A Hybrid e-Learning Model for QMS Auditor Training

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Abstract

The ISO9001 quality management system (QMS) has been adopted by millions of organizations and in just as many business sectors. Along with an increasing demand for QMS auditors comes an equally increasing demand for training applications. However, it is difficult for a QMS auditor to achieve the required competence, as the nature of their job demands both conceptual and practical skills. This paper has employed a modern hybrid e-learning model to address the time and location limitations in training QMS auditors. It also incorporates the following learning theories "Adaptive Learning", "Collaborative Learning", "Learning in Community", "Scaffolding Learning", and "Scenario Learning" on a computational platform. A series of hybrid, digital QMS components namely "e-Learning Map", "e-Illustration", "e-Learning Group", "e-Comprehension", and "e-Workshop" were developed, applied and validated to effectively reinforce the competence of the QMS auditors who received the hybrid e-learning training. As a result, an effective e-learning application model, that is applicable to current industry educational practices and the quality of training deliverables, has been proven.

Key words : ISO9001, QMS, Hybrid e-Learning, Learning Theories

品質管理稽核員的混合式電子學習

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摘要

ISO 9001品質管理系統已為各行各業數以百萬計的組織所採用。隨著市場上對品質管理系統稽核員的需求不斷增加，有關於品質管理專業稽核人員的培訓需求亦相對提高。然而，由於品質稽核的工作需要具備理念與實務的綜合技能，這使得品質管理系統稽核員的能力不容易培育與養成。本文運用混合式數位學習的模式排除品質管理稽核員培訓過程中的時間與空間限制。所發展的系統將「適性學習」、「合作學習」、「社群學習」、「鷹架學習」與「情境學習」等知名的學習理論應用於電腦學習的平台上。一系列名為「電子學習地圖」、「電子化案例演練」、「電子化社群交流」、「電子化應用理解」與「電子化作業觀摩」等有關於品質管理系統專業的數位內容，綜合應用於品質管理系統稽核員的培訓上而能有效強化品質管理系統稽核員的能力養成。研究結果證明此數位學習模式能有效的被使用於現代產業的教育訓練而所發展的數位內容應用足以達到業界所要求的訓練品質。

關鍵字：ISO 9001、QMS、混合式電子學習、學習理論

1. INTRODUCTION

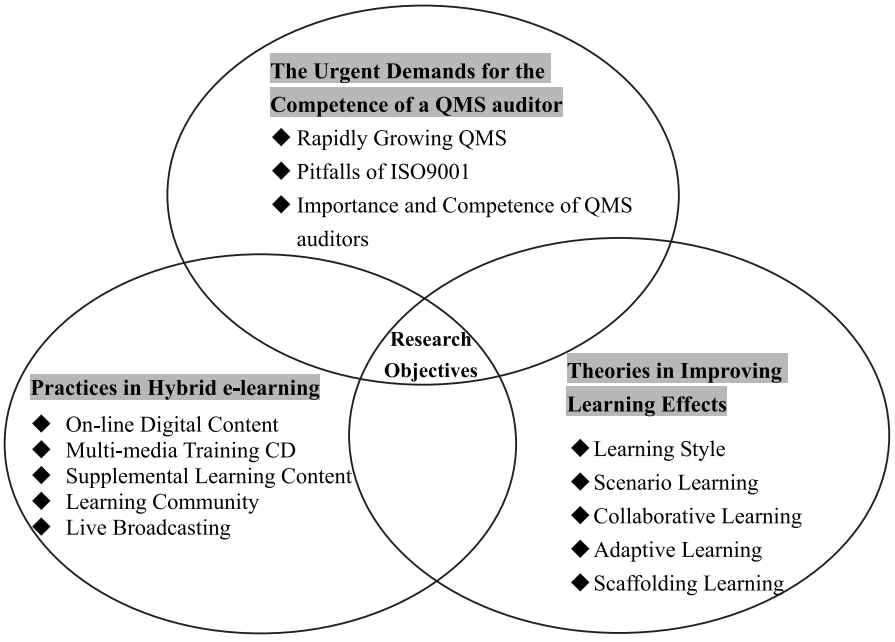

Figure 1: The Research Background

The research initiatives of this paper are described in Figure 1, which indicate trends in the industrial context of QMS auditors, learning theories for enabling a QMS auditor, and the practices of hybrid e-learning. In considering the benefits and values of quality management, the effectiveness and efficiency of a quality management system (QMS) is quite dependent on the competence of a QMS auditor (Carmody 2006). Consequently, the principles in training QMS auditors could be integrated with many hybrid e-learning practices such as on-line digital content, multi-media training CDs, supplemental learning content, on-line discussion and live broadcasting (Ijab et al. 2004).

Theoretically, all of the afore mentioned learning principles that enable QMS auditors could be incorporated into an integrated e-learning application to improve the teach-and-learn process. Thus, the hybrid e-learning platform could consist of existing modern IT platforms to deliver any proposed application. Most of the research on hybrid e-learning (Luo et al. 2006) has focused on the employment of multi-media technology, while the remaining research has focused on individual areas which apply specific learning theory to e-learning applications.

The objective of this paper is to improve the effectiveness and efficiency in training QMS auditors via a practical hybrid e-learning model while incorporating the previously mentioned learning principles. The relevant information technologies, with respect to "the application

of hybrid e-learning content”, are employed to develop a series of digital training material. An accredited training course for QMS auditors with the proposed e-learning content can be provided by an international certification body for validation.

This paper is organized in the following sections: 2. Discussions on literature reviewed for this article. 3. Research design for developing and validating a proposed hybrid e-learning model. 4. Validation data from the results of the hybrid e-learning contents. 5. Conclusions and suggestions.

