that the knowledge management process during the learning event will appeal to all learners [32]. Sadly, this type of online instructional strategy reflects a lack of understanding of the effects of computerized learning on the population at large, rather than reaching the individuals who may require increased assistance with access to information.

The design process of a computer-human interface is complex, and instructional designers need to ensure that careful attention is paid to sound and well-founded instructional design principles [33]. In general terms, online courseware designers need to be aware of a meta-knowledge acquisition process, relevant adaptive instructional strategies, the need to articulate the conditions-of-the-learner, which relate to information processing preferences and learning content environmental factors [19], and to demonstrate that the desired learning has occurred. This combination of design processes formulate a comprehensive HCI model to direct the online learning experience that best achieves a high quality instructional outcome [29]. The advent of ICTs has perhaps introduced a false sense of making life easier for the educational systems designers. While multi-sensory instruction is known to improve a student's capacity to learn effectively (as judged from appropriate evidence), the overarching role of knowledge-mediated HCI has been poorly understood in the design of instructional strategies that integrate contextual components in asynchronous learning frameworks. The limitations of contemporary approaches to instructional design appear to lie in the failure to recognise and accommodate learning process dynamics, specifically the interactive effects between cognitive style and instructional format and the need to adapt the instructional format dynamically. It may be concluded that the mechanism to achieve such dynamics lies in the concurrent acquisition of knowledge about the learner's cognitive performance within a contextual framework defined by a knowledge level analysis of task difficulty.

Customising learning environments draws together the inter-disciplinary nature of HCI. Aspects of instructional science, cognitive psychology and educational research are combined to articulate these meta-knowledge requirements. Consider the interactive relationships that occur between the environmental factors of an online work-space that, for example, includes general noise that surrounds the work-space, and health and safety factors that may directly induce stress through unwise choice of colour in the user interface design (Table 3, adapted from [33]).

Table 3 Human factors in HCI (adapted from Preece, 1994):31)

<table>
<tr><td colspan="2">ORGANIZATIONAL FACTORS
Training, job design, politics,
roles, work organization</td><td colspan="2">ENVIRONMENTAL FACTORS
noise, heating, lighting,
ventilation</td></tr>
<tr><td>HEALTH & SAFETY FACTORS
stress, headaches,
muscoluo-skeletal disorders</td><td colspan="2">cognitive processes & capabilities
THE USER
motivation, enjoyment, satisfaction
personality, experience level</td><td>COMFORT FACTORS
seating,
equipment layout</td></tr>
<tr><td colspan="4">USER INTERFACE
Input devices, output displays, dialogue structures, use of colour, icons, commands,
graphics, natural language, 3-D, user support materials, multi-media</td></tr>
<tr><td colspan="4">TASK INTERFACE
Easy, complex, novel, task allocation, repetitive, Monitoring, skills, components</td></tr>
<tr><td colspan="4">CONSTRAINTS
Costs, timescales, budgets,
Staff, equipment, building structure</td></tr>
<tr><td colspan="4">SYSTEM FUNCTIONALITY
Hardware, software, application</td></tr>
<tr><td colspan="4">PRODUCTIVITY FACTORS
Increase output, increase quality, decrease costs, decrease errors</td></tr>
</table>

There are few instances of online courseware design where these relationships are maximised. For instance, in a recent study of adult learners in Mexico [34], where special circumstances relating to access to educational technology were identified, the courseware designers neglected to address many of the HCI components listed in Table 3. In that nationwide qualitative diagnostic study, which involved community based adult education centres, the researchers were hoping to provide online educational facilities for disadvantaged adults without a basic education. It was known beforehand that these adult learners may also suffer from socio-economic marginalization, and may not have access to educational content relating to work-based training using printed, audiovisual and electronic media. Surprisingly, the study was not planned with an emphasis on any of these necessary HCI inter-relationships. Consequently, constructive learning or practical application was not achieved.

HCI relationships are magnified in the special education environment that has been described earlier in this paper. They involve people who require enhanced accessibility to information that is to be found on the Internet. Special education is now further defined here in a broader sense, as pedagogical practice especially designed as assistive technology for people with learning disabilities [35], which include the residual effects of recovering from an episode of mental illness [26]. While a special education literature on computerized learning programs has emerged in the last decade, mapping this type of HCI in terms of utilizing new knowledge in new situations has not been achieved. However, at this point, computerised learning systems that would monitor how teenagers and young adults engage in knowledge development, would implement HCI in a manner akin to a revolution in conceptual change [36]. Currently there are no assessment instruments that adapt according to the interactive effects of cognitive style and instructional format.

