Full Length Research Paper

An integrated e-learning solution for healthcare professionals

August Tsai

Department of Industrial Engineering and Management, Chin Yun University, Jung-Li, Taiwan, ROC.
E-mail: augusttsai@gmail.com. Tel: 886-3-4581196#6115. Fax: 886-3-220-7889.

The ISO 9000 quality management system (QMS) has been increasingly adopted by healthcare organizations, and more applications require continuing QMS training for healthcare professionals. Lifelong learning for healthcare professionals has just required greater flexibility regarding when courses can be started, where they can be taken and how long they last — a major limitation of existing training methods. Conversely, within the medical and healthcare milieu, factors such as: "heightened expectations for healthcare services quality", "acute shortage of healthcare professionals", "increased complexity of healthcare services" and "accelerated technological changes" all reinforce the need for continual competency-based training of its workers. This paper employs a modern hybrid e-learning model to reduce the time and location limitations in providing QMS knowledge and practices for delegates in continuing medical education, while principal learning theories such as: adaptive learning, collaborative learning, learning in community, scaffolding learning, and scenario learning are incorporated into a computational platform. A series of hybrid digital QMS contents, namely: e-learning map, e-illustration, e-learning group, e-comprehension, and e-workshop were developed, applied and validated to be effective in reinforcing the competence of those who received the hybrid e-learning contents. As a result, an effective e-learning application model for healthcare professionals and the quality of training is proven.

Key words: adaptive learning, collaborative learning, healthcare professional, hybrid e-learning, learning in community, quality management system (QMS), scaffolding learning, scenario learning.

INTRODUCTION

The research initiatives of this paper indicates the trend of quality management in the industrial context of healthcare, as well as the learning theories for enhancing the knowledge of healthcare professionals and practices related to hybrid e-learning. In considering the benefits and values derived from healthcare quality management, the effectiveness and efficiency of a healthcare organisation is highly dependent on the competence of its healthcare professionals (Hersh et al., 2006; Carmody, 2006). The principles in training healthcare professionals could be integrated with many aspects of hybrid e-learning, such as on-line digital content, multi-media training CD, supplemental learning content, on-line discussion and live broadcasting (Olapiriyakul and Scher, 2006; Teng et al., 2009).

Theoretically, all of the learning principles could be incorporated into an integrated e-learning application, thereby improving the teach-and-learn process for healthcare professionals (Whitsed, 2003; Childs et al., 2005; Hugenholtz et al., 2008). Still, the hybrid e-learning platform could consist of modern IT platforms in delivering the desired application.

Many researches on hybrid e-learning have focused on the employment of media technology (Ijab et al., 2004; Luo et al., 2006), while some exhibited single interests in applying a specific learning theory to the e-learning application (Liou et al., 2003; Dewiyanti et al., 2007; Chen et al., 2008; Clark, 2009). The objective of this paper was to improve the effectiveness and efficiency in training healthcare professionals using a practical hybrid

e-learning model incorporating the above-mentioned learning principles. The relevant information technologies with respect to "the application of hybrid e-learning content" were employed to develop a series of digital content. An accredited training course in Taiwan for quality management in healthcare is equipped with the proposed e-learning content for validation.

LITERATURE REVIEW

By the end of 2009, ISO 9001 certification hit a global record high, surpassing the one million mark, according to ISO statistics. Taking all the other off-record domestic certificates into account, the ISO 9001 standard has been adopted by millions of organisations worldwide. In the same regard, the role of implementing a quality management system in healthcare organisations is critical. According to research conducted by Beholz et al. (2003), the introduction of the ISO 9001 in a university cardiac surgery department, led to the conclusion that it was possible for the cardiac surgery department to implement and acquire ISO 9001 certification, and that this could prove the first step for the cardiac surgery department in progressing towards total quality management (TQM). Also indicated was that in a healthcare organisation with different healthcare departments, the acquisition of ISO 9001 certification for separate departments could help generate the requisite quality awareness for moving to TQM within the organisation.