2. LITERATURE REVIEW

By the end of 2006, global ISO9001 certification had hit a record high surpassing the 700K mark, according to statistics from North America (QSU 2005). Taking all the other domestic certifications into account, most of which are not on record, the ISO9001 standard has been adopted by millions of suppliers around the world. As regulated by the ISO/IEC 17021, all certification quality systems are subject to an annual review by qualified auditors (ISO 2006). Thus an increase in ISO9001 certifications would surly come with an increase in demand for qualified auditors.

In 2002, ISO issued a new auditing standard, the ISO19011, to act as a guide for all auditors (ISO 2002). It had a higher emphasis on competence and evaluation of auditors, and provided general requirements for an auditors' knowledge including principles, management, and audit activities. In this standard, auditor competence as well as criteria for evaluation is specified. The designated hybrid e-learning content in this paper attempts to meet the ISO19011 guidelines.

Carmody (2006) argues that auditors have to spend time in continual professional development in order to maintain their qualification. ISO19011 supports simultaneous training in multiple fields of QMS auditors because their background knowledge can come from any number of technical fields. Auditors sometimes struggle with expanding their competence in various fields while they are expected to possess the desirable attributes, knowledge and skills (Bransky et al. 2005); therefore, improving a QMS auditor's training and audit experience is a priority. Thus the acknowledged intent of this paper is to enhance the true value of competent auditors.

The latest standard ISO17024 dealing with the accreditation of training providers involves mechanisms to evaluate auditors (ISO 2003). Those training providers are offering and delivering training on a variety of auditing programs to facilitate an auditor's knowledge, skill and competence. The most common practice found is an accelerated training approach (Monk 2005) in which lecturing, discussion and visual aids are incorporated in a live classroom training session. Accordingly, we also employ an accelerated training course for applying the hybrid e-learning model.

Kolb (1983) categorized the learning styles into four characters namely diverger, assimilator, converger, and accommodator, and Milosevic (2005) described that those learning styles of learners could result in personalized learning profiles due to different learning preference. Sun et al. (2007) presented a novel approach to the incorporation of learning style theory in developing an adaptive e-learning system which improves the adaptation in education systems. Accordingly, in this hybrid e-learning model the adaptive e-learning is realized by providing customized e-learning content based upon delegates' learning styles.

The concept of situated learning could be applied to network teaching and learning (Own 2003), and the scenario of learning with a high value of knowledge could be chosen to strengthen the memory of a trainee and the direct learning practice (Siddiqui 2008). We therefore employ some formatted scenario of quality practices within our hybrid e-learning system.

Arnold and Smith (2003) proposed a practice-oriented community to connect members, share resources and to more effectively complete tasks. The results of mutual actions from members within the practice community could be emphasized by the learning practices in the community (Bradbury & Mainemelis 2001). We employ a newsgroup-like learning environment on the Internet to promote learning in the community for QMS auditor training.

Scaffolding is used to provide learners with the support, guidance, and assistance, to help them in completing their tasks and thus improving their ability. Liou et al. (2003) incorporated various language learning activities including listening, speaking, reading, writing and translation to construct a computational scaffolding learning system. In our auditor e-learning model, we employ the "process approach" (Bransky 2004) which incorporates media-rich illustrations to provide scaffolding for the learning of a specific body of knowledge.

Dillenbourg (2002) stated that the way to enhance the effectiveness of collaborative learning is by structuring the interactions between students. Brewer and Klein (2006) as well as Dewiyanti et al. (2007) depicted these outlooks in an asynchronous collaborated learning environment. In our Hybrid e-learning model, we construct an on-line workshop environment to simulate the collaborative learning experience.

The first hybrid e-learning model to promote Electronic Commerce was developed at the University of UNITAR in Malaysia (Ijab et al. 2004). In India, a hybrid learning center for improving management performance in the enterprise was set up by the commerce bureau (Bharadwaj 2003). Luo et al. (2006) described the importance of integrating heterogeneous e-learning systems and proposed the characteristics of an integrated platform. In our auditor e-learning model we have also proposed an integrated platform to fit the application. While most of the existing research is done for students with the same background in an academic context, our achievement is based on industrial training sessions consisting of various delegates that provide a much better external validity.

3. THE METHODOLOGY

3.1 Research Structure

The research structure to develop and validate a hybrid e-learning system is shown in Figure 2. For the purpose of this research, the afore mentioned learning theories are incorporated into the hybrid e-learning application for QMS auditors. The digital platform and content is designed and delivered in-line with the course requirements of an accredited QMS auditor trainer. A set of questionnaires, which are based on the effectiveness of the training and satisfaction level of the delegates, is then used to validate the provided Hybrid e-learning system.

