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Human Factors Engineering and Design of Learning Pedagogies in a KM framework

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Abstract: This paper presents a review of methodologies and techniques for the design of learning pedagogies and cognitive interfaces within a knowledge management framework. We refer to instructional design principles for the former and to human factors engineering for the latter. Subsequently, we propose a KM-e-learning framework which synergizes both the design of e-learning pedagogies and the design of cognitive interfaces as parallel processes. Our target learners are the remote Bario community in Sarawak, Malaysia. We will help them to develop means to create, acquire, store and share knowledge in order to improve on their English using their community's captured knowledge to build effective community of practice. We hope to extend this work to other remote communities.

Keywords: Human Factor Engineering, HCI, Knowledge Management, e-learning, cognitive interface.

Introduction

Remote rural communities are starved of information and are hungry for new information from any source that relates directly to their daily needs for their livelihood and cultural sustenance [3].The e-Bario project has changed the life of one such community, the Bario community. The project aims to determine opportunities for social development available from the deployment of information and communication technologies within remote communities in the state of Sarawak and to enable the rural communities to have equal access to ICTs, specifically the Internet. Through the e-Bario project, a community Telecentre has been established to allow the local communities to communicate with the outside world through VSAT satellite dishes and 6 public telephone booths. In addition, both lower secondary and primary schools have been equipped with computer labs and the teachers and students are required to learn computer literacy skills.

On the educational front, with the e-Bario project, learners in the Bario schools have gained access to multimedia CDs provided by the Ministry of Education. These multimedia CDs have enriched students' understanding, accelerated learners' learning of the English language, broadened their knowledge towards the use of ICT and expanded their learning horizons [3].

The e-Bario Telecentre set up through the e-Bario project has created a place, which enables online discussions among the Kelabit communities. However, the online discussions are often in the form of e-mail correspondences between tour guides in Bario and interested tourists. Students often use the Internet but it is to chat using ICQ. They have yet to utilize the available Internet access for educational purposes.

Furthermore, Bario is a popular tourist destination due to the Bario community's culture as well as the lush flora and fauna and historical artifacts. Hence, they are developing online facilities to preserve their cultural heritage for the development of the community's ecotourism industry. They intend to capture and assemble a digital library of Kelabit writings and songs [3].

In this paper I am focusing on the synchronization of e-learning system with Human Computer Interface, HCI principles within a KM framework carrying 5 interrelated processes with distinct methodology and techniques adopted to meet the above needs.

1. Problems addressed

Problems addressed in this thesis are:

1. As community resources in Bario have been mobilized towards achieving the project's goals and as nearly all influential members of the community are aware of the aims and potential of the project, there is now a need to capture the Bario community's rich tacit knowledge and help them improve their English using culture-specific problems and scenarios. Towards this end, the first research question is two-fold. The first aspect is what knowledge is core to the remote Bario community? The second aspect is what KMS features will be helpful in capturing this core knowledge and enhancing its development?
2. In order to encourage the Bario community to develop their own knowledge within their communities of practice, the design and development of ICT and learning activities/materials have to be user-friendly and relevant to the user/community. The second research question arises from the use of hierarchical cognitive task analysis, a method fundamental to cognitive engineering, to effectively design user-friendly ICT systems. The question is, having identified the hierarchy of cognitive tasks to be carried out, how can we design the presentation of information to create informative interfaces suitable to the Bario community?
3. The design of instruction or instructional design aims at creating meaningful interaction. The question is, how can we create meaningful interactions using collaborative ICT technologies and the informative interfaces?
4. Last but not least, prior to dissemination of knowledge, there is a need to evaluate the knowledge captured. However, considering that e-learning is implemented within a KM framework, the evaluation should be multidisciplinary. The fourth research question is what should we look for and how should we evaluate these?

2. KM-related work

Knowledge Management can be defined as the collection of **processes** that guide the creation, dissemination and use of knowledge in an organization. In the subsequent subsections, we elaborate on these processes and how review of prior literature has helped us to develop and refine our Knowledge Management e-learning framework/model.