Summary and conclusions

The two projects outlined in this paper have provided valuable experiential knowledge of the educational systems' design process. The EASY Project evaluated the effectiveness of an innovative testing tool, which enables differentiated teaching, provides adaptive cognitive skills measurement, correctly identifies different levels of competency, promotes self-confidence and enhances motivation towards learning abilities. The eWRAP Project evaluated an online job seeking prototype designed to assist the long-term unemployed.

To offer new options for Web-based courseware designers, this paper has presented examples of practical ICT applications that promote the principles of sound instructional design implemented through HCI. The essence of this work reflects the importance of the interacting relationships amongst the various HCI components as identified by Preece [33]. While it is suspected that these variables form dependent relationships online; it is still early days. More research is needed to understand how these interacting variables behave within a Web-mediated context. Progress may be slow, as it does take time to disseminate researchers' findings through to the community to solve real world problems.

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References

[1]. Bransford, J.D., Nitsch, K. and Franks, J.J. 1977. Schooling and the facilitation of knowing, in *Schooling and the acquisition of knowledge*, R.C. Anderson, R. Spiro, and W. Montague, Editors, Erlbaum: NJ.

[2]. Sonnier, I.L. 1989. Affective education: Methods and techniques. NJ: Educational Technology Publications.

[3]. Martinez, M. 2000. Foundations for personalized web learning environments*. ALN Magazine - A publication of the Sloan Consortium*, **4**(2 - December).

[4]. Gagne, R.M. 1985. The conditions of learning: And the theory of instruction. 4th ed. NY: Holt/Rinehart/Winston.

[5]. van Dongen, C. 1996. Quality of life and self-esteem in working and non-working persons with mental illness*. Community Mental Health*, **32**(6): 535-549.

[6]. Woolston, C. 2002. *Why unemployment is bad for your health*, Principle Health News.

[7]. McKay, E. and Merrill, M.D. 2003. Cognitive skill and web-based educational systems, E. McKay, Editor, Paper presented at the *eLearning Conference on Design and Development: Instructional Design - Applying first principles of instruction.* Melbourne: Informit Library: Australasian Publications On-Line: Available 15/09/06, from http://www.informit.com.au/library/ . 96-108.

[8]. Riding, R.J. and Mathais, D. 1991. Cognitive styles and preferred learning mode, reading attainment and cognitive ability in 11-year-old children*. Educational Psychology*, **11**(3 & 4): 383-393.

[9]. Riding, R. 1993. *A trainer's guide to learning design : Learning methods project report*, Assessment Research Unit, University of Birmingham, UK: Birmingham, 47.

[10]. Riding, R.J. and Rayner, S. 1998. Cognitive styles and learning strategies. United Kingdom: Fulton.

[11]. Riding, R. and Cheema, I. 1991. Cognitive styles - an overview and integration. *Educational Psychology*, **11**(3&4): 193-215.

[12]. Holzman, P. and Klein, G. 1954. Cognitive-system principles of levelling and sharpening: Individual differences in visual time-error assimilation effects. *Journal of Psychology*, **37**: 105-122.

[13]. Witkin, H.A., Dyke, R.B., Patterson, H.F., Goodman, D.R. and Kemp, D.R. 1962. Psychological differentiation. NY: Wiley.

[14]. Kagan, J. 1965. Individual differences in the resolution of response uncertainty. *Journal of Personality and Social Psychology*, **2**: 154-160.

[15]. Guilford, J. 1967. The nature of human intelligence. NY: McGraw-Hill.

[16]. Pask, G. and Scott, B.C.E. 1972. Learning strategies and individual competence. *International Journal Man-Machine Studies*, **4**: 217-253.

[17]. McKay, E. 1999. An investigation of text-based instructional materials enhanced with graphics. *Educational Psychology*, **19**(3): 323-335.

[18]. Riding, R.J. and Caine, R. 1993. Cognitive style and GCSE performance in mathematics, English language and French. *Educational Psychology*, **13(1)**: 59-67.

[19]. McKay, E. 2000. *Instructional strategies integrating the cognitive style construct: A meta-knowledge processing model (contextual components that facilitate spatial/logical task performance)*, in *Com.Sci.& Info.Sys.(PhD Thesis)*, Deakin Univ.: Australia, 3 Volumes. Available 18/11/06 from http://tux.lib.deakin.edu.au/adt-VDU/public/adt-VDU20061011.122556/ .

