INTERNATIONAL JOURNAL OF EDUCATION AND INFORMATION TECHNOLOGIES
Issue 1, Volume 2, 2008

A two-group evaluation to e-note

Shaista Rashid and Dimitris Rigas

Abstract— This paper comparatively analyses the traditional method of learning as opposed to electronic. Insight has been provided into learning parameters within the area of note-taking. Research regarding the capture and recording of notes have been covered providing explanations into different note-taking techniques. The stages involved in note-taking including encoding and reviewing have been analysed. Factors influencing note-taking skills and performance were explored. Pedagogical principles a part of the design and construction of an e-learning environment were derived. Influential stimuli metaphors including multimodality were researched stating the significance they provide to learning. A two-group study between two e-learning platforms, one an adaptation of the paper-based Cornell and the second En-AISR a platform comprising of multimodality have been developed and tested. Variables independent and dependent have been defined, restricting confounding factors where possible. Results of the experiment show statistical significance in favour of En-AISR in terms of usability parameters; effectiveness, efficiency, and subject satisfaction.

Keywords— E-Learning, En-AISR, Note-Taking, Multimodality.

I. Introduction

IN all walks of life obtaining knowledge is customary and can be captured in a number of ways. This can be achieved through deliberate means such as picking up a book or passive by listening to someone. The content of knowledge is translated by individuals and acquired by the skill of note-taking. This skill differs from person-to-person and is dependent upon personal preference of the technique utilized. The core entity associated with note-taking is students, who on a regular basis are required to undertake this task on a mass scale.

This paper provides insight into note-taking and the processes involved. Influences of note-taking upon learning are discussed explaining their significance in terms of improved results in performance tests. The trend towards e-learning and pedagogical principles are discussed alongside hardware and software associated with the task of taking notes. A within-subject comparative analysis into two electronic note-taking systems has been carried out. Attempts to keep consistent the procedure and variables to validate the experiment have been enforced. The results demonstrate how the En-AISR outperforms the E-Cornell according to usability parameters.

Manuscript received November 28, 2007; Revised received February 14, 2008.

S. Rashid is with the University of Bradford, Department of Computing, Bradford England, BD7 1DP; phone: 00 44 1274 236830; fax: 00 44 1274 235856; e-mail: S.Rashid5@Bradford.ac.uk.

D. Rigas is with the University of Bradford, Department of Computing, Bradford, England, BD7 1DP; e-mail: D.Rigas@Bradford.ac.uk.

II. Note-taking

Theoretically, note-taking is perceived as the transfer of information from one mind to another collecting and recording notes and/or ideas. Typically, communication is delivered by speech and assisted with anecdotes. This process continues with the adoption of an appropriate note-taking technique to organise the information. To capture notes there are many techniques one can adopt however, different techniques are appropriate in different situations.

The most popular technique to date is the Cornell note-taking method [1], Fig. 1. The Cornell method is a systematic approach for arranging and condensing notes without multiple recopying. This method is simple consisting of three main sections: Area A-Keywords; Area B-Notes and Area C-Summary. The major strength of this technique is its ability to deploy it within any area of study technical and non-technical modules. It is a straight-forward effective way of capturing and organising notes instantaneously.

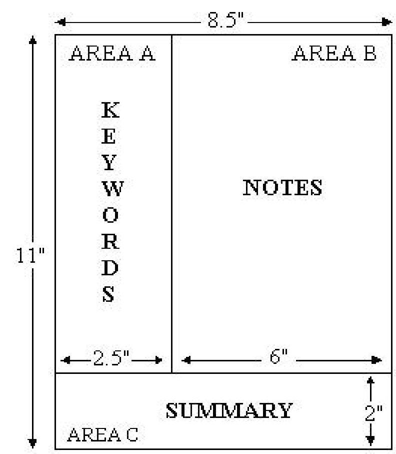

Fig. 1 the Cornell note-taking method

Comparatively, the Outlining method Fig. 2, involves dash or indentation and is not suitable for subject areas such as mathematics or physics. Specific facts are indented with spaces to the right; relationships are also represented via indentation therefore, eliminating the need for letters, numbers, and roman numerals [2]. The advantage of this technique is the neatly organised structure reviewing with ease. However, the downfall is, to achieve well-organised notes the student must fully concentrate. Thus, this technique is not preferred if the lecturer is going at a fast pace [2].