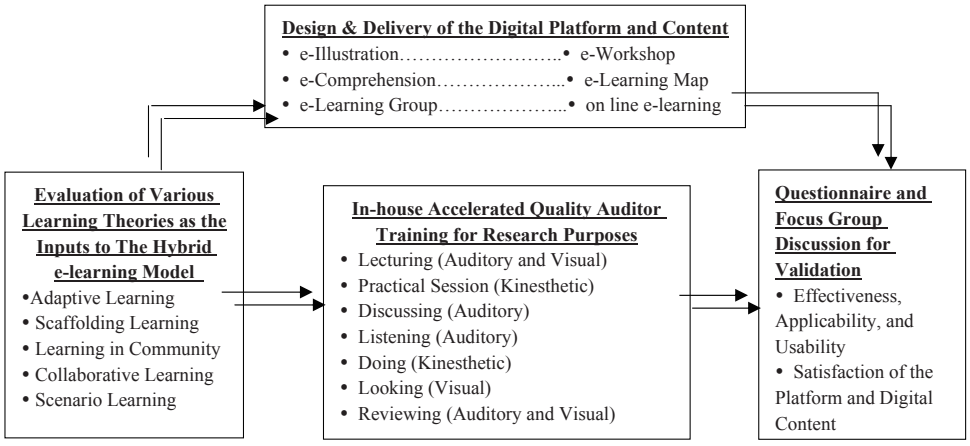

Figure 2: Research Structure of Hybrid e-Learning

3.2 The Research Steps

The research steps for hybrid e-learning in training a QMS auditor is shown in the Figure 3. The system structure of the hybrid e-learning application is first based on the defined research objectives and the result of a literature review. It is then verified by a focus group discussion. During the focus group discussion, three types of experts including e-learning providers, quality course lecturers and academic researchers are invited to the discussion. The electronic platform of the hybrid e-learning system is built up according to the outcomes of focus group discussion and then employed in developing the digital content of the hybrid e-learning application for QMS auditors. In total, six relevant experimental training courses were implemented and the survey of questionnaires on the system's effectiveness from those trained as QMS auditors were collected and analyzed by SPSS. The resulting information was used for validation and the findings and suggestions are presented later in this paper.

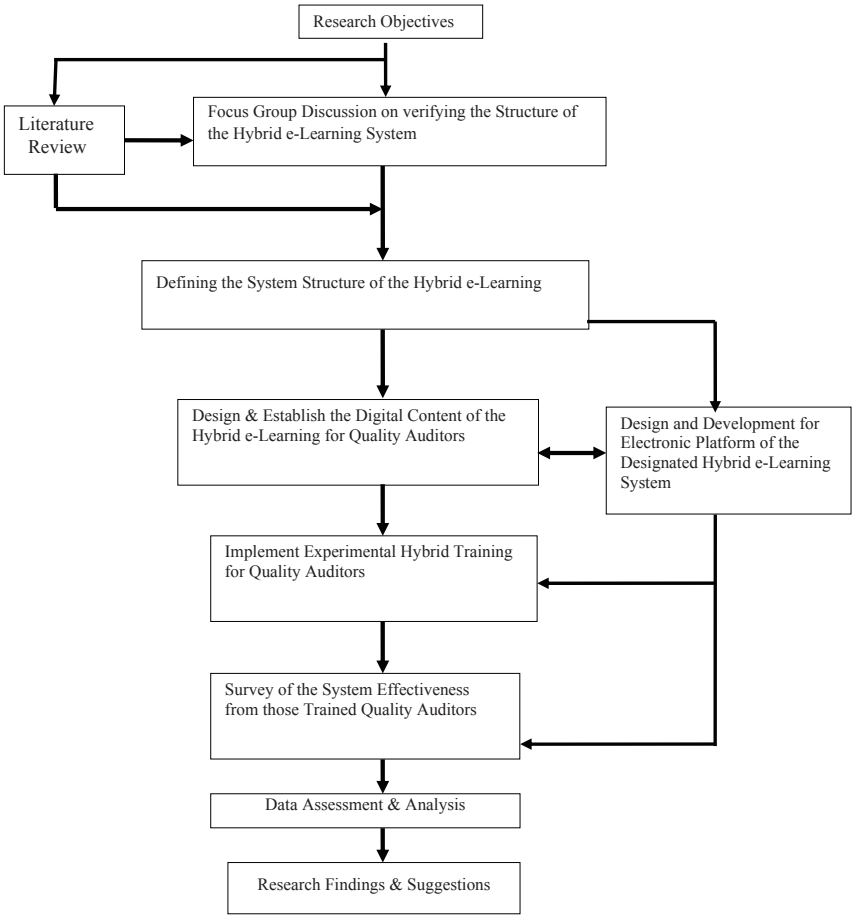

Figure 3: Research Steps of Hybrid e-Learning

3.3 Configuration for the IT Application

The three layers of IT configuration shown in Figure 4 include the hybrid e-learning application, tools, and a platform for auditor training. The interaction between the instructor and the learners is through the physical "Live Classroom" plus the following IT configurations:

1. A digital examination of learners' learning style followed by an adaptive learning map suggested by the system. This application is supported by a digital "Learning Style Inventory."
2. An asynchronous e-learning interface, which include an "e-Illustration in Practices" component, "Course and Test on Demand" component, and "Learning in Community +Workshop" component, is supported by a "Workflow server", "Streaming server", "Newsgroup server" and scenario Class.
3. A synchronous e-learning interface, consisting of an "On-line Consultation" component and "Live Broadcasting" component, which is supported by an e-conference server.

4. A hybrid e-learning content publication interface which is supported by a hybrid courseware module.
5. All of the above e-learning methods are incorporated in the traditional face-to-face lectures in the "Live Classroom", while the duration of the lecture itself has been significantly reduced. This arrangement tends to be inevitable as all QMS auditor training requires that the instructor observe the trainee's behavior live.

