Structured abstract

Purpose- This paper presents and discusses how ICT instruments can be used to enable and enhance a learner's learning performance within a Knowledge Management-Elearning usability framework. We aim to investigate whether integrating Merrill's First Principles of Instruction and usability properties as knowledge-based guidelines/ design factors within a KM framework would help learners develop higher order thinking skills and whether our design would result in positive technology acceptance. We hope that venturing beyond the use of usability attributes (which determine the *end results*/*outcome* of the usable product), to using usability properties to facilitate and *optimize* the e-learning instructional design process, will promote user-friendliness and aid comprehensive decision-making such as how to decide which properties are of a higher priority, thus meriting more design and development efforts.

Design/methodology/approach- We applied Merrill's First Principles of Instruction and usability properties as pedagogical and usability design guidelines, Knowledge Management and Hierarchical Task Analysis as methodological knowledge bases. We also developed a method matrix to map the selected methods of Cognitive Engineering to its potential uses in our KM e-learning Usability framework and mapped e-learning usability tools with KM processes in our KM e-learning Usability system.

Findings-Findings indicated that our design effectively helped learners to demonstrate higher order thinking skills and positive technology acceptance; promising indications towards the design and development of knowledge based usability frameworks and systems.

Originality/value- Our contributions are twofold: First, we proposed a KM e-learning Usability Framework, which frames the mapping of KM processes to e-learning principles and usability properties. Second, we proposed a method matrix which maps the selected methods of Cognitive Engineering to its potential uses in our KM e-learning Usability framework. Based on these mappings and focusing on the usability properties navigation and learning support, we used ICT/Web2.0 tools to present/visualize information more clearly and more sensibly/manageably to students, to help trigger new knowledge and develop higher order thinking skills such as application, evaluation and syntheses of knowledge and articulate information from different perspectives throughout the KM lifecycle.

Keywords:
Applied knowledge management, e-learning, human factors, knowledge-based development, sustainable development, team collaboration.

Article Classification:
Research Paper

Introduction

Remote and rural communities are often disadvantaged in terms of access to infrastructure, information and opportunities. We are interested to address specific e-learning problems faced by the remote Bario communities. These communities live in a highland village located 3280 feet above sea level in the centre of the Kelabit Highlands in the north east of Sarawak in Borneo island and form the main settlement in the Kelabit highlands.

Information and Communications Technology (ICT) has changed the way they do business and communicate in their everyday lives. The e-Bario telecentre set up by another research project has enabled the Bario community to access the outside world (Yeo, Hamid, Songan and Abdullah, 2007); enabling 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 to chat using ICQ (*instant messaging computer program*). They have yet to utilize the available Internet access for educational purposes.

We are concerned with three interrelated problems. First, although ICT has connected the remote community with the rest of the world, ICT has also resulted in the problem of information overload. Students often have difficulty in making sense or meaning from the information presented (Marzano, 2010). As such, there is a need to make presentation/visualisation of information clearer or more sensible/manageable to students.

Second, students are often not able to articulate information from different perspectives or to discuss complex issues (Hattie, 2012). This may be due to lack of feedback frequency and immediacy from the facilitator /instructor as compared with face-to-face communication in class. To provide feedback to knowledge sharing, we encourage the learners to use wikis to obtain constructive feedback from the instructors to ensure that students are on track. The RSS reader and Groupboard engaged students to acquire the latest news for a specific scope of information and better resources to carry out their assignments. These technologies minimized the lack of feedback immediacy.

Third, there is a need to provide more customized curriculum so that students can create new knowledge and develop higher order thinking skills such as application, evaluation and syntheses of knowledge suitable for themselves and for use in their communities (Chin & Lee, 2011). Hence, we are interested to investigate design factors that would help learners develop such invaluable skills (Chin & Lee, 2011). To help students develop higher order thinking skills such as application, evaluation and syntheses of knowledge, we applied Merrill's First Principles of Instruction and Knowledge Management (KM) processes as the methods by which knowledge about the users' background and application contexts are identified and Cognitive Hierarchical Task Analysis as the method by which users' tasks are designed. These were used to form our pedagogical and methodological knowledge base. Bloom's taxonomy (1956) is used to evaluate the effectiveness of these usability guidelines on learning effectiveness. Bottazzini, Fietta, Fonti, Mandelli and Ponasso's (2003) Web Usability evaluation (by learners) and the CUSQ evaluation (by experts) are applied to evaluate Web Usability and System usability respectively.

Significance of the study

Though we have some answers to the question: "Why do we need to develop a usable e-learning system?" we have fewer answers to the question: "How can the learners use ICT and Knowledge Management framework to enable and enhance their learning performance?" To address the latter question, we focus on how designing the learning materials and how ICT/Web2.0 can help students to navigate and provide learner support, so that new knowledge could be triggered through the process of sharing in informal and natural emerging channels, relationships and other KM processes in the LMS.

Significance lies in two aspects: First, thus far, guidelines for the design of Knowledge-based usability systems are based on usability attributes and/or usability properties. Usability attributes determine the *end results*/*outcome* of the usable product. Attributes include effectiveness, efficiency, reliability, flexibility, learnability, memorability, operability, understandability, as well as attitude, satisfaction, and attractiveness (Nielsen, 2000; Shackel, 1991; International Organization for Standardization [ISO] 9241-11, 1998; International Organization for Standardization/ International Electrotechnical Commission [ISO/IEC] 9126, 1991). Usability properties however, are used to facilitate and *optimize* the e-learning instructional design process, promote user-friendliness and aid comprehensive decision-making in respective events (Rennie and Morrison, 2013). There are fewer studies which utilize a comprehensive evaluation methodology for e-learning applications (Ardito, De Marsico, Lanzilotti, Levialdi, Roselli, Rossano and

Tersigni, 2007; Costabile, Marsico, Lanzilotti, Plantamura, Roselli and Rossano 2005; Zaharias and Poylymenakou, 2009). Furthermore, we do not find many studies contextualized within a Knowledge Management e-learning usability framework.

Our contributions are first, we have developed a KM e-learning Usability *Framework* which situates our mapping of KM processes to e-learning usability properties. This framework is useful in helping Web designers and instructional designers decide how to design a learning management system (LMS) for different user needs and to decide which properties are of a higher priority thus meriting more design and development efforts. We have also developed a method *matrix* to map the selected methods of Cognitive Engineering to its potential uses in our KM e-learning Usability framework. We expect that this contribution with its findings will lead to further development and refinement of usability heuristics for e-learning, contextualized within a Knowledge Management framework. Hence, our work has the potential to help designers not only to design more effectively and efficiently but also to adopt and adapt successful practice.

Outline of the paper

The first three sections describe the background, method and literature respectively, with the remaining headings each presenting analysis of data and summary. The first section gives a broad overview of Knowledge Management processes - Knowledge identification, Knowledge Acquisition, Knowledge Organization, Knowledge Dissemination and Knowledge Adaptation. The second section provides descriptions of all the tools (Hierarchical Task Analysis, Concept map, Groupboard) and the methodology applied to form the framework design and methodological knowledge base. Usability evaluations for both system and Web content developments have been used to test the usability of our KM-e-learning system. We hope that users can stimulate their higher order thinking skills and organize knowledge in their own way and share their knowledge more effectively in our KM e-learning usability system.

Research Question

We aim to investigate to what extent does adopting Merrill's First Principles of Instruction and usability properties as knowledge-based guidelines/ design factors help learners to develop higher order thinking skills and whether our design would result in positive technology acceptance.

Related work

KM e-learning

In a society emphasizing the importance of knowledge and IT, one can hardly deal with knowledge management outside an e-learning environment. According to Rosenberg (2001), "e-learning refers to the use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance." These arrays of solutions can be either asynchronous or synchronous, providing access anytime anywhere (Mayes and de Freitas, 2007; Clark and Mayer, 2011; Wang, Zhu, Chen, and Yan, 2009; Tan, Guo, and Li, 2008; Garrison, 2011).

KM: A human-centered system

KM Systems are human-centered with each design and development phase linked to human factors. The key to human factors engineering is cognitive engineering. Cognitive Engineering consists of a variety of disciplines, including Human Factors Engineering (HFE), Human Computer Interaction (HCI), Decision science, Cognitive psychology, Computer science, and other related fields (Bonaceto and Burns, 2007).

HFE contextualizes the intersection of people and technology to the development of work system efficiency. The application of this knowledge can bring human and system performance to new milestones. HFE is distinctive in being the only discipline that relates humans to technology and therefore must be integrated within the whole project instead of being added as a component in the project or an afterthought. HFE implements practices and principles to optimize how people perform to improve and match the standards of overall organizational performance by sharing knowledge among learners, nurturing the filtered learners' knowledge, and encouraging innovative knowledge creation.

With the contribution of HFE, problems in accumulating and maintaining knowledge during the learning process will be dealt with. The accumulated archived documents can be standardized to be reused and referred to by others. In this paper, the needs and significant knowledge of the learners will be identified through HFE methods and used in the development of the KM-e-learning usability system.

The core component of Cognitive Engineering is task analysis. Task analysis identifies the key tasks

or functions that are performed in a work domain and then systematically breaks each task into a series of lower-level tasks. The task breakdown analysis clearly states the allocation of functions between people and system. We have used the Hierarchical Task Analysis (HTA), developed by Annett, Duncan and Stammers (1971) to create overall views in every single module, to allow the users to refer back to these concepts, to monitor their own progress, and remember the key points quickly.

Proposed solution: *Design principles, methodology and instruments*
Figure 1 illustrates our KM e-learning Usability framework derived from the theoretically-grounded review above. Our KM e-learning Usability framework categorizes usability properties into two major categories. The looks great property is concerned with presentation. The works well property is concerned with navigation, communicative enablement, technical functionality, and learner support.