Example: -
Note-taking
_definition: short paraphrases to assist memory
_types -
_Cornell
_Outlining
_Mapping
_factors -
_cognition
_memory
_sensory

Fig. 2 Example of the Outlining method

The difference in the Mapping method, Fig. 3, in comparison to the Cornell method and Outlining method is that it is a graphical representation of the lecture content. Hence, to maximise the accuracy and quality of notes the student must actively participate and initiate critical thinking [3].

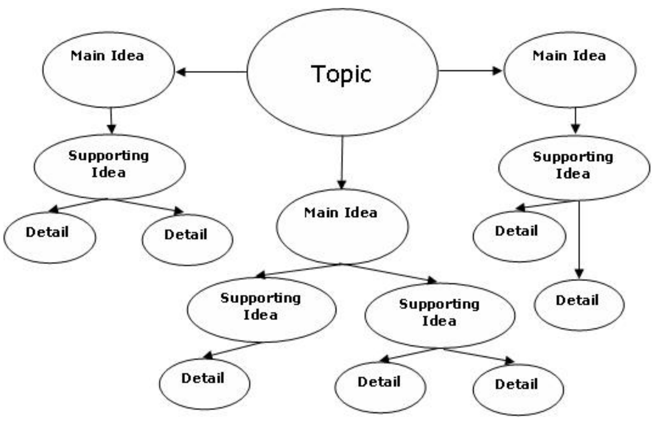

Fig. 3 Example of the Mapping method

The note-taking process can be broken down into two stages; encoding and reviewing. The former involves the capture of information whilst the latter directs towards the arrangement and reviewing of the recorded notes. The encoding process is immensely influenced by the quality of recorded notes. There is a 34% chance of recalling textual information if it is noted compared to a 5% chance in absence [4]. The relationship between encoding and reviewing is reported in many studies. One of many studies observed if notes are made but not reviewed then this is still positively shown in test performance [5]. However, this finding suggests note-taking aids but does not ensure recall and is encouraged by the reviewing process. Ideally, reviewing should be carried out nearer the exam to achieve maximum value. Many studies have reported students' capture less than 40% of the lecture content [4, 6] typically around 20%-40% of the important ideas [7]. To improve this students must be given training as they actively participate before, during and after lecture. Thus, the elements of what needs to be captured are influenced by their purpose, interpretation and technique.

The benefits of note-taking can be assessed in performance tests that measure generative learning and the amalgamation of new information to prior knowledge [8]. The author's findings reported that note-takers performed better than non note-takers. Moreover, students who recorded and reviewed their own notes achieved 93% accuracy in comparison to 71% accuracy in students who made notes but reviewed provided notes [9]. Students are not trained note-takers therefore, they will possess weak approaches including recording vague notes, making outlines and rehearsing content. More importantly, there is a 99% statistic of note-takers [10] with 80% of their time being spent on listening to lectures [11] and a 94% value of importance towards note-taking [12]. To prepare for an assessment, 29% of students revise by adding, deleting or re-organising their notes, 12% do nothing but merely recopy them exactly, and 47% review their notes [13]. To achieve effective comprehension, active participation from students is required whereby, they fully engage through reading and interpreting content. Thus, techniques initiating active reading, note-taking and learning flexibility are substantially significant.

III. E-LEARNING

E-Learning, also often referred as distance education, utilizes a number of technological devices. Educational institutes are today known to deliver academia over the Internet. The Internet has great potential allowing not only learning material to be taught but also for collaborative learning to take place. Within the next ten years the growth of online student learners is predicted to reach 5-million from 240,000 [14].

To have a successful e-learning system all sub-components and interrelated processes must be considered. This is because if one process fails then the entire system can fail therefore; underlying pedagogical principles must be derived. These include considering the user's behaviour towards the system as it is an isolated activity and users can become frustrated. As the Internet has a vast amount of knowledge it can be presented in a bias manner providing users with partial information. Considerations for the environment and the user actions to be performed to achieve a specific goal must be clearly outlined. Furthermore, user's interpersonal skills including their attitudes, perceptions and behaviour are central to affecting the effectiveness. E-learning reduces teaching time, increases proficiency and improves retention [15]. Nevertheless this is not always true, as one particular study presented lecture notes online and results showed students performed weaker [16].

E-learning is provided globally, allowing users to read books online, annotate, and collaborate by discussing subject content. Research has shown the use of an online notepad can achieve higher then pen and paper methods [17]. Reinforcing this point, annotation increases efficiency in a number of ways including supporting memorisation, improving comprehension, encouraging critical thinking, and allowing clearer understanding of text. Annotation applications introduced include Microsoft Word and OneNote that concentrate on annotation and SharePoint, which allows manipulation, editing, and annotation simultaneously.