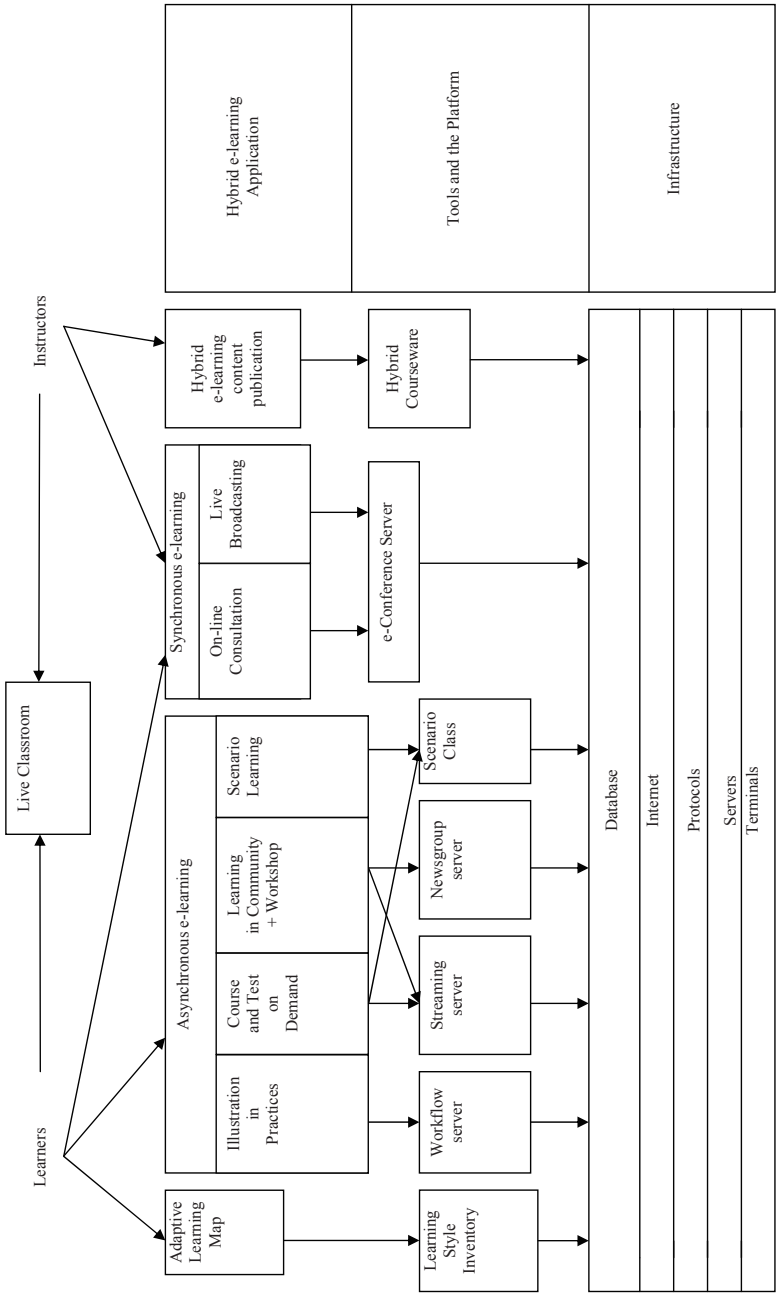

Figure 4: IT Application for Auditor Training

3.4 Focus Group Discussion and Questionnaire Design

In this research, the focus group discussion is used to analyze the system functions of a hybrid e-learning application within the context of a QMS auditor training course. Three types of experts including e-learning providers, quality course lecturers and the academic researchers were invited to the discussion. The subjects and system functions to be discussed are presented in Table 1. The prototype system to deliver QMS auditor training within a hybrid e-learning model, which consist of e-illustration, e-comprehension, e-learning group, e-workshop, and e-learning map, are evaluated in respect with those expected e-learning behaviors and performance. Moreover, the implemented training courses are surveyed by a set of questionnaires to validate the hybrid e-learning system for training QMS auditors. The questionnaire design follows the concept shown in Figure 5 in which both t-test and ANOVA are employed to examine the effects of delegates' personal attributes and the hybrid e-learning functions over the delegates' satisfaction.

Table 1: The Design for Focus Group Discussion

Performance / Manners	1.Effectiveness	2.Applicability	3.Usability
Adaptive	◆ e-Illustration ◆ e-Comprehension ◆ e-Learning Group ◆ e-Workshop ◆ e-Learning Map ◆ Online e-learning		
Scenario Rich			
Learning in Community			
Scaffolding			
Collaborative			

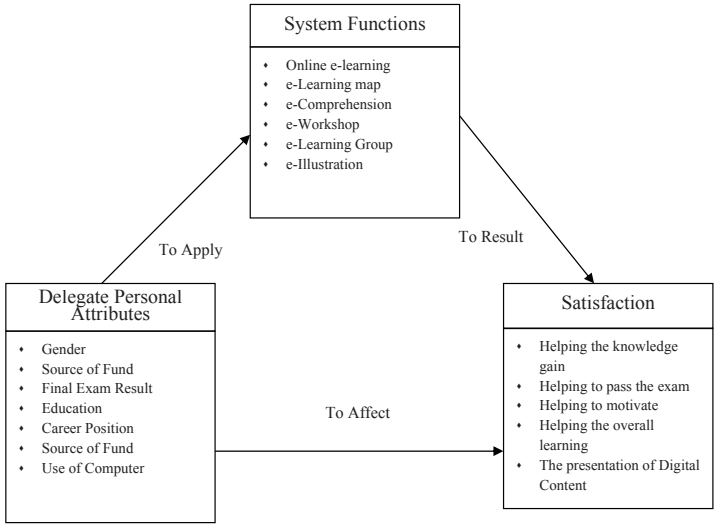

Figure 5: The Conceptual Design of Questionnaire

4. RESULTS AND ANALYSIS

4.1 Resulting Applications

The hybrid e-learning application to be used in an auditor training course is based on the afore mentioned principle learning theories. A focus group discussion determined the optimal configuration. It is outlined in the following paragraphs:

1. e-Learning Map (Figure 6): The first step is to identify a student's learning preference. This is done with the learning style inventory. Once a preference has been selected, the trainer can define a specific agenda for the learner. Each learning map emphasizes either "e-illustration", "e-workshop", or "e-comprehension" to best match the learning preference.