[20]. Merrill, M.D. 2003. Keynote address: Does your instruction rate 5 stars?, E. McKay, Editor, Paper presented at the *eLearning Conference on Design and Development: Instructional Design - Applying first principles of instruction*. Melbourne: Informit Library: Australasian Publications On-Line: Available 15/09/06, from http://www.informit.com.au/library/ . 13-14.

[21]. McKay, E. and Izard, J. 2004. Automated educational skills evaluation: A systems design case study, E. McKay, Editor, Paper presented at the *International Conference on Computers in Education - Acquiring and Constructing Knowledge Through Human-Computer Interaction: Creating new visions for the future of learning*. Melbourne Exhibition Centre, Australia: Nov 30th to Dec 3rd. Common Ground Publishing: Vol: 1 of 3. pp1051 - 1061. ISBN: 1 86335 573 1.

[22]. *English curriculum and standards framework II.* 2000. *375.0009945*.

[23]. Izard, J. and McKay, E. 2004. Automated educational/academic skills screening: Using technology to avoid or minimise effects of more formal assessment, P.L. Jeffrey, Editor. Paper presented at the *Australian Association for Research Education (AARE 2004): Positioning education research*. Nov 28 - Dec 2, in Melbourne. Retrieved 15/09/06, from http://www.aare.edu.au/04pap/iza04951.pdf .

[24]. Adams, R.J. and Khoo, S.-T. 1996. QUEST:The interactive test analysis system. Vol. 1. Melbourne: Australian Council for Educational Research. 96.

[25]. Izard, J. 1999. *Some potential difficulties in educational research studies (and how to avoid them), paper written for the third elementary education project, Philippines.*

[26]. McKay, E., Thomas, T. and Martin, J. 2004. Work search prototype design: Human-computer interaction for vocational rehabilitation, v.Uskov editor, V. Uskov, Editor, Paper presented at the *International Association of Science and Technology for Development - Computers and Advanced Technology in Education (CATE 2004), held August 16-18*. Kauai, Hawaii, USA. 167-172: ACTA Press: Anaheim. 167-172.

[27]. Chen, C. and Rada, R. 1996. Interacting with hypertext: A meta-analysis of experimental studies. Human-Computer Interaction, 11: 125-156.

[28]. Izard, J. 1995. *Trial testing and item analysis*, International Institute of Educational Planning: Victoria, Australia.

[29]. McKay, E. 2000. Measurement of cognitive performance in computer programming concept acquisition: Interactive effects of visual metaphors and the cognitive style construct. *Journal of Applied Measurement*, **1**(3): 257-286.

[30]. Axmann, M. 2002. An online mentorship programme for the online educator: Patterning for success, Paper presented at the *Australian Society for Educational Technology International and Technology Conference (ASET 2002): Untangling the Web-Establishing Learning Links*, held July 7 - 10, Melbourne, Australia.

[31]. Axmann, M. 2004. Human capital development in an online mentoring system. MA Thesis, University of Pretoria.

[32]. Axmann, M., McKay, E., Banjanin, N. and Howat, A. 2006. Towards web-mediated learning reinforcement: Promoting effective human-computer interaction, Paper to be presented at the conference on Web-Based Education (WBE 2007), International Association of Science and Technology for Development (IASTED), to be held March 14-16 in Chamonix, France.

[33]. Preece, J., Rogers, Y., Sharp, H., Benyon, D., Holland, S. and Carey, T. 1994. Human-computer interaction. Harlow - UK: Addison-Wesley.

[34]. Santos, A. 2004. Do community technology centers decrease social inequities? Results of a nationwide qualitative study to evaluate the plazas communitarieas project in Mexico, E. McKay, Editor, Paper presented at the *International Conference on Computers in Education - Acquiring and Constructing Knowledge Through Human-Computer Interaction: Creating new visions for the future of learning*. Melbourne Exhibition Centre, Australia: Nov 30th to Dec 3rd: Common Ground Publishing. 1133-1144.

[35]. Atkinson, D. and Walmsley, J. 2003. Time to make up your mind: Why choosing is difficult. *British Journal of Learning Disabilities*, **31**(1, March).

[36]. Thargard, P. 1992. Conceptual revolutions. NJ: Princeton University Press.