Many institutes have integrated Tablet PC's [18, 19] as a medium to replace the blackboard. These are typically connected to a data projector so students are able to make notes that are visible to the rest of the class. During an experiment that utilizes these, results demonstrated students had a better understanding of the lecture and concentrated more [20]. Thus, the use of Table PC's is known to increase and enhance a greater collaborative learning environment with increased interactivity being its main benefit.

The significant difference between the traditional method of learning in comparison to computerisation is the medium over which content is transmitted. The flexibility enables students to learn at a time and place of their choice however; this in terms of feasibility regarding whether learning should be entirely web-based is arguably one of the most important factors. The major difficulties faced by the e-learning shift are the drive for motivation and culture clash. Many learners are just not prepared to accept the change and so prefer the traditional means of study.

IV. Multi-modality

Use Learning is typically perceived as a classroom activity with the tutor stood at the front writing content on a white/blackboard and conveying material through speech. However, today one can broaden this perception with the adequacy of e-learning and potentially more flexible resources. The exploration into multimedia as an enhanced mechanism assisting learning is ongoing. It has been learned that the average student captures information using a number of metaphors, 29% visual, 34% audio, and 37% through haptics [21]. Although, the presentation of material on-line has been perceived as textually oriented and overwhelming [22].

Multimedia as a term refers to the assimilation of two or more media for example, text, video, animation, sound and music. The interactivity parameter draws users in a particular system to engage in a distinctively enhanced experience, interacting and navigating throughout with greater flexibility. Instructions conveyed through multimedia increase efficiency in learning tasks and effectively motivate users. The aural sense can be influenced by the pattern of sound, which can determine the effects by either being disruptive or pleasurable. The incorporation of non-speech sounds in interface is growing due to the positive influence it provides. This includes improved performance and increased usability [25].

Non-speech sound is complemented with visual output because the information is distributed across various senses. The visual angle of the retina can subtend an angle of two-degrees around the point of fixation, whilst the flexibility of sound is such that it can be heard 360-degrees without paying attention towards the output device. Additionally, another task can be carried out simultaneously. The arrangement of visual displays can be expressively powerful, with organisation of objects in sequence and motion, toolbars, menu options, and iconic representations. This reduces visual overload and allows structuring of content in an instructional methodological form. Within the object features for example scrollbars, sound enhancements can assist in solving usability issues with varied tones.

The relatively significant potential of speech recognition within interfaces is advancing. The prime means of interacting between human and computers may possibly be through speech and sound. Two types of speech include speech as spoken input and Automatic Speech Recognition (ASR). Spoken input refers to dictation, navigation or transaction systems where the spoken input appears as text output, Text-To-Speech (TTS).

Numerous challenges are faced by speech recognition programs which include, the extensibility of existing technologies, input complexities with pronunciations of words, sound clarity, efficiency in respect to the holding of large dictionaries, and effects from the surrounding environment with variations in levels of noise [24]. Predominantly, the major obstacle is the reduction of error rate and the sensitivity element. A way to overcome this is by amalgamating much more multi-modality specifically assigned to particular tasks. Thus, limiting implementation and rigorously constructing metaphor use resulting in reducing complexities [25]. Moreover, speech recognition can be used as a means of information retrieval. The Sphinx II open source framework supports a 20,000-word dictionary and has been a successful speech recogniser when compared to alternative transcripts [26].

V. Experimental Note-Taking System

The note-taking systems designed and developed include the E-Cornell and En-AISR platforms. Both systems are electronic based. The design structure concentrates on three main concepts; the encoding, storage and reviewing processes. The encoding stage depends upon directing the students towards the initial capture of notes and the effectiveness of this initial collection. The storage process concentrates on the structural organisation and arrangement of the notes and the review process focuses on the retrieval aspect. The difference between the two systems is the structural layout with the En-AISR comprising of multi-modality. The E-Cornell will serve as the control group and the En-AISR the experimental group.

The E-Cornell note-taking system adapts the paper-based method devised by Professor Pauk [1]. The design structure has a keyword column, a note-taking area and a summary area. The keyword column allows users to form keywords or phrases, the note-taking area remains for the capture of notes during lecture and the summary area where students reflect on the main points of the lecture.