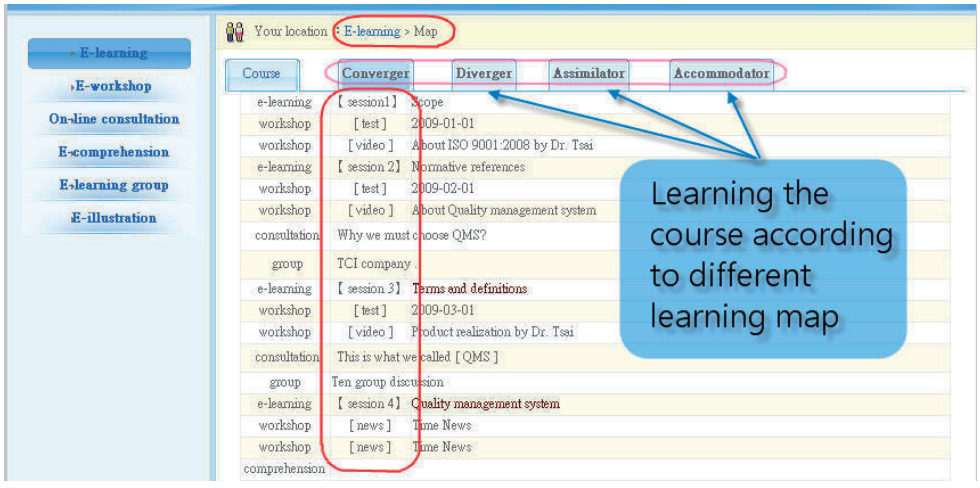

Figure 6: e-Learning Map for QMS Auditor Training

2. On-Line e-Learning (Figure 7): Two alternative on-line applications are provided for the students. One is a live broadcasting component provided through a web-conference server for synchronous e-learning. The second is an on-line component delivered through media-streaming server for asynchronous e-learning. Together the two applications provide location and time flexibility for the students.

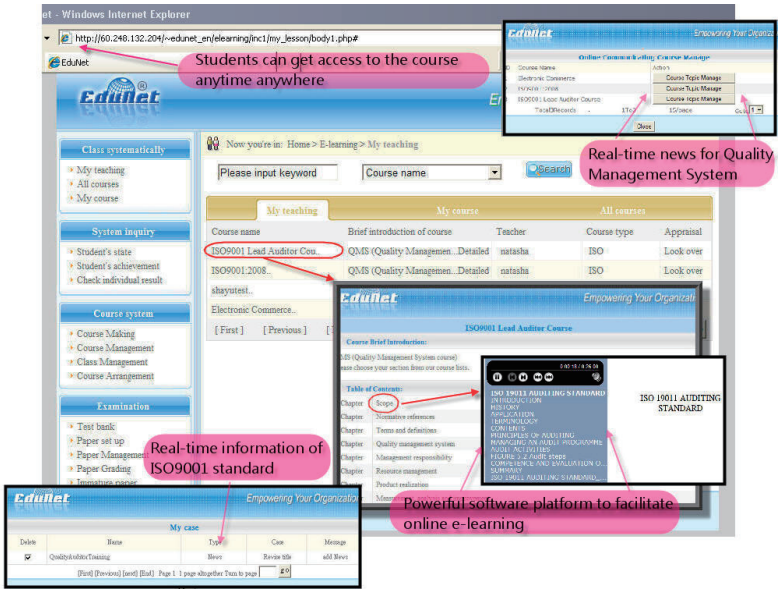

Figure 7: On-Line e-Learning for QMS Auditor Training

3. e-Learning Group (Figure 8): Learning community resources are available to everyone through a newsgroup server. Communications between trainers and learners as well as the interactive actions amongst the learners are realized via publications and discussions on the Internet. An audio-video platform is provided for publishing training "news" by speaker phone or web-cam.

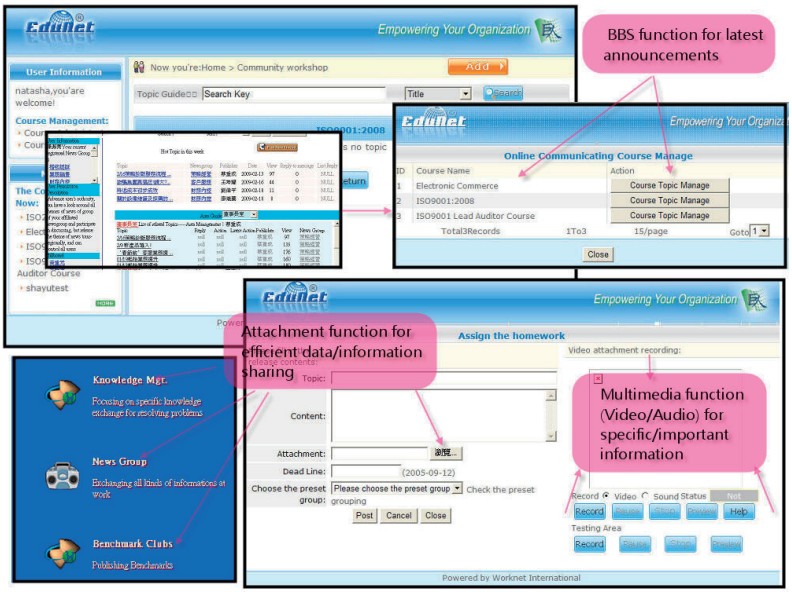

Figure 8: e-Learning Group for Auditor Training

4. e-Comprehension (Figure 9): The knowledge application cases seen in some examples of vocational practices are provided through a scenario-class server. The server contains a number of interfaces for trainers to link various case studies in the form of web-sites, flash-based presentations, quizzes, etc.