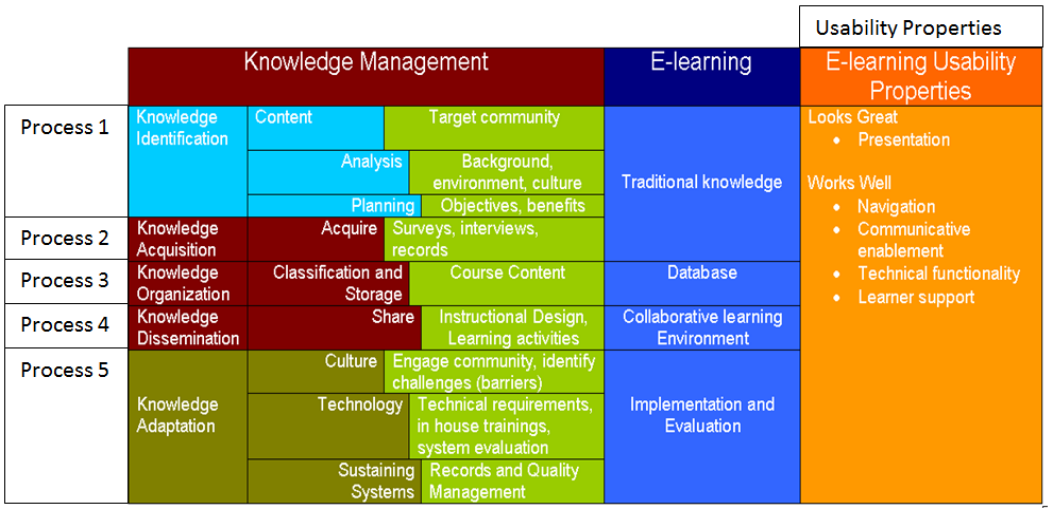


Figure 1. KM e-learning Usability properties framework

Pedagogical design principles

The design of learning activities is based on Merrill's First Principles of Instruction with emphasis on problem solving, communication and collaboration skills. The First Principles (Merrill, 2007), is an instructional design theory based on numerous reviews of other instructional models and theories (Merrill, 2007). This instructional design theory is described as a set of interrelated principles that can be used in a Task or Problem-Centered cycle of instruction (Merrill, 2007). We choose Merrill's First Principles as the instructional design methodology as they capture the general principles pertinent to all instructional design models. These principles are:

1) solving real-world problems,
2) activating existing knowledge to build new knowledge,
3) demonstrating new knowledge to the learners,
4) allowing learners to apply new knowledge, and
5) integrating knowledge into the learner's world.

Each of these principles has its own objective in ensuring proper delivery of instruction to learners. Other examples of design principles are:

- ✓ *Go through course structure and expectations* - To review with students the course structure/modules, assignments, and expectations for forum participations and deadlines to ensure the structure aligns with their needs, expectations, and goals.
  Allow Flexible alterations to assignments- to allow specific alteration to assignments based on personal learning goals and readiness.
- ✓ *Allow peer interaction* - Team assignments and peer reviews are powerful community building and assessment tools. This is to allow knowledge sharing and peer collaboration in their assignments.
- ✓ *Build leadership opportunities* -To allow students with different learning styles to lead a seminar or discussion forum or to demonstrate their learning by writing a summary or conducting an interview.
- ✓ *Customize and personalize projects*- To encourage participation in all Knowledge Management processes among the class members by increasing learning interest.

- ✓ *Offer review opportunities*- Peer and expert reviews of project proposals, projects-in- process, and finished projects help build community, improve the KM e-learning system; extend learning, and unwelcome surprises.

Usability properties as knowledge-based guidelines

Usability properties as knowledge-based guidelines / design factors are adopted to help our design towards achieving positive technology acceptance. Such properties can help Web designers and instructional designers design for different user needs and decide which properties are of a higher priority thus meriting more design and development efforts.

To assess usability, we have used feedback obtained from Web Usability questionnaires (Bottazzini, Fietta, Fonti, Mandelli and Ponasso, 2003), where we have focused on two main categories. The first category consists of two sub categories: system usability and Web usability aimed at gaining insights from the learners. The second category aims at obtaining expert feedback on the overall system development and interface design by using Lewis' (1995) Computer System Usability Questionnaire /CUSQ.

Mapping cognitive methods to system development phases

To show how cognitive task analysis and systems development are complementary in building human-centered systems, we have applied a method matrix to map the selected methods of Cognitive Engineering to its potential uses (Table I). It provides a means to understand and organize the process of designing human-centered technology and how the component activities of design can support each other. This matrix forms the foundation for the development of our KM e-learning usability system, which contextualizes KM processes with e-learning content and activity development (Chin, Lee & Yeo, 2010). A suitable e-Learning platform - Moodle - is chosen to manage all learning modules. It is customized to provide learners an environment that will assist the Bario students.

Table I. Mapping cognitive methods to KM system development phases

System development Phases	Cognitive methods	Concept Definition
Knowledge identification Knowledge Acquisition Knowledge Organization Knowledge Dissemination	**Cognitive Task Analysis** • Hierarchical Task Analysis (HTA)	The HTA, developed by Annett, Duncan and Stammers (1971) is used to break down the task under analysis into hierarchy of goals, operations and plans in this thesis.
Knowledge Adaptation	**Interface Analysis technique (evaluation of informative interfaces)** • Web Usability	Web usability (Bottazzini et al, 2003) is used to identify the user and plan its interaction. The design of the architecture of a website: rules and phases and strategies to provide significant usability testing plans in this thesis.
	Usability and user expériences questionnaires • CUSQ, Computer System Usability Questionnaire	Computer System Usability Questionnaire (Lewis, 1995) was adopted to evaluate the psychometric properties of questionnaires designed for use in scenario-based usability evaluation. The questionnaires address evaluation at both a global overall system level and at a more detailed scenario level.

In the following section, we illustrate how the above design principles support our KM-e-learning usability system corresponding to each KM process in our KM e-learning Usability properties framework.

KM processes supporting our KM-e-learning usability system

Although the synergistic relationship between KM and e-learning has evolved over the years, majority of the researchers have focused on the integration of KM processes and e-learning systems to create, share and reuse knowledge in academic institutions and organizations (Qwaider, 2011; Murugaboopathi, Harish and Sujathabai, 2012; Khademi, Kabir and Haghshenas, 2011). They have not incorporated usability properties

in their frameworks. This is because KM reflects more on the strategic view of the organization whereas e-learning reflects more on the tactical and departmental focus (Ellis, Reus and Lamont, 2011). We note that the use of usability properties to bridge the two disciplines together is absent. Thus, it is crucial to fill this gap. The benefit is obvious: KM processes allow and enable users to organize, collaborate and share their learning resources together in a systematic manner.

With the development and popularization of Web technologies, it is important to integrate different web technologies to encourage more knowledge sharing activities among the students. Table II shows the mapping of instruments, usability tools with components in our Knowledge management e-learning Usability system. The Instruments are used to create, share and reuse knowledge in the KM processes. For the Knowledge adaptation process, usability questionnaires e-learning properties and CSUQ attributes are used as the guidelines for the design of Knowledge based e-learning usability systems.

Table II. Maps e-learning usability tools with components in our Knowledge Management E-learning Usability system.

Knowledge Identification **Knowledge Acquisition** **Knowledge Organization** **Knowledge Dissemination**	**Knowledge Adaptation**			
Instruments	**Usability questionnaires** (Bottazzini et al 2003)		**E-learning Usability properties** (Jacques, 2004)	**CSUQ attributes** (Lewis 1995)
	Web usability	**System Usability**		
- Questionnaire - Wikis - Groupboard (Web conferencing)	Student Background General Reaction	User Experience	Attitude & satisfaction	User satisfaction
- Questionnaire - Wikis - Groupboard (Web conferencing) - Forum (open discussions) - HTA - Concept Map	Page Structure Terminology	General Judgment	Attractiveness Operability	System quality System efficiency Information quality Information Satisfaction Overall satisfaction
- Questionnaire - HTA - Concept Map	Multimedia Objects Management	Special Judgment	Effectiveness Efficiency Flexibility Memorability	System efficiency Information quality Software satisfaction
- Questionnaire - Wikis - Groupboard (Web conferencing) - Forum (open discussions) - HTA - Concept Map - KWL	Framework Learning Framework Capacity	System Learning	Efficiency Flexibility Memorability	System efficiency Process quality Individual impact Software satisfaction
- Questionnaire - Wikis - Groupboard (Web conferencing) - HTA - Concept Map	Student Satisfaction	Information Grant	Understandability Learnability	Information quality Information Satisfaction

The main objective is to encourage knowledge sharing through these instruments and to evaluate its effectiveness in increasing knowledge dissemination/transfer. We have incorporated concept map, Groupboard (Web conferencing), wikis, forum, HTA, KWL, RSS reader and questionnaires corresponding to the processes in the KM-e-learning usability framework. We have also provided a flexible array of course activities - Forums, Quizzes, Glossaries, Resources, Choices, Surveys, Assignments, Chats, and Workshops such as interactive activities in the Kelabit language - through the Communities of Practice (CoP) concept (*open forum discussion*). These learning activities are aimed at encouraging learners to identify how to disseminate information to as wide a community as possible in a user-friendly manner.

Groupboard allows synchronous interactive communication through drawing/chat Java applets between peers and facilitators. The embedded RSS feed enables readers/students who want to subscribe to timely updates from favorite websites or to aggregate feeds from many sites into one place.

In terms of pedagogy, we applied Merrill's First Principles of Instruction as the instructional pedagogy to design the activities in each KM process. These principles are: - 1) solving real-world problems, 2) activating existing knowledge to build new knowledge, 3) demonstrating new knowledge to the learners, 4) allowing learners to apply new knowledge, and 5) integrating knowledge into the learner's world.

Next, we apply HFE methods to integrate practices and principles to optimize how people perform, to build organizational intelligence by improving the way people work in capturing, sharing, and using knowledge. It involves formenting the ideas and experience of learners to improve the organization's performance in innovative ways.

We designed six modules for our KM-e-learning usability system. In the following subsections, we used a module as sample for illustration, i.e., Unit 2 Why we need to learn simple business skills.

Process 1: Knowledge Identification

According to Polanyi, Arensberg and Pearson (1957), the unwritten tacit knowledge functions as a background to assist in accomplishing the physical task, though the authors are not aware of everything the author knows. Rüdiger and Vanini (1998) further pointed out that the identification of tacit knowledge is often heavily hindered, but is made possible through the scope of personal contacts where ideas are sharply critiqued but individuals are respected. Sveiby (1997) agreed with Polanyi's emphasis on the importance of tacit knowledge. He highlighted that "*because we know more than we can tell, it followed that what has been made articulate and formalized is in some degree under-determined by that of which we know tacitly. When we bring new words or concepts into our existing system of language, both affect each other. So the system itself enriches what the person has brought into it. We adapt new concepts in light of our experiences*". Bennet and Bennet (2008) have also *recognized that tacit knowledge resides beyond ordinary consciousness leads to the search to develop greater sensitivity to information stored in the unconscious to facilitate the management and use of tacit knowledge*. Education must therefore, make the acquisition of knowledge strategies possible, where the learner understands the interpretations of the phenomenon of reality and the places where they are built (Santoro & Saparito, 2006).