Kobs (2006) introduced examples of how the ISO 9001 can support the nursing process, thereby achieving positive outcomes for patients. She also mentioned that the ISO 9001 provides the structure/framework with which to support quality nursing care. Helbig(a) et al. (2006) proposed research on quality assessment according to ISO 9001 certification in a university Ear, Nose and Throat (ENT) department; the outcome of the research attested to the quality management system being "required" by the hospital management. The university also has a Quality Management Department that plays a key role in the professional guidance and training of quality management representatives; this points out the correlation between the hospital management system and the quality management system.

According to the study of Heuvel et al. (2005) in the Netherlands' Red Cross Hospital on the implementation of the ISO 9001, the result of implementation revealed several benefits of use. Heuvel et al. (2005) stated that the positive effects reported in their research showed how the ISO 9001 is expected to become more prevalent in the healthcare industry. However, in order to achieve the goal of an effective quality management system within healthcare organisations providing quality care, the healthcare personnel in the organisation require ongoing development of their quality management capability

(Carmody, 2006). Hence, it is crucial for a healthcare organisation to deliver effective quality management training courses to healthcare professionals, and allow them access to the learning resources without time and location limitations. As for e-learning in healthcare organisations, Whitsed (2003) introduced a concept in his research on the use of handheld computers in e-learning for medical students at the Royal College of Surgeons in Ireland. He concluded that all healthcare organisations should take the integration of all relevant technology into a seamless environment as their ultimate goal, thus attesting to the importance of e-learning and e-learning technology for healthcare organisations.

Hersh et al. (2006) stated that healthcare education is becoming more competency-based, and also that there is an increasing use of e-learning technologies related to competencies through emerging e-learning standards. They declared that their efforts facilitated access to competencies and e-learning content in the medical informatics area linked by content-competency associations, and demonstrated that such standards can be successfully used as well as implemented in other domains. A research project was conducted in Northumbria University to identify the e-learning barriers facing healthcare professionals and students. The project esta- blished possible ways to overcome these barriers (Childs et al., 2005). The proposed solutions include standardisation; strategies; funding; integration of e-learning into the curriculum; blended teaching; user-friendly packages; access to technology; skills training; support; employers paying e-learning costs; and dedicating work time for e-learning. Hugenholtz et al. (2008) evaluated the effect of e-learning on knowledge in regard to mental health issues as compared to lecture-based learning in a Continuing Medical Education (CME) programme for Occupational Physicians (OPs). They found a significant gain in knowledge from e-learning focused on mental healthcare. It concluded that the effect of e-learning on OP's mental healthcare knowledge was comparable to a lecture-based approach; that is, e-learning can be beneficial to the CME of OPs.

According to the research of Harun (2001), there is a need for appropriate management and leveraging for the knowledge base. This is already available and accessible to all stakeholders within healthcare organisations. He pointed out several factors that reinforce the need for regular refresher courses, training, and retraining of medical and healthcare workers, and the solution to those requirements was delivered through Internet-based content incorporating e-learning into health-related settings and the daily, routine life of medical and healthcare professionals.

With regard to those useful learning theories, Kolb (1983) grouped the learning styles into four categories, each representative of a different character type. Sun et al. (2007) presented a novel approach to the incorporation of

learning style theory in developing an adaptive e-learning system which improves adaptation in education systems. Essalmi et al. (2010) declared that the recent e-learning practices have raised challenging issues with respect to providing adequate learning experiences to different learners, since Web-based learning systems generally do not adapt content to suit individual learner's needs. Accordingly, in this hybrid e-learning model, the adaptive e-learning is realized by providing customized e-learning content based upon participants' learning styles.

On the other hand, the concept of situated or scenario learning could be applied to network teaching and network learning (Own, 2003), and the learning scenario with highly valued knowledge could be chosen to strengthen the memories of trainees and their direct-learning practice. In simple terms, scenario-based learning is that learning that occurs in a context, situation, or social framework (Kindley, 2002). Clark (2009) declared that scenario based learning (SBL) generally works best in teaching non-routine job tasks that involve judgment and decision making, and that SBL is most appropriate for learners who already have some relevant job experience. We therefore employ some quality application scenarios in healthcare for hybrid e-learning delegates with job experience.