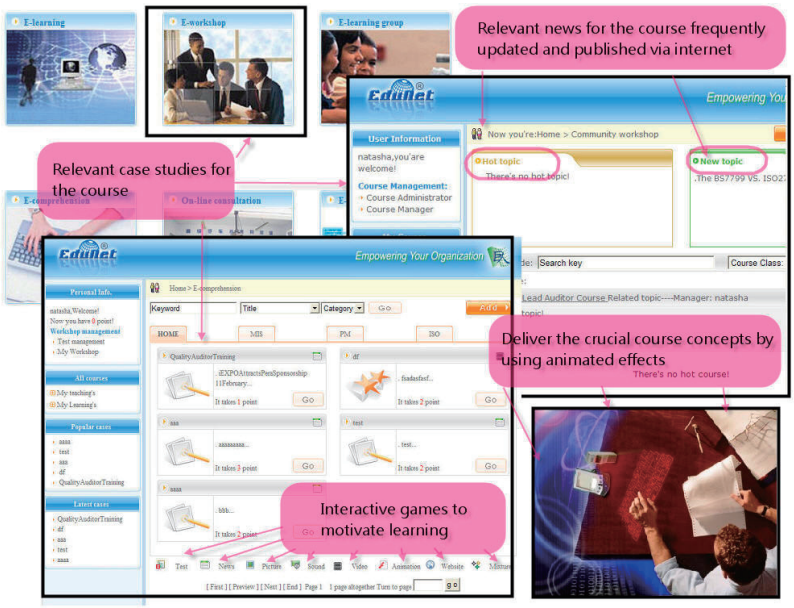

Figure 9: e-Comprehension for QMS Auditor Training

5. e-Illustration (Figure 10): The learners are inspired by an illustration of the full capabilities of the application. The objective of applying a targeted body of knowledge and the key procedures within the application are presented through in an index of each process. A work-flow server capable of processing multimedia is employed for this application.

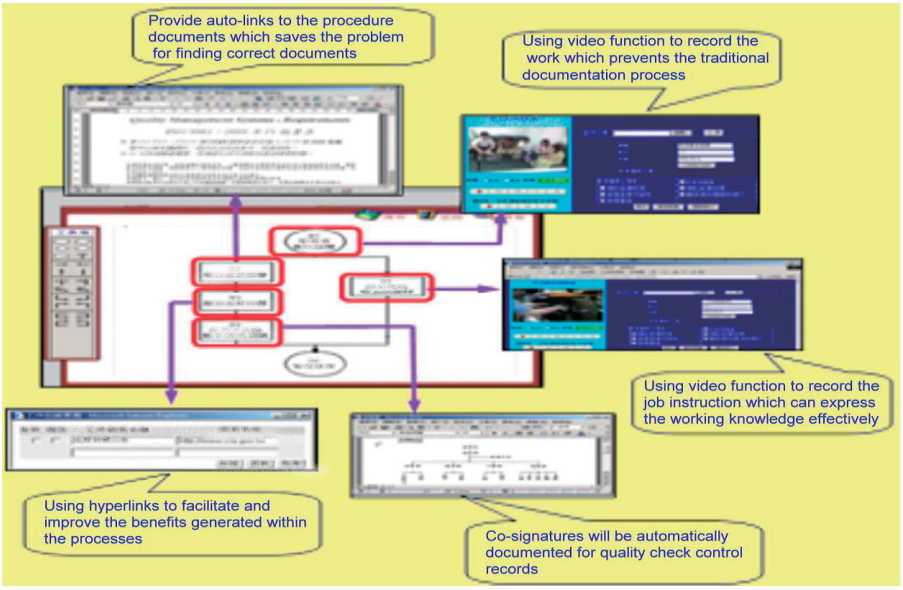

Figure 10: e-Illustration for QMS Auditor Training

6. e-Workshop (Figure 11): The students are divided into different groups and are able to view other group topics as well as the details of each group. A specific procedure for on-line discussion and presentation is required to be followed. The trainer has the ability to guide each workshop and identify and illustrate useful knowledge resulting from the on-line collaborative learning.