We conducted a survey using a questionnaire to identify significant knowledge and needs to develop the learning modules from the target learners. Subsequently, the core knowledge identified as relevant and familiar to the leaners were those relevant to equipping them to promote ecotourism, namely, how to search the Internet effectively, why we need to learn simple business skills, how others set up simple businesses, how to carry out simple steps to address a problem, how to apply these and finally, how to integrate all the knowledge learnt. Based on the survey outcomes, we designed the task/problem based on Merrill's First Principle: Activation.

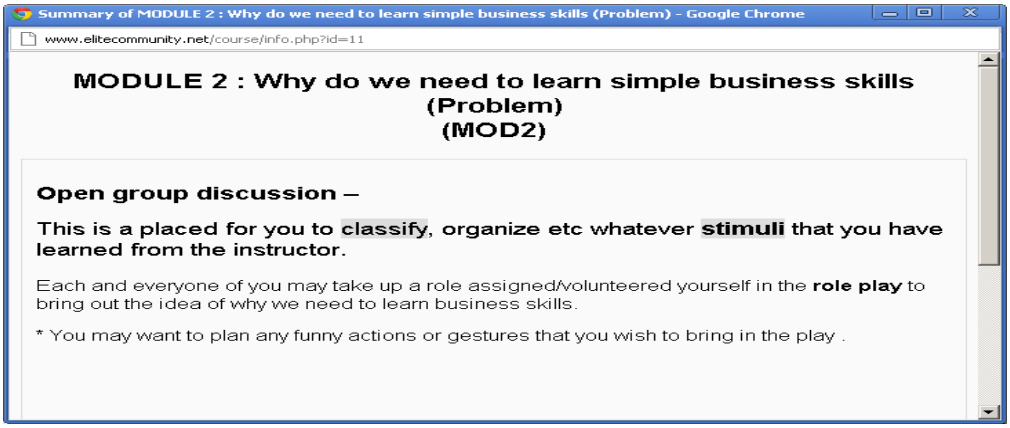


Figure 2. Merrill's First Principles of Instruction: **The task / problem**

Process 2: Knowledge Acquisition

The Association for Computing Machinery (ACM) defines HCI as "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and study of major phenomena surrounding them (Baecker, Card, Carey, Hewett, Gasen, Perlman, Mantei, and Strongand Verplank, 1992).Thus, one of the critical challenges in building a usable e-learning system is to develop a flexible navigational structure and accessible and active hyperlinks in the e-learning system. To analyze usability of interaction mechanisms of e-learning systems, a number of studies have been carried out using standard assessments such as those elaborated below.

The essence of usability evaluation is the contextualization of theories of information technology, computer and social science research to the challenge of designing tools that are useful and usable to humans (Mehlenbacher, Bennett, Bird, Ivey, Lucas, Morton & Whitman, 2005). Interfaces should be designed according to the way students learn with good usability, to encourage students to interact with the e-learning system in natural and intuitive ways (Costabile et. al., 2005; Cockton, 2013). If however, the e-learning system usability is low, the learner will spend more time to learn the software functionality instead of learning the content (Costabile et al., 2005).

To overcome this problem, we suggested using preliminary usability criteria guidelines to grasp features in the e-learning systems and also adopted Bottazzini, Fietta, Fonti, Mandelli and Ponasso's (2003) systematic Web and system usability evaluation questionnaire to evaluate the KM-e-learning usability system.

In this phase, students were expected to integrate the knowledge elaborated in this phase with the core knowledge they identified in Process 1. This aimed at providing students with a holistic picture of the motivation as well as the critical success factors/barriers to becoming successful in business (see Figure 3). In order to help students integrate and consolidate what they have learnt during the Knowledge Identification and Knowledge Acquisition phases, students participated in the Wiki in the Moodle system (see Figure 4).

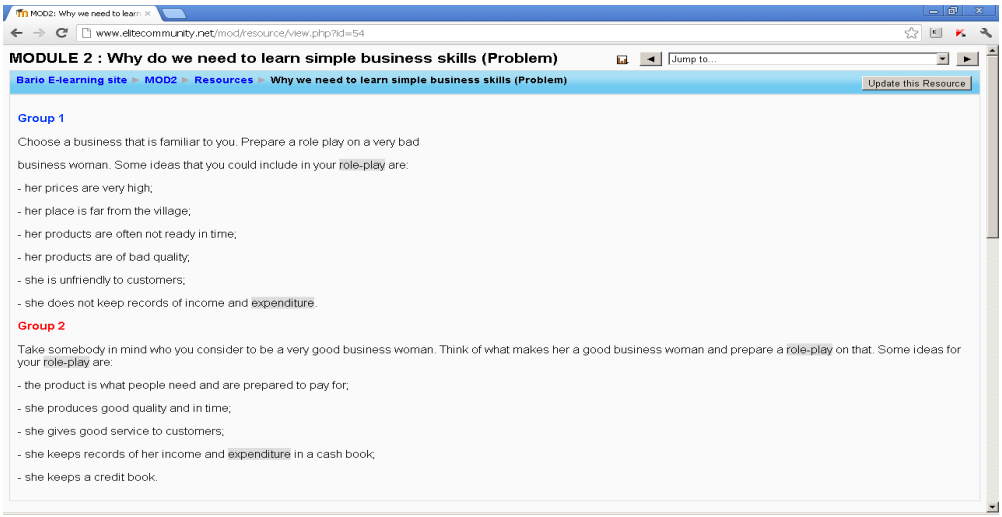


Figure 3. Merrill's First Principles of Instruction: **The activation principle**

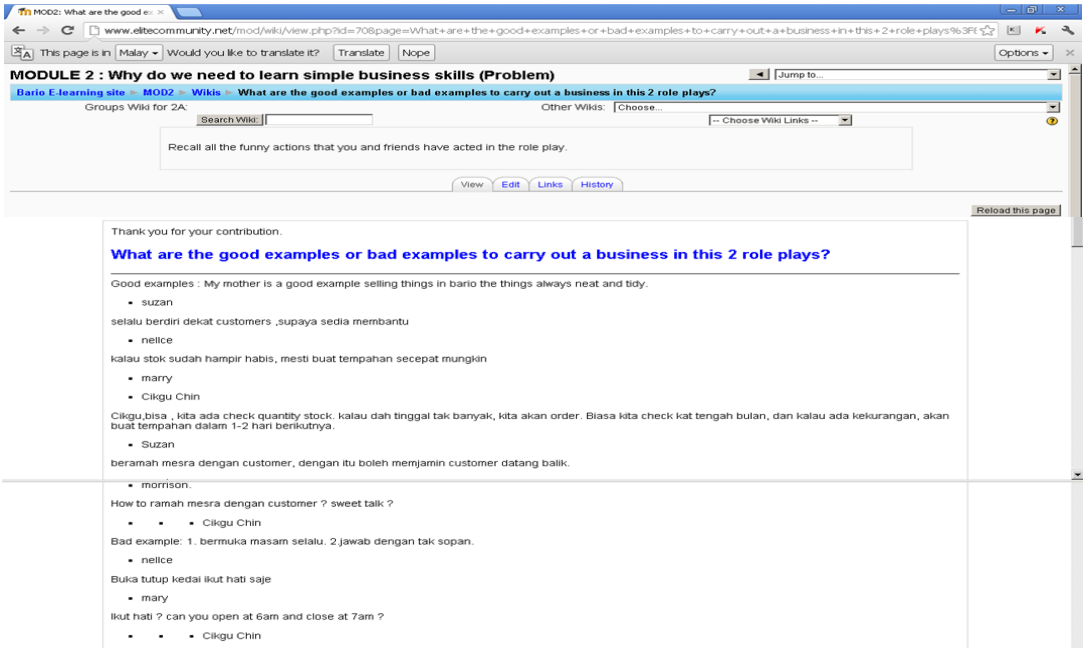


Figure 4. Merrill's First Principles of Instruction: **The demonstration principle**

Process 3: Knowledge Organization

Students can retain information longer if the learning content is illustrated with diagrams (Lim, Tan, and Platts, 2005; Butcher and Aleven, 2008; Wang and Beck, 2012). From the initial findings in the project, it was found that many of the Class 2A and 2B students are visual-learners. Thus, a visual approach such as organizer, to organize or brainstorm for information was strong recommended. Organizers illustrated knowledge in a meaningful way can bring clarity to ideas for learner knowledge retention. Two examples of graphic organizers used in this paper are the KWL table and CM.

A KWL table /KWL chart is a graphic instructional reading organizer focus in planning a learning session and defining the learning strategy. According to Terrance (2008), who has explored the extent to which the modeled reciprocal teaching strategies of predicting, questioning, clarifying, and summarizing are specifically taught and tutored within the lessons and provide opportunities for students to generate their questions freely. The author has revealed positive feedbacks were collected from the question generation from the reader side as they raise more questions when they read the test; hence, helping them to assess their level of comprehension, and achieving independence as readers.

On the other hand, a quantitative research done by Tseng, Chang, Lou, Tan, & Chiu (2012) have investigated students' perception of concept maps as a learning tool where knowledge transfer was the goal to provide valuable reference work for science education. The result of the study showed that positive perception with better learning attitudes could increase students' willingness to use CM and to get students to be more satisfied with their learning and thereby make the KT process more effective.

Hence, in this phase, students were encouraged to work collaboratively on the KWL table by sharing what they have learnt in previous sessions and then selecting what they wanted to learn in the current session. Concept maps (CM), were used to enable the students to establish the connection between the concepts in ICT and business management skills to enable knowledge retention and enhance better problem solving skills (see Figure 5 and 6).These two tools were chosen for our project after we have done our comprehensive literature reviews from below. It was also hoped that the KWL table and CM would help set expectations and provided an effective tool for students to relate the knowledge gained in one part with the knowledge gained in the earlier phase (see Table III).

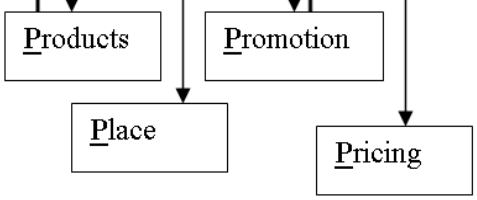
Table III: KWL Table from students of class 2A.

KWL Chart

First, list details in the first two columns before you begin your research. Fill in the last column after completing your research.