Arnold and Smith (2003) proposed the practice-oriented community for bringing the members together to share the resources and complete the task effectively. The results of mutual actions on the part of the members in the community could be emphasized for community learning (Bradbury and Mainemelis, 2001). We employ a newsgroup-like learning environment with the internet to promote learning in the community as part of the healthcare worker's professional training.

Scaffolding is required in order to provide the learners with support, guidance and assistance, and then to help them complete the task to improve their ability. Liou et al. (2003) incorporated various language-learning activities, including: listening, speaking, reading, writing and translation to construct computational scaffolding for learning. Chen et al. (2008) designed a learning support system to send e-news to each student's e-mail account to increase knowledge and information visibility. On-line learning records and performances were analyzed into adaptive e-news for scaffold students to receive up-to-date announcements, instructions or peer interactions. In our healthcare professional e-learning model, we employ the "process approach" (Bransky, 2004), incorporating media-rich illustrations to provide scaffolding for learning some specific body-related knowledge and applications for the QMS in healthcare.

Dillenbourg (2002) stated that the way to enhance the effectiveness of collaborative learning was by structuring the interactions between delegates. Wang (2006) depicted the outlooks in a collaborative learning environment, and suggested that assigning roles for

the beginning and ending of collaboration would be beneficial. Dewiyanti et al. (2007) supported the idea by exploring an asynchronous collaborative learning environment. The result indicated that group members' involvement in regulating group processes might take some time to occur and would not automatically happen at the beginning of the collaboration. In our hybrid e-learning model, we constructed an on-line workshop environment to scaffold healthcare professionals' collaborative learning from the beginning of the training.

Olapiriyakul and Scher (2006) referred the concept of hybrid learning or blended learning to the mixed mode of instruction which formally combines face-to-face learning and distance learning by incorporating technology to facilitate the learning process. 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 centre for improving the 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. Teng et al. (2009) surveyed 112 participants who worked in various types of organizations. The survey results revealed that the most significant issue related to hybrid learning is a lack of understanding of what it is. In our healthcare professional e-learning model, we also proposed an integrated platform to fit the application. While most of the existing researches are done for delegates with the same background in regard to academic context, our achievement is based on industrial training sessions involving a variety of delegates that provide much better external validity.

Regarding the effectiveness of e-learning, Greenhalgh et al. (2003) conducted a systematic review of evidence pertaining to on-line education and concluded that the evidence regarding education should not only include formal and research-derived knowledge but also tacit knowledge such as practical wisdom, informal knowledge, and shared experiences of practices. Delialioglu and Yildirim (2008) declared the effectiveness of the hybrid instruction should be based on students' achievement, knowledge retention, attitudes towards the subject, and course satisfaction. Lim et al. (2007) discovered the determinants of effective on-line training and revealed how those variables affect learning performance and transfer performance. In our research, we adopted those dimensions proposed by Lim et al. (2007) to evaluate the effectiveness of developed hybrid e-learning courses through focus group discussion.

METHODOLOGY

The course design

For the ISO 9001-like QMS in the healthcare sector, ISO specifically

Table 1. Content of the two-week hybrid e-learning.

Training content	Traditional course (6 h of classroom meeting per week)	e-learning course (12 h of on-line learning per week)
Introduction of quality management. in healthcare	Opening lecture by hybrid e-learning orientation and PowerPoint presentation	Complementary on-line lecture, scenario quizzes, on-line and off-line consultation, web forum
ISO/IWA1 clause by clause interpretation	Complementary Q and A	On-line lecture, scenario quizzes, on-line and off-line consultation, web forum
The planning and implementation of QMS in healthcare	Complementary Q and A	On-line illustration of complete QMS procedures in a hospital, on-line and off-line consultation, web forum
Quality audit for the QMS in healthcare	Complementary Q and A	On-line lecture, scenario quizzes, on-line and off-line consultation, on-line illustration of quality audit reports in a hospital, web forum
Case study of quality management in healthcare	Complementary Q and A	On-line lecture, scenario quizzes, on-line and off-line consultation, web forum
Workshops of quality audit in healthcare	Closing workshop with performance evaluation and 2 h final examination	On-line illustration of previous workshop, On-line mock examination with answer rationale