In comparison, the design structure of the En-AISR constitutes of three specific areas; (1) a *Que* column, (2) the primary note-taking area, and (3) the secondary note-taking area. The Que column allows students to form keywords or phrases which act as markers for the notes captured within the primary/secondary note-taking areas. Such Ques act as reminders assisting memory retrieval and can take the form of questions supporting recall over recognition. This concept was initially developed and supported by Professor Pauk in his design of the Cornell note-taking method [1].

The primary note-taking area is a blank area for the encoding of notes and can be used by students in technical and non-technical modules. The secondary note-taking area has a regular grid targeting those students who are a part of a technical discipline. The grid can be used for mathematical expressions and scientific calculations. The design considers simplicity at its utmost so that students irrelevant of their personal learning ability, subject discipline and note-taking skills can combine their personal note-taking method within the structural technique.

The En-AISR system amalgamates audio sounds and earcons, visual stimuli and speech metaphors. The multi-modality has been limited during the encoding process because the note-taking platform simulates the lecture environment. Therefore, during the encoding process a student would not be paying attention to audio sounds or speech but would require visual sophistication. Nonetheless, during the reviewing process, audio and speech modality would be best suited rather then overwhelming the student with visual content, thus enabling greater flexibility. As a result, the audio sounds have been used as reminders of a particular action carried out by a user. Speech modality has been divided. Within the encoding stage students are able to set-up and prepare the environment using spoken dialogue by default commands including; ‘New’, ‘Open’, ‘Save’, and ‘Exit’. Within the reviewing process the speech modality has been expanded to retrieve spoken Ques. This restricts mouse movement, allows concentration towards the notes and promotes flexibility. The electronic platform incorporates additional features including a highlighting toolbar, editing and formatting options.

VI. Experiment

The Aspects of Human Computer Interaction (HCI) to be measured consisted of usability attributes. These attributes include effectiveness, efficiency and satisfaction. The ISO standard defines effectiveness as the “accuracy and completeness with which users achieve their goals”; efficiency as the “resources expended in relation to the accuracy and completeness with which users achieve goals”; and satisfaction as the “freedom from discomfort, and positive attitudes towards the user of the product” [27]. Specific level of performance was measured with the successful completion of tasks, the error rate and time taken to complete the tasks. The subject satisfaction was measured on a 5-point Likert Scale comprising of the SUS questionnaire.

A. Hypothesis

The hypothesis stated: En-AISR note-taking system will encapsulate input, storage and retrieval of information, successfully facilitating an enriching experience through greater interactivity.

B. Variables

The variable types considered in controlling the validity of the experiment are independent, dependent and controlled. The independent variables are the factors being manipulated therefore, the two note-taking systems, E-Cornell and En-AISR. The dependent variables are the results of the manipulation including accuracy of tasks, error rate, task completion time and subject satisfaction. The controlled variables were dependent upon the experimenter and so it was vitally important to ensure consistency throughout the experiment. All tool devices and apparatus used remained consistent. These included a stopwatch, microphone and headset.

C. Subjects

The subjects were 24 students both undergraduates and postgraduates. The students are regarded as experts because they use computers on a daily basis and are from the Engineering and Computing disciplines. Participants in the experiments were voluntary and subjects were first-time users of the technological note-taking systems. They had no prior knowledge of the systems or its methodological structures.

D. Tasks

Each subject answered 12 questions, six recall and recognition questions on each system. Each recognition question offered four options. For each correct answer a subject was rewarded one mark.

E. Procedure

The experiment employed a within-subject testing where all subjects attempted to solve all tasks. There were six subjects per case study group, with a total of four case study groups; CS1, CS2, CS3 and CS4. Both technological systems and the case studies were assigned to subjects on a systematically random rotation basis to enforce the learning effect.

The experiment was explained to subjects during the training period, demonstrating each system and explaining the tasks. Subjects listened to an audio recording about the case study once only and were provided a transcript copy of it. During this time they were instructed to record notes using their personal note-taking technique on the respective system. Once the audio recording had finished, subjects were provided with a 5-minute review period. In this period they could add, edit or simply review their notes using the transcript as reference before proceeding to the short test. The short test involved answering 12 questions relating to the case study, six recall and recognition questions. Thereafter, subjects completed a satisfaction questionnaire regarding their experience and the tasks. This procedure was repeated for the second system.

VII. Data Analysis and Results

The number of successfully completed tasks and subject satisfaction rate was analysed using Wilcoxon whereas, time taken has been analysed using T-Tests.