Topic : How To Set Up A Simple Business

K What I *ALREADY know*	W What I WANT to know	L What I have LEARNED
• I nak buka business jual macam2 kasut • Lokasi kat kedai bapa saya • Harga mesti sederhana • Mesti buat promo	• Jenis2 kasut yang saya nak jual • Jenis customers dekat kedai bapa • Berapa saya nak jual dalam sehari • Promo apa untuk menarik customer datang • Supplier dari mana ? • Perlu register dengan siapa? • Berapa untung saya nak? • Pekerja berapa orang ?	• Mesti ada Nike,adidas, sebab ramai suka sukan • Kebanyakkan customer bapa saya terdiri drpd gologan suri rumah, mesti mereka akan beli untuk anak2 mereka. • And pemuda pemudi jua akan jadi sasaran saya • Mesti jual 2-5 pasang sehari baru dapat untung • Selain jual kasut mesti jual sarung kaki juga, minyak kilat kasut jua. • Mesti buat promosi untuk tarik perhatian orang ramai. Macam buy 1 free 1 sock. • Kasih dikaun kasut10%-20%



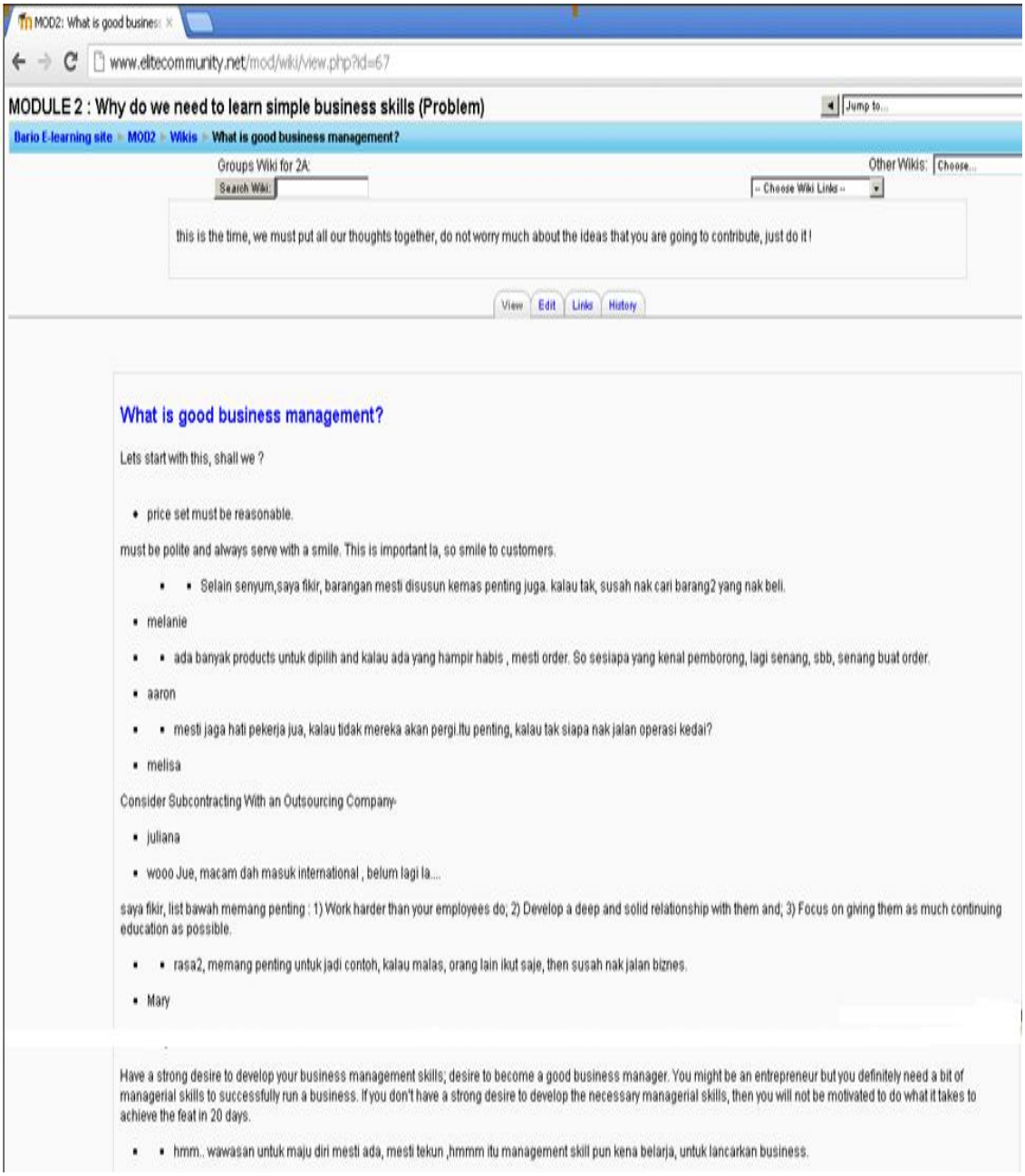


Figure 5. Merrill's First Principles of Instruction: **The application principle**

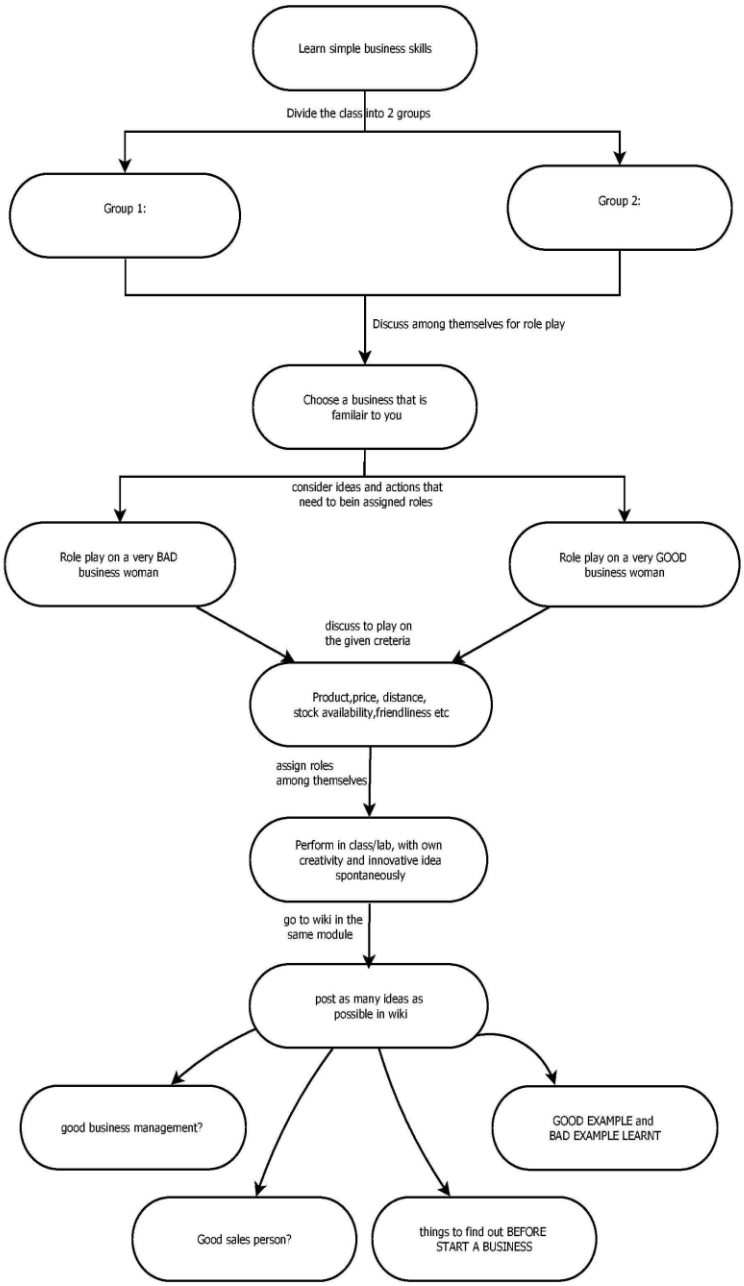


Figure 6. A sample concept map illustrating how students organized their knowledge and associated their ideas on ICT and business management.

Process 4: Knowledge Dissemination

The researcher, Cannata (2009) found that students do not automatically learn chunks of information, or acquire competences and skills in a mechanical way. Hence, he proposed a new pedagogical approach based on "Connective intelligence", which combined pedagogy with empathic skills to form the appropriate psychological framework for a positive response in the language classroom through the use of Interactive Whiteboards (IWBs). His findings indicated that Interactive whiteboards (IWBs) offered easy and practical ways for visual knowledge management and connection in language learning.

These findings illustrated that well-designed IWB activities could result in a more productive and collaborative learning environment, with better human engagement and mutual confidence. More

importantly, one of the main reasons contributing to students' learning progress and to fostering connective intelligence in a shorter time and more effectively was that teachers were prompted to exploit existing resources by combining serious intentions with fun in newer ways.

In our system, every module is equipped with forum, wiki, and some small assignments. Throughout the participation in the modules, learners can interact with other class members, brainstorm each other in the same class or inter class by posting questions in the forum by using their common language/dialect. Furthermore, students' learning was reinforced through the active presence of visual elements, which helped students to understand and retain more functional contents and retain these more effectively (Higgins, Beauchamp and Miller, 2007). In this study, visual representation of concepts and emphatic exercises through Interactive Whiteboards (IWBs) contributed to better cognitive development and better attitudes.

Process 5: Knowledge Adaptation

Figure 7 shows an example of students' discussion in the Wiki where knowledge from prior processes 1, 2, 3 and 4 were integrated and adapted to achieve the learning goal for each Module. The discussions in the Wiki were supported by KWL and concept maps. For knowledge identification, students have identified the significant steps needed to register their business license for setting up a business at the outset**.** In terms of knowledge acquisition, the students have suggested to apply the 4Ps' learned to capture as much information as possible to avoid making rush decision. After the students have captured the main ideas, next, they were going into details. For knowledge organization, they have listed out things needed for business operation, the making of business chop, name cards, business letterhead etc. As for business products, they have to find and filter the products needed and search for suppliers. To disseminate information /knowledge, students were discuss about the business development plan to promote their business.