Phase 1: Knowledge Identification

The phase involves identifying research context, performing analysis and planning. The context here refers to a community where the research is applied. After identifying the context, an analysis of the community background, culture and environment will be carried out. This analysis facilitates in identifying knowledge items to be acquired (Phase 2). The next activity is planning, which, involves determining the benefits, requirements, objectives and budget to be implemented in the study.

Objective:	To identify the target communities needs, cultures, background.
Discipline:	Human Factors Engineering [4]
Evaluation methods/ Criteria:	Human-computer interface design is not to be viewed as peripheral to the primary concerns of software engineering. Instead, a user-centered, or practice-centered, system design approach is embraced in which the questions that drive design include the following: • What are the goals and constraints in the application domain? • What range of tasks do domain practitioners perform? • What strategies do they use to perform these tasks today? • What factors contribute to task complexity? • What tools can be provided to facilitate the work of domain practitioners and achieve their goals more effectively? • What are the goals and constraints in the application domain?

Phase 2: Knowledge Acquisition

Members of the community create their own knowledge through interactions and this traditional knowledge is mostly stored in their minds (tacit knowledge). Thus, in this phase, the existing knowledge is acquired from the target community. Interviews and surveys will be carried out to collect data and it will be stored in a database for the purpose of the e-Learning content. This data may include the names of animals, plants,

fish and others that are commonly found within the community's environment.

Objective:	To integrate the design of learning pedagogy with HCI's cognitive principles
Methodology	**Merrill's First Principles of Instruction**
Evaluation methods/ Criteria	1. Problems /task centered 2. Activation 3. Demonstration 4. Application 5. Integration
Methodology	**HCI components from ACM**
Evaluation methods/ Criteria	• HCI. Human factors • HCI. Human-Centered Evaluation
Reference 1:	Zhang et al (2010) [6]
Evaluation methods/ Criteria	• Psychological theory and learning theory- from Gagne's HCI and animation have added to influence the following three stages: acquire attention, stimulate the recall of prior learning by using pop-up window and hyperlinks, and present the stimulus content and to lead the change of the learner's internal cognitive learning process and mental model. A set of 17 subjective and objective questions has been used to test the subjects' knowledge and then the tests were scored to measure the quality of subjects' mental models. The findings have proven that HCI and animation features of e-learning have positive influence on learners' cognitive perception and structuring psychological process of learning by comparing a traditional web design course and an e-learning web design course
Reference 2:	Belisle et al (1997)[1]
Evaluation methods/ Criteria	All User/learner needs and technological advances were studied and matched, in order to produce a contextualized browser, integrating specific functionalities that provide learners with 'cognitive tools' to develop navigation competencies. The main steps of this software design process: a) understanding the operational context : domain, users, tasks and goals; b) investigating the cognitive processes involved in Web navigation and relating these processes to functionalities in the NESTOR browser; c) integrating cognitive and software engineering into a coherent model of the system; d) implementing a first prototype and evaluating usability. Pre-experiment and post-experiment questionnaires were filled out by both teachers and learners in order to assess computer literacy, previous experience, ease of use. Results show that the graphical map was heavily used (both as a production tool by teachers and as an access tool by learners) while the annotation system had some usability problems and the concept-map was only slightly used. Learners can attach annotations in the NESTOR to every visited document. The Annotations contain a free text, an HTML document and an icon. It facilitates cognitive tracing and also facilitates the establishment of landmarks (icons) and routes (individual pathways) and thus the development of navigation abilities. However, both annotation and concept-mapping tasks are demanding and should be evaluated in the course of long-term use.

Phase 3: Knowledge Organization

This phase involves categorizing and storing collected data. Data needs to be filtered based on identified subject areas. It is done to ensure accessibility and to ease the process in developing the course content. Once filtered, the classified data is stored in a database.