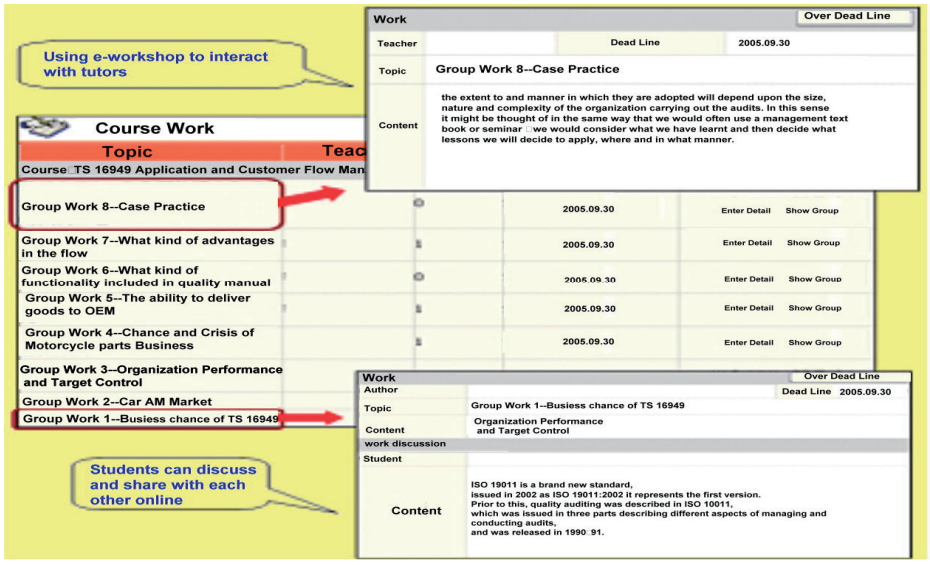

Figure 11: e-Workshop for QMS Auditor Training

4.2 Results from Focus Group Discussion

The result of focus group discussion on the effectiveness, applicability and usability of the applied hybrid e-learning system was summarized into the strengths and weaknesses of each applied e-learning subject. The above Table 2 shows each weakness found with the corresponding corrections.

Table 2: Results from Focus Group Discussion

Topics	Subjects	Weakness	Correction
Effectiveness	e-Learning Group	Limited participation because of the short duration of training	Offer this application to the delegates before the training
	Online e-learning	Not complying with SCORM	Under evaluation
Applicability	e-Illustration	Not very smooth in producing the digital content	Enhance the training for teaching assistants
	e-Learning Map	The alternative for accessing learning subjects is not provided	Improve the system design by allowing the by-pass of e-learning map
Usability	e-Comprehension	Needs a more comprehensive search function	To provide multiple indexes for each illustrative file in the search function

4.3 Results of Questionnaire

The relevant results of hybrid e-learning can be analyzed by using the questionnaire. The effects of gender, tuition and the final exam taken by the learners on hybrid e-learning can be tested by using the t-test shown in Table 3. The results show that the effect of gender on hybrid e-learning is not significantly different. The learning outcome and the knowledge of the application are significantly different for the learners whose tuition fees were publicly supported.

The one factor analysis of variance (ANOVA) is used to test the effects of training and computer operating time and career position on the relevant results of hybrid e-learning. In Table 4 the results indicate that the effects of training, computer operating time and career position on hybrid e-learning are significantly different. Computer operating time of more than 50 hours can affect on-line learning and the exercises significantly. The effect of education on the community and the examples is significantly different.

Table 3: The Effect of the Gender, Tuition and the Final Exam Taken by the Learners on Hybrid e-Learning by Using the T-Test

Factors	Variables	Category	Number of Samples	Mean	Standard deviation	t value
Online e-learning	Gender	Male	39	3.9744	0.27977	-2.234
		Female	47	4.1489	0.41592	
	Tuition	Self	17	4.9412	0.24254	4.769*
		Company support	69	4.3623	0.48419	
	Final Exam	Pass	69	3.6232	0.57141	-2.321
		Fail	17	4.0000	0.70711	
e-Learning Group	Gender	Male	39	4.0769	0.42206	-0.343
		Female	47	4.1064	0.37498	
	Tuition	Self	17	4.8824	0.33211	2.912
		Company support	69	4.5072	0.50361	
	Final Exam	Pass	69	3.6087	0.69064	-3.350
		Fail	17	4.2941	0.98518	
e-Comprehension	Gender	Male	39	4.0256	0.42841	-0.471
		Female	47	4.0638	0.32332	
	Tuition	Self	17	4.8235	0.39295	1.984
		Company support	69	4.5652	0.49936	
	Final Exam	Pass	69	3.6957	0.52312	-3.467
		Fail	17	4.2941	0.98518	
e-Workshop	Gender	Male	39	4.0000	0.22942	-1.997
		Female	47	4.1489	0.41592	
	Tuition	Self	17	4.8235	0.39295	1.590
		Company support	69	4.6087	0.52067	
	Final Exam	Pass	69	3.6232	0.57141	-1.602
		Fail	17	3.8824	0.69663	
e-Illustration	Gender	Male	39	3.9487	0.39395	-2.276
		Female	47	4.1489	0.41592	
	Tuition	Self	17	5.0000	0.00000	4.512*
		Company support	69	4.4493	0.50106	
	Final Exam	Pass	69	3.6232	0.57141	-2.561
		Fail	17	4.0588	0.82694	
e-Learning Map	Gender	Male	39	4.1282	0.46901	-0.217
		Female	47	4.1489	0.41592	
	Tuition	Self	17	4.8824	0.33211	2.802
		Company support	69	4.5217	0.50319	
	Final Exam	Pass	69	3.6232	0.57141	-2.872
		Fail	17	4.1176	0.85749	

Note: * denotes that t-value is higher than 3.0, and the effect is significant.

Table 4: The Effect of the Education, the Computer Operating Time and Career Position on Hybrid e-Learning by Using One Factor ANOVA