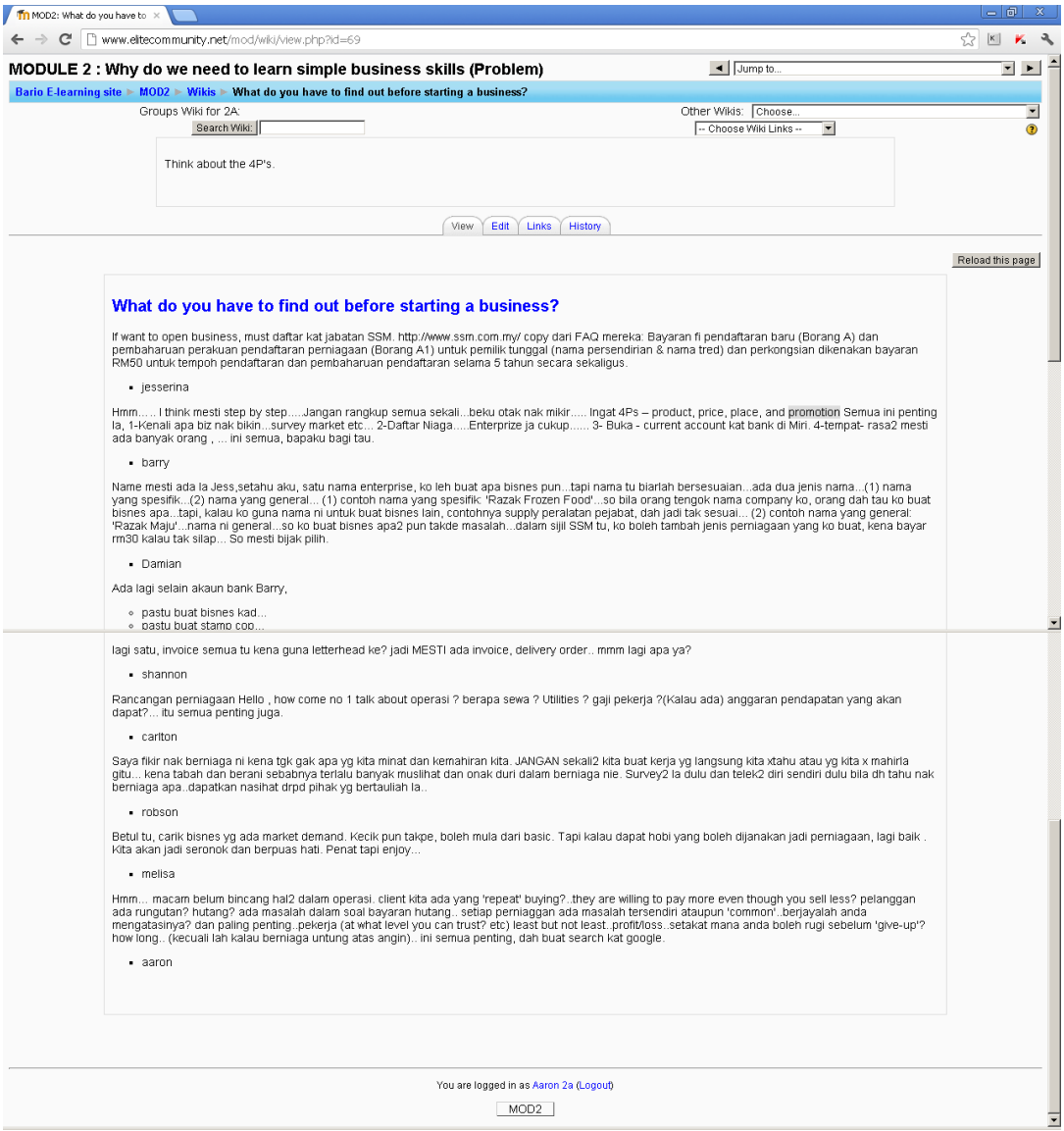


Figure 7. Merrill's First Principles of Instruction: **The integration principle**

Methodology: Experimental Design and the Test Plan

The whole pilot system was carried out in the year 2009- 2012. There is only one secondary school with no upper secondary classes (Form 4 and 5).The participants were chosen because we do not want to disturb Form 3 students who will be sitting for their Lower Secondary Assessment (*PMR*, a *Malaysian public examination*). The Form 2A and 2B students from SMK Bario, Sarawak were chosen for our studies. Our focus was to evaluate the potential effectiveness of these technologies for teaching and interacting with the learners. To achieve this, data was collected based on their personal and group ICT experiences.

System design and development

The system was developed using Moodle, an open source Learning Management System to teach basic Internet search skills and how to develop an online business website.

To help students navigate, we provided a concept map designed based on hierarchical task analysis (HTA) as shown in Figure 8 and Figure 9. HTA is used to create overall views in every single module, to allow the users to refer back to these concepts, to monitor their own progress, and remember the key points quickly.

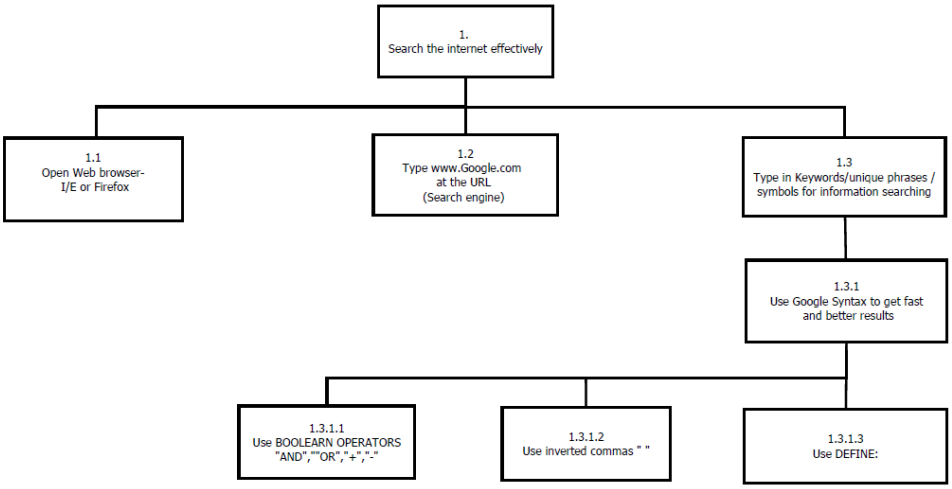


Figure 8. Design of concept map based on HTA

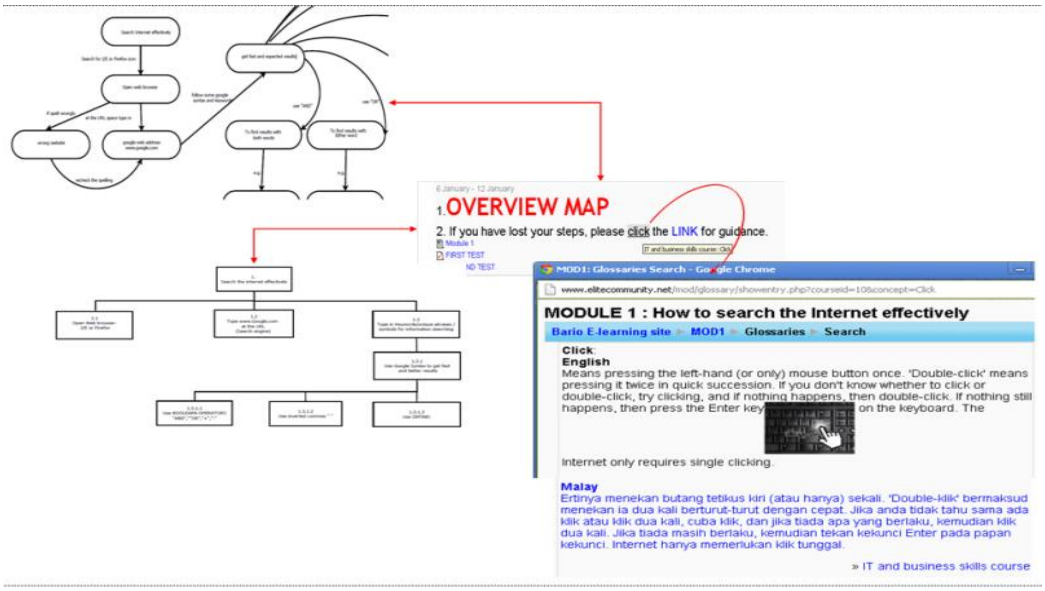


Figure 9. Sample concept map and HTA overview

Furthermore, we provided graphical objects in the Learning Management System, (LMS)'s notice board to direct the students to navigate the learning materials in a user-friendly manner and to create a self-regulated learning environment. This was to encourage students to organize their knowledge in a taxonomy relevant and acceptable to the local communities. For better understanding of the learning context, we also provided customized dual language terminology/definition facility.

In addition, through Web conferencing, the users would be able to communicate and share ideas both in oral and visual communication. Moreover, drawing on the whiteboard in Groupboard and inserting files were some extra features that the users could use to increase their level of comprehension. In addition, they could make use of the RSS reader to get the latest news for a specific scope of information. In this way, the target community could widen their horizon with better resources and information. To scaffold multidimensional thinking, role play was designed (Figure 10), supported by collaborative learning technologies such as forum, wikis, Groupboard and RSS feed. Some of the Web design guidelines we adopted as part of our knowledge base as shown in Figure 11.

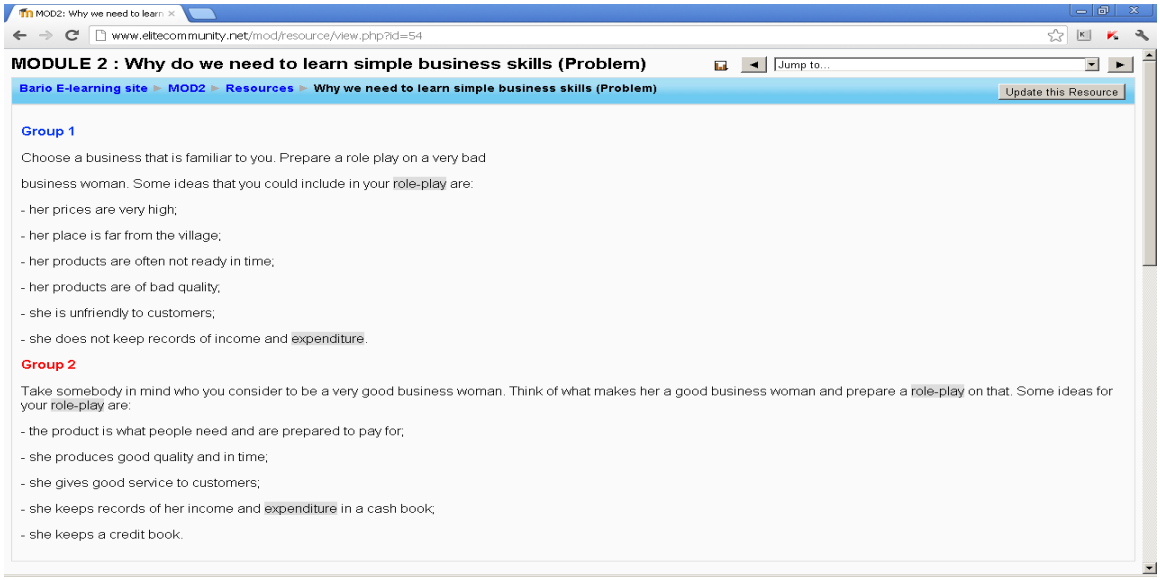


Figure 10. Knowledge based: Sample Role play activity

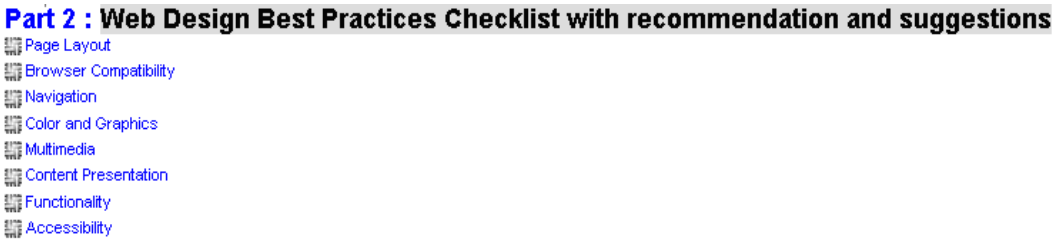


Figure 11. Knowledge based: Web design best practices adopted as part of knowledge base in the creation of wikis.