published a guideline standard, ISO/IWA1 "Quality Management lift Systems – Guidelines for process improvements in health service (ISO, 2005). AFNOR, the standardization body of France, adopted this standard to develop qualification training for these healthcare professionals responsible for QMS in a healthcare organisation (AFNOR, 2006). The original course lasts for 5 consecutive days, a system that does not fit the natural working style of healthcare professionals who work multi-shifts doing heavy duty. In order to lift such a constraint in training healthcare professionals, we have redesigned the course, breaking it into two parts: traditional face-to-face and on-line e-learning in a hybrid format. The hybrid course lasts for two consecutive weeks and allows delegates to align their learning in both synchronous and asynchronous manners. The provided hybrid e-learning content is summarized in Table 1.

The principles and participants

The principal QMS practices in healthcare are quality planning, quality improvement and quality audit, and that practical knowledge could only be transferred via auditory, visual and kinaesthetic training arrangements (Monk, 2005). The proposed hybrid e-learning organises various institutional principles to accommodate different learning principles, different delegates and instructor roles in each e-learning function.

Our research involved 2 public training sessions and 1 in-house training session consisting of 46 delegates who are nurse, administrative staffs, laboratory staff and dispensers in hospitals.

The delegates who participated in the hybrid training are all expecting to receive professional qualifications to practise ISO 9001-like QMS in hospitals. The overall training principles of our hybrid e-learning are summarized in Table 2.

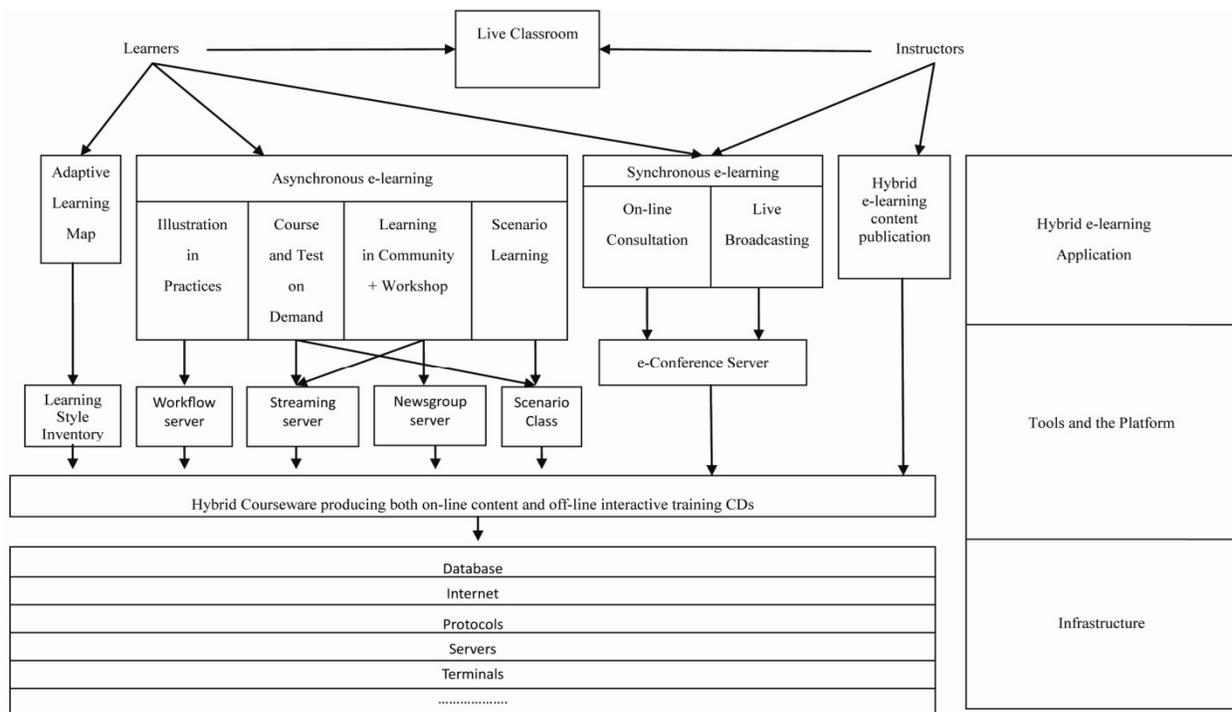**Configuration for the IT Application**

The three layers of IT configuration shown in Figure 1 include the hybrid e-learning application, tools and platform for healthcare professional training. The interactions between the instructor and the learners occur through the physical "Live Classroom" plus the following IT configuration:

1. A digital examination of learners' learning style followed by an adaptive learning map suggested by the system and the instructor.
This application is supported by a computerized test on "Learning Style Inventory."
2. Asynchronous e-learning, including: e-Illustration in practices, course and test on demand, learning in community + workshop, is supported by: workflow server, streaming server, newsgroup server and scenario class.
3. Synchronous e-learning, consisting of an On-line Consultation and Live Broadcasting, supported by an e-conference server.
4. A hybrid e-learning content publication interface which is supported by a hybrid courseware module. This module supports both pre and post-course production for hybrid digital contents which exist in both on-line servers and off-line complementary training CD.

**Table 2.** Synopsis of hybrid e-learning principle.

Feature/ Function	Learning principle accommodated	Delegate's role	Instructor's role	Institutional framework
e-learning map	Adaptive learning, scaffolding learning	Identifying his own learning preference	Planning scaffolding learning maps by different learning styles	Delegates complete the learning style test before entering the course
e-Illustration	Scaffolding learning, scenario learning	Cognizing the illustrated QMS in healthcare	Providing the real case of QMS implementation in healthcare	Instructor requests delegates' feedback in the e-Learning group
e-Learning group	Collaborative learning, learning in community, scaffolding learning	Participating the newsgroup discussion	Observing to guide the newsgroup discussion	Regulating at least 1 h engagement and 3 discussion subjects per week for each delegate
e-Comprehension	Scenario learning	Practicing the situated comprehension test	Designing those scenario quizzes and answers	The quizzes are mocking the final qualification exam.
e-Workshop	Scenario learning, collaborative learning, learning in community	Completing the QM assignment in healthcare with his team mates	Reviewing workshop reports, and providing both face-to-face and on-line feedback	Delegates must pass the workshop performance evaluation before taking the final exam.

Figure 1. IT application for healthcare professional training. This figure shows the three layers of IT configuration including the hybrid e-learning application, tools and platform for healthcare professional training. The interactions between the instructor and the learners occur through the physical "Live Classroom" plus the illustrated IT configuration.

Table 3. The design for focus group discussion.

Manners	Performance (32)	Effectiveness (Training and transfer achievement)	Applicability (Communication and trainee)	Usability (Content and easiness)
Adaptive Scenario Rich Learning in community Scaffolding Collaborative		e-Illustration, e-Comprehension, e-Learning Group, e-Workshop, e-Learning Map, On- and off-line lecturing		
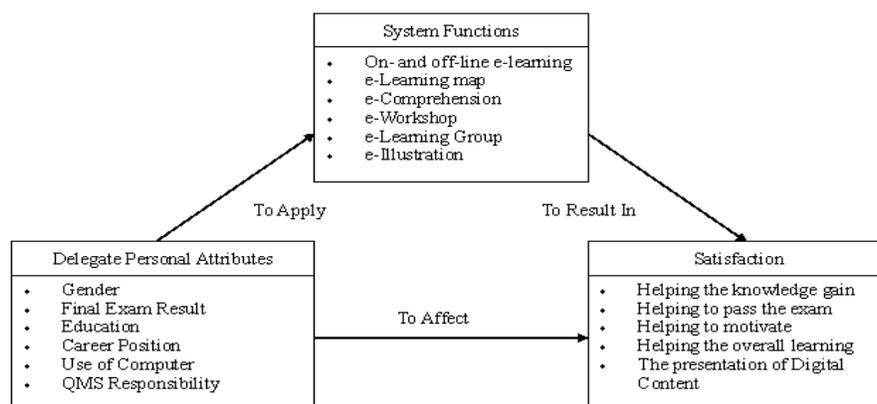
Figure 2. The conceptual design of the questionnaire. This figure shows the design concept of questionnaire set which was to survey the hybrid e-learning system for training healthcare professionals. The questionnaire design examined the effects of delegates' personal attributes and the hybrid e-learning functions in relation to the delegates' satisfaction.