A. *Effectiveness*

The total number of correct answers achieved between both systems found the En-AISR dominating with 54% compared to the E-Cornell with 46%. From the 12 questions, E-Cornell subjects averaged 9 correct answers per subject in comparison to an average of 11 on the En-AISR system. The minimum and maximum scores achieved in the E-Cornell were 6 and 12 whilst the En-AISR observed a count of 8 and 12 correct answers respectively. According to group subdivisions, subjects in CS1 were the only group from all groups on both systems to complete all the questions correctly using the En-AISR. The Wilcoxon signed ranks test found 18 views in support of H_1 with 4 counter-evidences. On average the positive split finds a mean rank value of 12.44. There are more positives against an average of 7.25 negatives. The z-value is –3.20 with a significance p-value of 0.001.

The break down by question type, recognition and recall has been computed. Findings report, the E-Cornell had a 91% rate of correct answers in recognition questions and 65% in recall questions. In contrast, En-AISR performed significantly better with 99% in recognition questions and 84% in recall question type. The En-AISR observed an error rate of one incorrect recognition answer amongst all four groups, thus a highly significant rate of effectiveness. The E-Cornell observed 9% incorrect recognition answers.

Recall question type found 35% incorrect answers using the E-Cornell whereas En-AISR observed a 16% error rate. Wilcoxon signed ranks test on recognition question type reports an observed rank of 10 positives with a mean rank of 6.15 compared to 1 negative rank at a mean rank of 4.50. As a result, z = -2.65 and p = 0.004. In contrast, the Wilcoxon signed ranks test for recall question type found 15 positive ranks with a mean rank value of 10.57 and 4 negatives with a mean rank of 7.88. The z-value was –2.59 with a significance of p = 0.005.

B. *Efficiency*

The time taken to answer all questions was recorded in milliseconds. From the total experiment time, E-Cornell subjects took 61% and En-AISR the remaining 31%. The mean was much greater for subjects using the E-Cornell at 143487.50ms compared to 91638.33ms on the En-AISR. Therefore, a t-value of 5.772 has been derived at 23 degrees of freedom with a significance p-value of 0.001.

The total time taken on the E-Cornell system found subjects taking 56% of that time to answer recognition questions and 66% for the recall question type. En-AISR subjects took 44% of their observed time in answering recognition questions and 34% in recall questions. T-Test results derived for the time taken to answer recognition questions on both systems found t=2.377, 23df, p = 0.013. A comparison between both systems for recall questions found t = 5.739, 23df, p = 0.001.

C. *Subject Satisfaction*

Subject satisfaction on both systems reported an average calculated SUS percentage of 54% using the E-Cornell compared to 79% satisfaction rate using the En-AISR. The minimum satisfaction percentage awarded to both systems by a subject was 13% E-Cornell and 50% En-AISR. The maximum values found a subject feeling 95% satisfied with the E-Cornell compared to two subjects rating the En-AISR with 100% satisfaction rate. The E-Cornell and En-AISR observed a median satisfaction value of 51% and 78% respectively.

Overall, it has been observed that the En-AISR note-taking system outperformed the E-Cornell system in terms of effectiveness, efficiency and satisfaction. As a result accepting H_1 at the alpha level 0.05. The relationship between the number of correct answers and efficiency in terms of time taken to answer questions found a higher degree of positive correlation in the En-AISR, with outstanding results in recognition questions. Subject ratings of the systems showed a comfortably enriching experience with the En-AISR dominating by 79% satisfaction.

VIII. Conclusion

In conclusion, the literature places emphasis upon the processes of note-taking; encoding and retrieval. A number of studies have been used to demonstrate effects on performance. The growth of e-learning and significant benefits were discussed covering various associated technologies. The integration of Table PC's to replace the blackboard is a versatile media providing a flexible collaborative learning experience. Although there is potential for e-learning environments, the largest drawback seems to be amongst user habits preferring the traditional manner of learning. People are not prepared and willing to change. Results of the experiment demonstrated the successful arrangement of the En-AISR note-taking platform as opposed to the electronic Cornell system. Further experiments will be conducted testing multimodality, in particular speech to provide insight into the contributing effects to learning.

REFERENCES

[1] Pauk, W. *How to study in College*. Boston (MA):Houghton Mifflin Company, 2001.

[2] Price, J., *Outlining Goes Electronic Draft of Chapter 4 A History of Outlining: From Papyrus to Electrons*, 1999.