A variety of activities were provided throughout the study. These were situated within ***role play*** **(**Figure 10), the challenge of ***Online search education***, ***discussions in Groupboard***, ***forum*** and creation in ***wikis*** and assessed via ***multiple choice quizzes***. Each collaborative technology was carefully selected to help learners improve their learning performance in future e-learning course/projects/future working life. Collaborative technologies such as Groupboard web conferencing, forums and wikis were used to engage students and to guide them to develop their own understanding and to become critical thinkers and problem solvers. We responded spontaneously as discussion of the topic progressed while students gathered ideas from individual and collective activity and quickly changed focus and goals as the situation requires. Example of how students organized their knowledge and associated their ideas on ICT and business management based on guidelines for building online business website in wiki is shown in Figure 12.

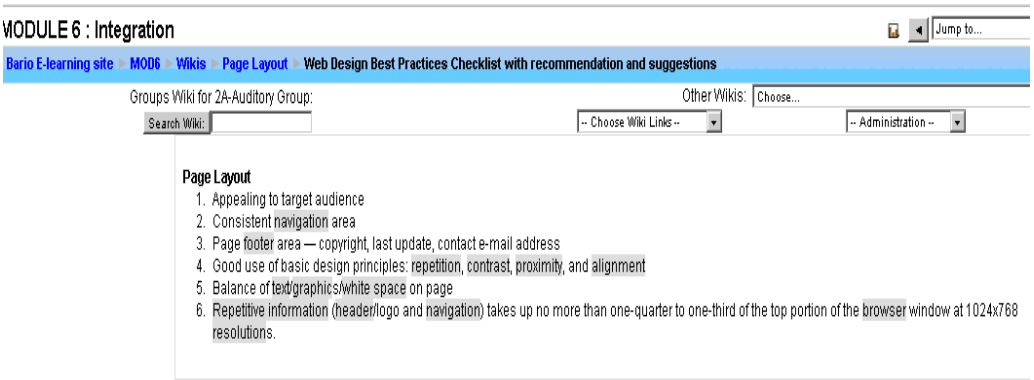


Figure 12. Knowledge based: sample outlines for discussion

Methods and processes
A summary of each collaborative technology and the level of learning which occurred in each (based on Bloom's taxonomy) is provided in Table IV.

Table IV: Learning effectiveness based on Bloom's taxonomy

Collaborative learning technology	**Bloom's Taxonomy**	**Supporting data (corresponding taxonomical level indicated in parentheses)**
Forum Encouraged students to share their knowledge and skills by answering specific questions or contributing to a topic which needs them to adapt to a novel situation.	(a) Knowledge/ Remembering (b) Comprehension/ Understanding (c) Application (d) Synthesis	• Learners remember what have been taught (4PS), were able to identify the major problems in the assignments as well as how to solve these problems--- ***(a, b)***. They shared in the forum to solve the given problems;-"what is good business management?"— (***c, d***). • Learners were able to understand and determine which keywords to use for Web searches to gather more information on the forum topic ***(b, c, d).***
Groupboard Enabled students to engage in communicating and sharing ideas both through oral and visual (drawings) communication**.**	(a) Knowledge/ Remembering (b) Comprehension/ Understanding (c) Application (d) Creation (e) Evaluation (f) Synthesis	• The learners were engaged in communicating and sharing ideas about the best options for their business building website. They showed priority in promoting both products and the holiday package at their e-business website. ---***(a, b, c, d, e, f)***
Wikis In groups, students were given a content-specific activity for discussion online in their convenient language and were encouraged to read, comment and suggest alternatives to help each other. The students were involved in several learning processes: discussion, explanation, justification, sharing of information and resources, analysis and problem-solving. Then, they created wiki content, which could be utilized by their peers for learning and reference.	(a) Knowledge/ Remembering (b) Comprehension/ Understanding (c) Application (d) Creation (e) Evaluation (f) Synthesis	• Learners provided and shared knowledge for Web design Best Practices Checklist with recommendation and suggestions. --- ---***(a, b, c, d, e, f)*** • "Wiki is easy for us, we can share our ideas , knowledge, we can add in or delete at any time, that's all" (*quoted feedback from learner)*----***(c, d)***

Glossary and popup Glossary In both English Language and Bahasa Malaysia. They provided brief definitions of key terms and concepts to the targeted learners in the context of this **KM e-learning Usability system**. It is intended to clarify terms and phrases. (Figure 13)	Knowledge/ Remembering Comprehension/ Understanding Application Evaluation Synthesis	• The glossary streamlined the learners' search process for word/phrase definitions. Learners were able to automatically create links with similar word or phrase to these entries from throughout the course without opening a new browser/tab for Google search. • The followings are some of the learners' comments on how Glossary feature has encouraged and helped them: Learner A: We were encouraged to use any language in the forum in Module 3. and because of this, it makes me feels easy to give my ideas in the forum." Learner B:" The Glossary us just like dictionary. It has made my work easier without searching in Google." Learner C: "With the Glossary available, it is much easier, because some words have links, so when my member wanted to make a reference, he/she just has to click and will be able to get the similar answer."
RSS Reader	Application	• Learners referred to the subscribed feeds for new updates in their assignments and website building.

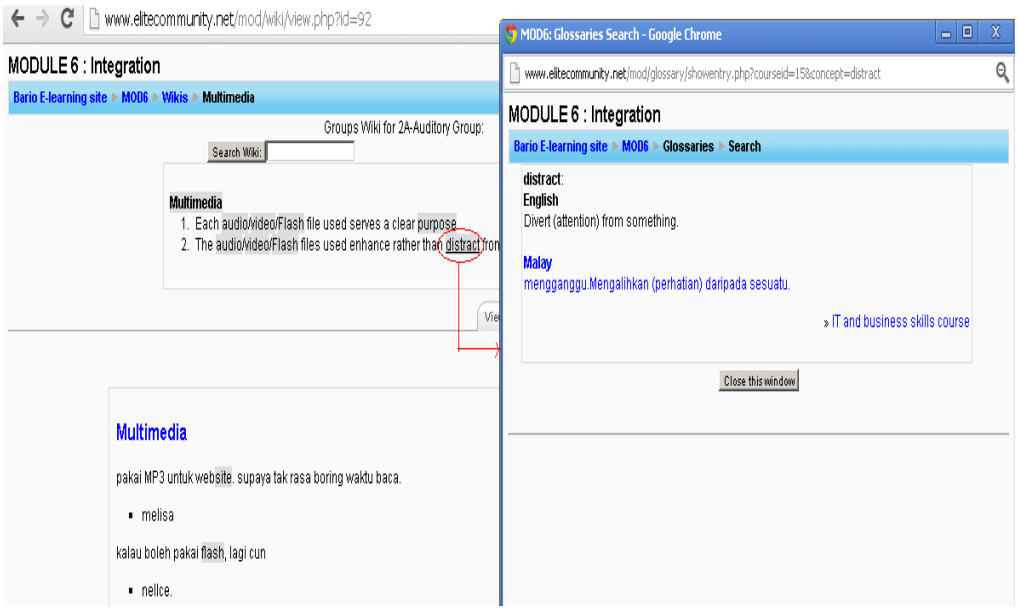


Figure 13. Screenshot for Glossary

Overall Findings

We conducted usability tests to evaluate the usability of the e-learning content and system (see Table V-Table X). The usability factor is crucially important to create an effective e-learning system with comprehensive and advanced functions, while preserving easy and flexible interaction that is aligned with learners' needs and to maintain learners' satisfaction (Triacca, Bolchini, Botturi, and Inversini ,2004; Ardito, De Marsico, Lanzilotti, Levialdi, Roselli, Rossano, and Tersigni, 2004). The usability evaluation is the critical aspect to maintain the quality assessment in any e-learning system (Cervone , 2014; Mestre, 2012;

Botturi, Cantoni, Inversini, and Succi, 2007; Stefani, Vassiliadis, and Xenos, 2006; Zaharias and Poulymenakou, 2006).

We have adopted the web usability questionnaire from Bottazzini, Fietta, Fonti, Mandelli and Ponasso (2003). Five sets of criteria are used for evaluation: User Experience, General Judgment, Special Judgment, System Learning and Information Grant. As for the Expert review, we have adopted Computer System Usability Questionnaire, CSUQ (Lewis, 1995). Usability evaluation was carried out by both learners and five expert reviewers and was complemented with heuristic inspections.

From the findings, we found positive results for our research to help learners develop higher order thinking skills through applied a method matrix to map the selected methods of Cognitive Engineering to their potential uses in the KM-e-learning usability system framework. The overall perceived usability findings are presented in Table V (Class 2A) and Table V (Class 2B).