Phase 4: Knowledge Dissemination

After organizing and storing data, the next process is sharing the knowledge. Data is retrieved to develop the course content. In this phase, appropriate learning theories such as constructivism can be applied to design learning modules. The learning modules are built upon information that has been acquired, using English as the medium of instruction. Hence, modules are designed to not only share local knowledge but also to provide skills in writing and speaking in English. Besides that, instructions are designed based on an existing instruction design method, which is the Merrill's first principle of instructions. There are five major phases in this instructional design model and namely; identify problems/tasks, construct instructional analysis by activating the problems and develop formative evaluation and use the knowledge in real world after gone through observation from demonstration and apply it by the users themselves . Each of these phases has its own purpose in ensuring proper delivery of instruction to learners. A suitable e-Learning platform is then chosen to accommodate all learning modules which have been designed earlier. It is customized to provide learners an environment that will assist in their learning.
A comparative study is done to measure local knowledge competency and English language proficiency of the target learners. Two tests are performed, which are, pre-test and post-test. Pre-test is carried out before the e-Learning system is deployed in the community while post-test will be carried out at the end.

Phase 5: Knowledge Adaptation

The final phase is the implementation of the e-Learning system to the target community. Getting to know the community to identify their learning needs are important before implementing the learning programme. This is to ensure full participation from the community and as well as to achieve the learning objectives. Level of IT skill among the community members will be measured to check whether an IT skill training session should be done first to improve their skill. Other challenges will also be identified to assist in the knowledge process.

3. KM-e-learning framework

Our Knowledge Management-e-learning framework/model is as illustrated in Fig. 1 below.

Figure 1: Proposed framework for culture-specific KM e-learning development

Based on the above literature review in our study, we will design MOODLE, an open source LMS with the following features corresponding to our KM-e-learning framework:

Component	Features	Objectives	Criteria
Target Community: Culture, Background	Human Factors Engineering	• To identify what knowledge is significant to the local communities in helping them to learn English Language, ICT and to promote tourism. • To identify how to acquire and capture knowledge from the local communities, i.e. how to motivate the community to contribute to the KM system.	To develop culture-specific learning materials in Modules/level of difficulty- to avoid overloading learners cognitive capacity
Course Content		• To identify how to organize knowledge in a taxonomy	Provide **Hierarchical concept** map at the notice board- to direct the learner to

		relevant and acceptable to the local communities.	navigate the learning materials-user friendly and to create self-regulated learning environment.
Instructional Design and learning activities	Merrill's' First Principle of Instruction	• To identify how to disseminate information to as wide a community as possible in a user-friendly manner.	Flexible array of course activities - Forums, Quizzes, Glossaries, Resources, Choices, Surveys, Assignments, Chats, Workshops such as interactive activities in Kelabit language- through CoP concept
Technology and Sustaining System	Moodle- open source LMS	To implement a domain specific application by encouraging knowledge sharing through web based applications and evaluates its effectiveness in increasing knowledge dissemination/transfer.	Incorporate feedback in the domain specific application from heuristic evaluation and cognitive principles.

4. Conclusion

The implementation of e-learning as a tool to help and enhance the process of learning based on the unique circumstances of the environment in Bario will bridge the gaps between rural and urban areas. It is very significant that e-learning will give hope and empowerment and stimulate innovation among those low income Bario who lack opportunity and consequently lack hope for the future. With the provision of e-learning, the Bario communities will be able to share the benefits that the people in urban areas or the world enjoy. Moreover, with knowledge gained through e-learning, great ideas will be stimulated and this may upgrade their standard of living. In addition, with the presence of e-learning, the Bario communities will be no longer isolated from the rest of the world.

Consequently, the provision of e-learning will give Bario communities more hope, motivation and freedom to move forward in life instead of live for the day and try to make ends meet. We hope that this KM e-learning framework will eventually be adapted to other remote communities.

5. Research Implication

To achieve the KM e-learning framework with the Matrix methods, the paper proposes to combine the learning from examples concepts with the hint-based feature recognition approaches. The method applies knowledge acquisition techniques for generating knowledge hints automatically. Hints are extracted from the knowledge base for every problem statement in a given taxonomy. In particular, the method includes two main processing stages, learning and knowledge hint recognition. During the learning stage and knowledge stage, hints are extracted from knowledge base. Then, these hints base are utilized in the problem solving stage to improve their ICT skills.

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