[3] Horn, R. E., "Clarifying Two Controversies About Information Mapping's Method", *Educational and Training Technology International* 29 (2), 1992b.

[4] Howe, M. J. Using students' notes to examine the role of the individual learner in acquiring meaningful subject matter. *Journal of Educational Research 64*, 1970, pp. 61-63.

[5] Kiewra, K. A., & Fletcher, H. J. The relationship between levels of note-taking and achievement. *Human Learning, 3*, 1984, pp. 273-280.

[6] Kiewra, K. A. Students' notetaking behaviors and the efficacy of providing the instructor's notes for review. *Contemporary Educational Psychology vol. 10*, 1985, pp. 378-386.

[7] O'Donnell, A., & Dansereau, D. F. Learning from lectures: Effects of cooperative review. *J. of Experimental Education, 61*, 1993, 116-125.

[8] Peper, R. J., and Mayer, R. E. Generative effects of note-taking during science lectures. *Journal of Educational Psychology*, 78, 1986, pp. 34-38.

[9] Kiewra, K. A. The relationship between notetaking over an extended period and actual course-related achievement. *College Student Journal 17*: 1984a, pp. 381-385.

[10] Palmatier, A. R., and Bennett, J. M, 1974. Note-taking habits of college students. *Journal of Reading*, 18, 215-218.

[11] Armbruster, B.B. *Taking notes from lectures*. In R.F. Flippo & D.C Caverly (Eds.), Handbook of college reading and study strategy research, pp. 175-199. Mahwah, NJ: Erlbaum, 2000.

[12] Bauer, A., & Koedinger, K. R. Selection-Based Note-Taking Applications. *Proc. CHI 07*, San Jose, CA, USA, pp. 981-990.

[13] Van Meter, P., Yokoi, L., Pressley, M. College Students' theory of note-taking derived from their perceptions of note-taking. *Journal of Educational Psychology 86*, 1994, pp. 323-338.

[14] http://www.idc.com/

[15] Jones, K. O. Issues in moving towards web- based teaching and learning. *The Institution of Electrical Engineers*, 2001.

[16] Barnett, J. E. Do Instructor-Provided Online Notes Facilitate Student Learning? *Journal of Interactive Online Learning*, Vol. 2, No. 2, 2003.

[17] Quade, M. A. An assessment of retention and depth of processing associated with notetaking using traditional paper and pencil and on-line notepad during computer-delivered instruction. *Proc. Annual National Convention Association for Educational Comm & Tech (AECT).* 1995.

[18] Clark, C. & Keating, B. Notre Dame Tablet PC Initiative. *Presented to Teaching & Learning with Technology Conference*, Purdue, 2004.

[19] Wachsmuth, B., September 2003. SHU Tablet PC Project. Retrieved 3/10/2004 from http://www.cs.shu.edu/tabletpc/.

[20] Anderson, R. Experiences with a Tablet PC based Lecture Presentation System in Computer Science Courses. *Proceedings of SIGCSE*, 2004.

[21] Dryden, G., and Vos, J. The Learning Revolution, *The Learning Web*, CA, USA, 1999.

[22] Horton, W. *Designing Web-Based Training*, John Wiley and Sons Inc. 2000.

[23] Brewster, S. A., 1994c. *Providing a structured method for integrating non-speech audio into human-computer interfaces*. PhD Thesis, University of York, UK, 1994.

[24] Selouani, S.A., Lê, T-Ho., Moghrabi, C., Lanteigne, B., & Roy, J. Online Collaborative Learning System Using Speech Technology. Proceedings of World Academy of Science, Engineering & Technology, vol 15, 2006, 52-57.

[25] Neti, C., Iyengar, G., Potamianos, G., Senior, A., & Maison, B. Perceptual Interfaces for Information Interaction: Joint Processing of Audio & Visual Information for HCI. ICSLP Proceedings 1, Beijing, 2000, pp. 11-14.

[26] Hwang, M., Rosenfeld, R., Thayer, E., Mosur, R., Chase, L., Weide, R., Huang, X., & Alleva, F. Improving Speech Recognition Performance via Phone-Dependent VQ Codebooks and Adaptive Language Models in Sphinx II. ICASSP-94, vol. 1, 1994, 549-552.

[27] ISO, 1998. Ergonomic requirements for office work with visual display terminals (VDTs)-Part 11: guidance on usability - (ISO 9241-11: 1998).