Web Usability Findings

Web usability findings for class 2A and 2B have presented the results of perceived usability in terms of score values on a Likert scale of 1-9 (Table V and Table VI). The satisfaction levels of the learners in class 2A and 2B are separately analyzed to confirm that the student background conditions his/her degree of satisfaction and consequently the perceived usability (Table VII and Table VIII)

Table V . Web usability evaluation:
Class 2A: Perceived KM-e-learning-usability system usability testing score

2A																		
Categories	Questions	Learner 1	Learner 2	Learner 3	Learner 4	Learner 5	Learner 6	Learner 7	Learner 8	Learner 9	Learner 10	Learner 11	Learner 12	Learner 13	Learner 14	Learner 15	Learner 16	Mean
User Experience	1.1	FG	G	IS	S	FG	FG	S	S	FG	G	G	S	FG	IS	IE	IS	
	1.2	G	S	IE	IS	S	S	G	IS	G	G	I	G	G	IE	IS	G	
General Judgement	General means	7.5	7.75	7.5	8.5	7	6.75	7	7.5	7	7.25	8.5	8.25	7.5	5.75	7.75	8.25	**7.48**
Special Judgement	General means	7.5	7.5	8	7.5	7.25	8.25	8.25	7.5	7.5	8.25	8	7.75	6.5	8.5	8.25	7.5	**7.75**
system Learning	general means	6.917	7.417	6.92	8	7	6.75	7.917	7.667	7.333	6.917	7.917	8.167	7.333	7.167	7.667	7.833	**7.43**
Information Grant	general means	8	7	6.5	7	7	6.5	6.5	8.5	9	8	7	8	8	8	7	8.5	**7.53**

Table VI. Web usability evaluation:
Class 2B: Perceived KM-e-learning-usability system usability testing scores

2B																					
Categories	Question	Learner 1	Learner 2	Learner 3	Learner 4	Learner 5	Learner 6	Learner 7	Learner 8	Learner 9	Learner 10	Learner 11	Learner 12	Learner 13	Learner 14	Learner 15	Learner 16	Learner 17	Learner 18	Learner 19	Learner 20	mean
User Experience	1.1	FG	G	IS	S	FG	FG	S	S	FG	G	G	S	FG	IS	IE	IS	FG	IS	IS	IS	
	1.2	G	S	IE	IS	S	S	G	IS	G	G	I	G	G	IE	IS	G	IE	IE	IS	IS	
General Judgement	General means	6.5	6.5	6.25	6.75	6.5	6.75	7	7.25	6.5	7.75	7.25	7	7	7.25	8	7.75	7	7	7.5	7.5	7.05
Special Judgement	General means	8.00	8.25	8.00	7.75	8.00	8.00	7.25	7.50	7.25	6.75	7.00	6.75	7.25	7.25	6.75	6.50	7.50	7.00	7.00	7.50	7.36
System Learning	general means	6.58	7.17	6.92	6.58	6.67	7.25	7.67	7.67	7.67	7.67	6.50	7.42	7.92	7.33	7.33	7.08	7.08	7.50	7.92	6.50	7.22
Information Grant	general means	8	7	6.5	7	7	6.5	6.5	8.5	9	8	7	8	8	8	7	8.5	6.5	7	6	6	7.30

From the summarized perceived usability results collected for class 2A and class 2B, in the *General Judgment* category, more than 50.00% of the students rated the system as fairly good and above for both classes. For class 2A, 8 (*12.50%)* students perceived the KM e-learning system Usability as *sufficient* whereas 25 *(39.06%)* students perceived it as *fairly good*, while 19 *(29.69%)* learners perceived it as *good*. For class 2B, 17*(21.25%)* perceived it as *sufficient*, 40 *(50.00%)* learners as *fairly good*, 17 *(21.25%)* as *good*. We specially noted that 4 *(5.00%)* of the students rated the system as *excellent*.

The *Special Judgment* category aimed at evaluating the learners' reactions to the KM e-learning Usability system's tool usage. A suggestion area was provided to collect feedback on learners' perceived usability after interaction with the system. Relevant suggestions from the learners were gathered: learners 10, 12, 15 and 16 from class 2B found the user interface very simple and not stylish. Thus, they suggested enhancing the graphical user interface with colours and some Flash to make it more appealing and consequently improve the perceived usability level.

For the *Information grant* category, in terms of information provided by the system during the definition of adaptive learning processes, 15 out of 16 students and 16 out of 20 students out of from class 2A and class 2B respectively perceived it as fairly good. These appreciable results were due to the fact that all the components of the graphical user interface were understandable and the result of each operation always produced a predictable result.

From System Usability findings from both classes (Table VIII and Table IX), learners from class 2A and 2B scored the KM e-learning Usability system above 6.8 in the *general reaction* category. Learners generally found the KM e-learning Usability system simple to use. However, analysis of the learners' suggestions found that the learners encountered difficulties in distinguishing certain pages such as the concept mapping page, HTA page, module 1 page, first test page and second test page. At the initial stage, if they click the HTA page, it's a new window and sometimes some of them get disorientated and subsequently, lose their way amidst the many web pages and contents. The mean values for Class 2A and 2B in the ***Learner Experience*** category are 6.95 and 6.94 respectively. Hence, a possible reason for the difficulty faced is due to insufficient ICT knowledge and experiences.

The overall reaction for the *Page Structure* category was perceived as good. The perceived usability level by all learners was at a mean value of 7.50 and 7.55 from both classes. Learners from both classes appreciated the page graphical layout in terms of characters, image colours, and navigation. Despite the positive reaction of the students, some of them suggested to have more visualized information. The situation in Bario with the constraint of the bandwidth restricted this issue. However, this can be done in the future, once the bandwidth has been upgraded. With the customized dual language dictionary appearing as pop-ups, the learners perceived usability for *Terminology* as fairly good.

Interesting results were achieved for the *System Learning* category. In general, the learners from both classes found learning/mastering the KM e-learning Usability system as fairly good. However, answers to question E4 (*Remembering the names and using the framework commands*) and the annotated comments highlighted that students found it difficult to remember the names found on different pages as this was the first time that they were using the e-learning system.

For the *System Capability* category, the mean score was rated as sufficient and above. It is worth noting that the performance of the KM e-learning Usability system can be easily improved using a Web Server. The learners perceived usability of multimedia objects in both the system and the knowledge contents (*Multimedia Object Management* category) on average as fairly good.

Finally, the results in the *Student Satisfaction* category confirmed that designing knowledge contents by taking into account human factors such as student interest, ability and needs, the Knowledge Management process and Merrill's First Principles of Instruction is effective.

Table VII. Web usability evaluation:
Class 2A: Summarized perceived usability of the KM-e-learning-usability system

Categories	2A	Question	Scant	Insufficient	Mediocare	Sufficient	Fairly Good	Good	Excellent
	General Judgement	General means	0	0	1	8	25	19	11
	Special Judgement	General means	0	0	0	6	20	22	16
	System Learning	general means	0	0	0	17	41	44	25
	Information Grant	general means	0	0	0	4	15	5	8

Table VIII. Web usability evaluation:
Class 2B: Summarized perceived usability of the KM-e-learning-usability system

Categories	2B	Question	Scant	Insufficient	Mediocare	Sufficient	Fairly Good	Good	Excellent
	General Judgement	General means	0	0	2	17	40	17	4
	Special Judgement	General means	0	0	0	19	26	22	13
	System Learning	general means	0	0	1	35	61	42	21
	Information Grant	general means	0	0	0	10	16	6	8

System usability findings
The perceived KM e-learning Usability system usability testing results shows the scores and mean values for each question category for class 2A (Table IX) and class 2B (Table X).

Table IX. System Usability findings for Class 2A

2A																		
Categories	Question	Learner 1	Learner 2	Learner 3	Learner 4	Learner 5	Learner 6	Learner 7	Learner 8	Learner 9	Learner 10	Learner 11	Learner 12	Learner 13	Learner 14	Learner 15	Learner 16	mean
Learner Experience	A1	G	G	G	IE	G	G	EX	IE	G	G	G	G	G	G	IA	IE	
	A2	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	NO	
General Reaction	partial means	7	6.6	7.6	5.6	7	6.6	7.4	5.8	7	6.6	7.6	7	7	8.6	7.8	6	6.95
Page Structure	partial means	7.4	7.73	7.4	7.6	7.53	7.8	7.4	7.6	7.53	7.53	7.6	7.47	7.27	7.67	7.13	7.4	7.50
Terminology	partial means	7.63	7.75	7.25	7.38	7.25	7.63	7.63	6.5	7.5	7.63	7.38	7.5	7.5	7.88	7	7.13	7.41
Framework Learning	partial means	7	7.6	7.4	5.4	7.4	7.2	7.4	5.6	7	7.6	7.2	7.4	7.2	7.8	6.6	6.2	7.00
Framework Capability	partial means	6.67	6.67	6.33	6.33	6	6.67	6.33	6	7	6.67	7	6.33	6.33	7	6	6.33	6.48
Multimedia Object Management	partial means	7	8	8.5	7.5	9	9	9	7.5	8.5	8	8.5	8.5	8	8	8.5	7.5	8.19
Student Sastisfaction	partial means	6.33	7.33	7.33	7.67	7.67	7.67	34.3	7	8	7.67	7.33	7.33	7	7	7	7	8.98

Table X. System Usability findings for Class 2B

categories	Question	Learner 1	Learner 2	Learner 3	Learner 4	Learner 5	Learner 6	Learner 7	Learner 8	Learner 9	Learner 10	Learner 11	Learner 12	Learner 13	Learner 14	Learner 15	Learner 16	Learner 17	Learner 18	Learner 19	Learner 20	mean
	A1	IE	FG	G	IE	IE	G	EX	IE	G	FG	IA	FG	G	G	IA	IE	G	IA	G	IA	
	A2	NO	YES	YES	NO	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	
Learner Experience	A3	IE	G	S	IE	IE	G	G	IE	G	G	IE	G	S	G	IE	IE	G	IE	S	IE	
General Reaction	partial means	7	6.6	7.6	5.6	7	6.6	7.4	5.8	7	6.6	7.6	7	7	8.6	7.8	6	7.4	7	6.8	6.4	6.94
Page Structure	partial means	7.40	7.73	7.40	7.60	7.53	7.80	7.40	7.60	7.53	7.53	7.60	7.47	7.27	7.67	7.13	7.40	7.73	7.73	7.87	7.53	7.55
Terminology	partial means	7.63	7.75	7.25	7.38	7.25	7.63	7.63	6.50	7.50	7.63	7.38	7.50	7.50	7.88	7.00	7.13	7.75	7.88	7.50	7.75	7.47
Framework Learning	partial means	7	7.6	7.4	5.4	7.4	7.2	7.4	5.6	7	7.6	7.2	7.4	7.2	7.8	6.6	6.2	7.6	8	8.2	8	7.19
Framework Capability	partial means	6.67	6.67	6.33	6.33	6.00	6.67	6.33	6.00	7.00	6.67	7.00	6.33	6.33	7.00	6.00	6.33	6.67	7.33	6.67	7.67	6.60
Multimedia Object Management	partial means	7	8	8.5	7.5	9	9	9	7.5	8.5	8	8.5	8.5	8	8	8.5	7.5	8.5	8	8.5	9	8.25
Student Sastisfaction	partial means	6.33	7.33	7.33	7.67	7.67	7.67	7.33	7.00	8.00	7.67	7.33	7.33	7.00	7.00	7.00	7.00	7.00	7.33	7.00	7.67	7.28

Expert Review: Overall Evaluation (content activities and system evaluation)

After the system usability evaluation, the KM e-learning Usability system was evaluated by the CUSQ evaluation (by experts) (Table X). Details are presented in same table.