Factors	Variables	Category	Number of Samples	Mean	Standard deviation	p value
Online e-learning	Education	Above University	26	4.19	0.40192	0.283
		University	52	4.37	0.48624	
		Below University	8	4.25	0.46291	
	Computer operating time	Less than 10 hours	26	4.46	0.58177	0.042*
		11~30 hours	17	4.71	0.46967	
		31~50 hours	26	4.54	0.50839	
		More than 50 hours	17	4.88	0.33211	
	Career Position	Low Level	17	4.76	0.43724	0.189
		Middle Level	52	4.88	0.32260	
		High Level	17	4.71	0.46967	
e-Learning Group	Education	Above University	26	4.15	0.54349	0.029*
		University	52	4.52	0.57702	
		Below University	8	4.25	0.70711	
	Computer operating time	Less than 10 hours	26	4.35	0.48516	0.247
		11~30 hours	17	4.53	0.51450	
		31~50 hours	26	4.42	0.50383	
		More than 50 hours	17	4.65	0.49259	
	Career Position	Low Level	17	4.59	0.50730	0.041*
		Middle Level	52	4.87	0.34464	
		High Level	17	4.71	0.46967	
e-Comprehension	Education	Above University	26	4.15	0.54349	0.042*
		University	52	4.50	0.57735	
		Below University	8	4.25	0.70711	
	Computer operating time	Less than 10 hours	26	4.38	0.49614	0.183
		11~30 hours	17	4.59	0.50730	
		31~50 hours	26	4.46	0.50839	
		More than 50 hours	17	4.71	0.46967	
	Career Position	Low Level	17	4.53	0.51450	0.019*
		Middle Level	52	4.85	0.36432	
		High Level	17	4.65	0.49259	
e-Workshop	Education	Above University	26	4.15	0.36795	0.082
		University	52	4.33	0.47367	
		Below University	8	4.00	0.53452	
	Computer operating time	Less than 10 hours	26	4.54	0.58177	0.015*
		11~30 hours	17	4.76	0.43724	
		31~50 hours	26	4.50	0.50990	
		More than 50 hours	17	4.94	0.24254	
	Career Position	Low Level	17	4.88	0.33211	0.379
		Middle Level	52	4.96	0.19418	
		High Level	17	4.88	0.33211	

Factors	Variables	Category	Number of Samples	Mean	Standard deviation	p value
e-Illustration	Education	Above University	26	4.62	0.49614	0.194
		University	52	4.46	0.50338	
		Below University	8	4.25	0.70711	
	Computer operating time	Less than 10 hours	26	4.77	0.42967	0.864
		11~30 hours	17	4.71	0.46967	
		31~50 hours	26	4.73	0.45234	
		More than 50 hours	17	4.82	0.39295	
	Career Position	Low Level	17	4.94	0.24254	0.964
		Middle Level	52	4.92	0.33409	
		High Level	17	4.94	0.24254	
e-Learning Map	Education	Above University	26	4.38	0.49614	0.289
		University	52	4.56	0.50151	
		Below University	8	4.38	0.51755	
	Computer operating time	Less than 10 hours	26	4.81	0.40192	0.676
		11~30 hours	17	4.82	0.39295	
		31~50 hours	26	4.73	0.45234	
		More than 50 hours	17	4.88	0.33211	
	Career Position	Low Level	17	4.88	0.33211	0.129
		Middle Level	52	4.98	0.13868	
		High Level	17	4.82	0.52859	

Note: * denotes that p-value is less than 0.05, and the effect is significant.

4.4 Results of Trainee Survey

The results of the t-test and ANOVA analysis for the feedback from 86 delegates who attended six of the hybrid e-learning training courses, shows the extent of satisfaction differs for each of the hybrid e-learning applications. Among them, e-illustration received the greatest attention and appreciation while e-comprehension and e-learning group attracted the least attention.

1. The results of the test for satisfaction, based on the effects of gender, age and career on using the hybrid e-learning system was insignificantly different. Some significant differences that correlated with the learning effects are noted below:
2. The source of training funds for a QMS auditor is correlated with the application of e-Illustration and Online e-learning. Due to the industrial practices in digital content, delegates with company funds tend to have more commitments in picking up the content of e-Illustration and Online e-learning for practical application in companies.
3. An auditor who passes or fails the training course is correlated with the e-Comprehension and e-Workshop. Delegates who passed the final examination tend to have more involvement on e-Comprehension and e-Workshop which cover some mock exams.

4. Auditors educational background is correlated with the e-Comprehension and e-Learning Group especially for those university graduates. Delegates with higher education tend to be more involved with e-Comprehension and e-Learning.
5. The amount of hours per week spent on a computer by an auditor is correlated with e-Workshop and on-line e-learning, especially for those exceeding 50 hours per-week. Due to the requirements of computer skills, delegates with more hours using a computer tend to be more interested in e-Workshop.

5. CONCLUSION

In this paper, we have proved that the proposed hybrid e-learning system which incorporates the principal learning theories is favorable and capable in meeting the training requirements for ISO9001 QMS auditors. The proposed application could generate a comprehensive model for training auditors on line. As QMS auditor training within industry is increasing in demand, and training effectiveness is still being improved, we have illustrated an innovative way to train QMS auditors in a less costly and more effective way. The hybrid e-learning model in this paper is recommended to replace part of the live course sessions in an accredited auditor training course so the cost/benefit in training international QMS auditors could be greatly improved.

In the light of applying various learning theories to improve the teach-and-learn process, the literature review in this paper does identify a great opportunity to incorporate many principle learning theories into an integrated application. The further development of an integrated digital platform in this research has led to a successful hybrid e-learning model, and proved that there is great interest in integrating different learning theories for e-learning applications.

Moreover, taking into account the effects of an auditors' education, the source of funding, and the use of computers, we have found that the proposed model could be even more adaptive by providing an individual e-learning map according to an auditors' different attributes in terms of the educational level, the training fund provided and the weekly time allocated using computers.

Finally, with the perspective of fitting in with the current Internet culture, we suggest that the hybrid e-learning system, in respect to the integrated model in this paper, could be greatly enhanced by incorporating the concept of Web 2.0 characteristics in which participants create and share knowledge that results from their training. In addition, with more digital content to be developed on the proposed hybrid e-learning system as well as integrating with more off-line hybrid e-learning content, the system could expand the benefits of organizational learning on a broader industrial basis.

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