From Table X, Class 2A and 2B learners showed positive reaction to the overall system. The perceived usability was very positive among the users, with an average of 37.40% rating the system as fairly good, 27.71% good and 16.81% excellent. This was due to the simplicity of the language used in the KM e-learning Usability system and the created knowledge contents with the embedded multimedia objects. They appreciated very much the facilities of the KM e-learning Usability system in inserting multimedia objects and in exporting the created knowledge contents. They appreciated the results of their work and how the knowledge objects were shown in the Web browser.

An interface evaluation to find usability problems in the KM e-learning Usability system was performed. Five evaluators were involved in this usability evaluation. The aim of this evaluation was to find specific usability problems in the design so that they could be attended to as part of an iterative design process. The evaluators, from different geographical areas and universities were chosen based upon their recognized expertise in Learning Management System (LMS) and usability evaluations.

The evaluators produced and delivered a usability report, with the objective of identifying and resolving the problems identified. The evaluation was conducted separately from January to March 2012. They examined the interface and judged its compliance with the Computer System Usability Questionnaires or CSUQ (Lewis, 1995). The questionnaire addresses evaluation at both a global overall system level and at a more detailed scenario level with four main categories for analysis: system usefulness, information quality, interface quality and overall satisfaction. Analyses of variance indicated that variables such as the study, developer, stage of development, type of product and type of evaluation significantly affected CSUQ scores. The CSUQ usability report is summarized in Table XI**.**

Table XI. Responses to Computer Usability Questionnaire by five Experts

	Computer System Usability Questionnaire, CSUQ	Evaluator	Evaluator	Evaluator	Evaluator	Evaluator	Average Total
1	Overall, I am satisfied with how easy it is to use this system	3	5	5	4	6	4.6
2	It was simple to use this system	4	5	5	4	4	4.4
3	I can effectively complete my work using this system	4	3	4	3	6	4.0
4	I am able to complete my work quickly using this system	4	3	4	4	5	4.0
5	I am able to efficiently complete my work using this system	4	3	4	3	4	3.6
6	I feel comfortable using this system	4	3	4	3	4	3.6
7	It was easy to learn to use this system	5	3	5	4	5	4.4
8	I believe I became productive quickly using this system	5	3	4	5	4	4.2
9	The system gives error messages that clearly tell me how to fix problems	4	3	5	3	6	4.2
10	Whenever I make a mistake using the system, I recover easily and quickly	6	3	5	4	4	4.4
11	The information (such as online help, on-screen messages, and other documentation) provided with this system is clear	3	2	4	5	5	3.8
12	It is easy to find the information I needed	3	2	5	4	4	3.6
13	The information provided for the system is easy to understand	3	2	4	4	4	3.4
14	The information is effective in helping me complete the tasks and scenarios	4	2	4	4	4	3.6
15	The organization of information on the system screens is clear	3	1	5	5	4	3.6
16	The interface of this system is pleasant	4	2	5	5	5	4.2
17	I like using the interface of this system	4	2	4	5	4	3.8
18	This system has all the functions and capabilities I expect it to have	4	2	4	5	5	4.0
19	Overall, I am satisfied with this system	4	3	4	5	5	4.2

Overall, the evaluators were satisfied with the whole system. For questions 1-5, the evaluators felt the usability of the system was moderate and they were able to complete their work accordingly. With mean value 4.4 for questions 6-10, the evaluators found the system was quite easy to use with clear directions from the popup messages. The mean value for questions 11-15 showed that the evaluators used little extra effort to locate the needed information needed. As for questions 16-19, the evaluators were pleased with the interface design and layout. Table XII presents the most positive aspects that the five expert evaluators found on the KM e-learning Usability system.

Table XII. The qualitative summary of the five expert reviewers

	The most positive aspects	Contributing Design Factor(s)
Evaluator 1	1. Immediate feedback for assessment (albeit only objective questions)	Knowledge Acquisition, Merrill's First Principles of Instruction
	2. Some navigation aid, e.g. breadcrumbs provided.	Knowledge Adaptation, System usability
	3. Content is largely complete	Knowledge Organization
Evaluator 2	1. There are lot of functions provided	Knowledge Dissemination, HTA
	2. Page customization can be performed easily	Knowledge Adaptation, System usability, HTA
Evaluator 3	1.Good use of color	Web usability
	2.Variety of activities provided	Knowledge Acquisition, Merrill's First Principles of Instruction HTA
	3. Students can use any language for discussions (this is good to encourage flow of ideas)	Knowledge Dissemination, System usability
Evaluator 4	1.Immediate feedback for quiz	Knowledge Acquisition, Merrill's First Principles of Instruction
	2.Overall class performance charts	Knowledge Acquisition, Merrill's First Principles of Instruction
Evaluator 5	1. Modules are well organized	Knowledge Identification, Knowledge Organization
	2. Overall the content is comprehensive	Knowledge Identification, Knowledge Organization
	3.Wiki really encourage students to interact, good job	Knowledge Acquisition, Merrill's First Principles of Instruction

Implications

From our project, we have obtained constructive results for our question: "How can the learners use ICT instruments and Knowledge Management framework to enable and enhance their learning performance". We will discuss four implications to solve the two identified problems: that is from solving the use of ICT instruments to able to articulated different perspective information.

The students learned to share and to discuss when problems are raised by posting questions about complicated and complex issues in the open class discussion. Members of the groups were interacting constructively to evaluate evidence posted and found from the Web, to come out with refined information to accomplish the task given.

(i)Instructional design of learning activities, especially role-playing

Through role-playing, students learned to represent the problem in different perspective quickly and changed focus and goals as the situation required after being hinted by the facilitator. This promoted the students' cognitive development. This has solved the first problem for information overloading and making sense of information presented. The students are practicing the perspective taking process where they can understand and interpret others' viewpoints, interest and thoughts through positioning others' viewpoint in relation to own knowledge (Müller-Seitz, and Güttel,2012).

(ii) Design of learning content

To solve the second problem, we have found that the students were able to articulate information from different perspectives or to discuss complex issues by applying Merrill's First Principles of Instruction. This principle was successfully integrated to design blended learning materials for rural students. The learners integrated and consolidated what they learnt in *Knowledge Identification* and *Knowledge Acquisition*. These customized learning activities, especially role-playing, content and hint-based teaching-learning strategies engaged students to assume greater responsibility over the process of role-playing and has challenged the learners to think and reflect about significant facts in the learning activities instead of memorizing them.

The learning content carried in wikis and groupboard cultivated a basis for interaction, adaptability and learning in rapidly changing circumstances. Through participation in wikis/forum, learners developed new ideas and 'transformed' knowledge in order to be accessible at their local context and to be 'assimilated'.

(iii) Design of hint-based teaching-learning strategies to scaffold learning

The facilitator provided hints or questioned learners' assumptions when necessary. Hint-based customization helped learners to filter and consider multiple perspectives and to represent the problem from different perspectives quickly and helped them to change the focus and goals as the situation required. They posted questions about complicated and complex issues in the open class discussion. The results (see table V-X) suggested that the framework had truly encouraged the active group's online learning interaction. In order to achieve sustainability in this project, the stakeholders' active participation are needed to enable knowledge reification (Wenger, 1998).The application dimension of the KM-e-learning usability system framework by the students has enabled them to enact the newly acquired knowledge within their learning process, and this also gave rise to new opportunities for creating new competencies or new queries across groups.

(iv)Design of technology- enhanced collaborative learning.

The concept Map and interactive web conferencing tool (Groupboard) were essential tools in the LMS for knowledge sharing among the students. Through wikis, the learners obtained constructive feedback from the instructors to be on track. The RSS reader and Groupboard engaged students to acquire the latest news for a specific scope of information and better resources to carry out their assignments. These technologies minimized the lack of feedback immediacy.

The application dimension of the KM-e-learning usability system framework relies on the inter-relation of knowledge reification and active participation to trigger new knowledge. In this project, we have provided the *technology- enhanced* collaborative learning environment for the stakeholders to reify knowledge through active participation. This combination mechanism will expose the stakeholders to new context which then lead into new transformation and refinements of prevailing learning activities and contents.

Conclusion

For our project, we focused on learner-centered learning designed based on three important factors: KM processes, Merrill's First Principles of Instruction and usability properties. We wanted to ensure the students would be engaged and retain the knowledge learned through the use of simple and easy interaction with the lesson content irrespective of the facilitators being online or them participating in the lessons in an asynchronous environment.

The whole KM e-learning Usability system successfully created a conducive environment for the learners to learn and practice new skills and retain new information. Through interactive learning contents,

students were able to identify key issues, obtain relevant information, relate and compare data from different sources, and identify alternative solutions using a logical, systematic, sequential approach.

The well-organized learning modules enabled learners to acquire different knowledge and skills. This helped the learners to acquire the desired significant knowledge and skills from the right learning content which influenced the results and learning goal in knowledge and skill areas. The comprehensive learning contents attracted learners' enthusiasm in the subject matter. This is important in learning effectiveness, where the contents were readied for acquisition.

The three collaborative learning technologies (Groupboard, wiki/forum, and RSS feed) encouraged the learners to learn new knowledge in multiple ways (verbally and visually); consequently, further consolidating the knowledge in their mind. These technologies helped the learners to share their knowledge and skills among their group members. Through interactions, the learners can translate the information by relating new information to things that he/she already knew into their own words and this process has helped the learners to retain the new knowledge.

In forums, the learners discussed ideas on the specific topic. Learners utilized critical thinking skills. The learners read other perspectives and carefully considered a response. If the learners had doubts with the earlier poster, one can ask clarifying questions. Students supported their points in a discussion board posting by integrating research or class readings with which they were familiar and cited research and class readings. Moreover, learners achieved greater cognitive and exploratory learning. Hence, the use of forum encouraged active engagement with course content at getting students to learn, retain, and apply course content to novel and practical situations.

Wikis allowed ongoing knowledge management and note-taking among the learners with the same interest to write, share, argue and interacts knowledge or ideas collaboratively. In wikis, the learners were guided by the facilitator to avoid moving to the wrong track of discussion. Wikis gave an impetus to learners' collaborative work, and inspired greater interest in wikis being used in e-learning.

In conclusion, the Web and KM e-learning Usability system usability *findings* from both classes confirmed that the learners found our KM e-learning Usability system easy to learn and understand. Based on the data collected from the perceived usability score level from both classes, we infer that the perceived usability of an e-learning system could be conditioned by the quality of the knowledge contents as well as one's knowledge and one's self expectation. We intend to investigate on a bigger sample size as the findings in this paper cannot be generalized.

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