Focus group discussion and questionnaire design

In this research, focus group discussion is employed to validate the system functions of hybrid e-learning within the context of the healthcare professional training course. Three types of experts: e-learning providers, quality course lecturers and the academic researchers were invited to the discussion. The subjects and system functions in a matrix are shown in Table 3. The prototype system to deliver healthcare professional training in a hybrid e-learning model consisting of: e-illustration, e-comprehension, e-learning group, e-workshop, and e-learning map are evaluated in respect to the expected e-learning manners and performance. Moreover, the implemented training courses were surveyed by a questionnaire set to survey the hybrid e-learning system for training healthcare professionals. The questionnaire design follows the concept shown in Figure 2 in which both t-test and ANOVA are employed to examine the effects of delegates' personal attributes and the hybrid e-learning functions in relation to the delegates' satisfaction.

RESULTS

Resultant applications

E-learning map

The learning style inventory is first provided for identifying

each student's learning preference. The trainer then defines the specific agenda for each individual group for one learning style. Each learning map has different emphasis on "e-illustration", "e-workshop", "or "e-comprehension", to match the learning preference (Figure 3).
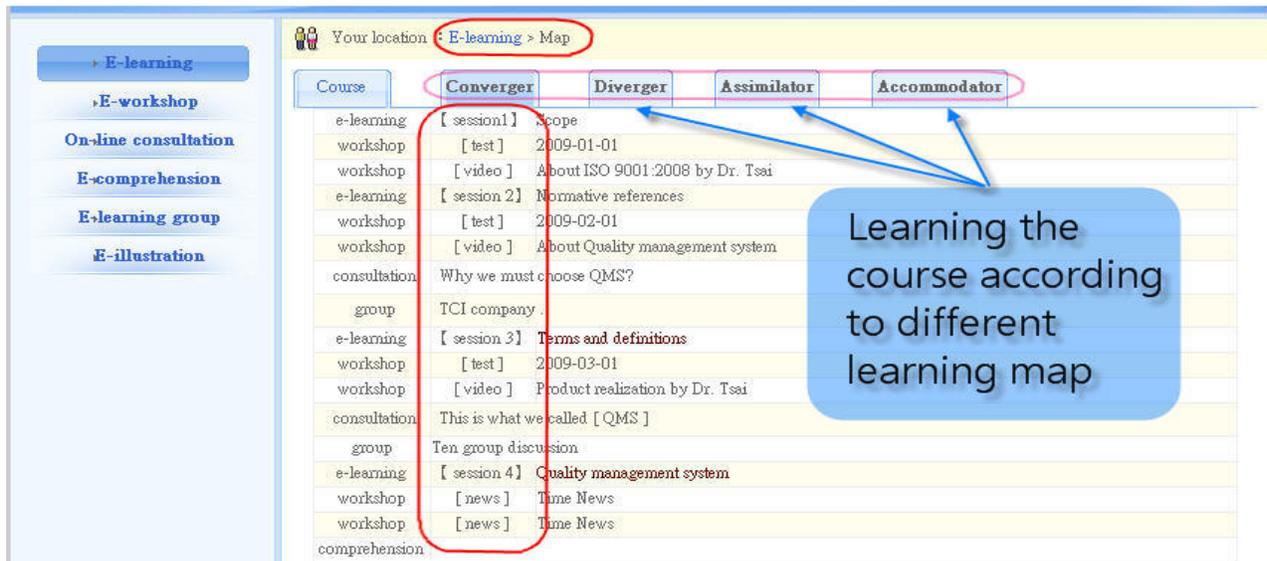
On- and off-line e-learning:

Three alternative on-line applications are provided for delegates. One is the live broadcasting through the web-conference server for synchronous e-learning. The second is the on-line downloading through the stream server for asynchronous e-learning.
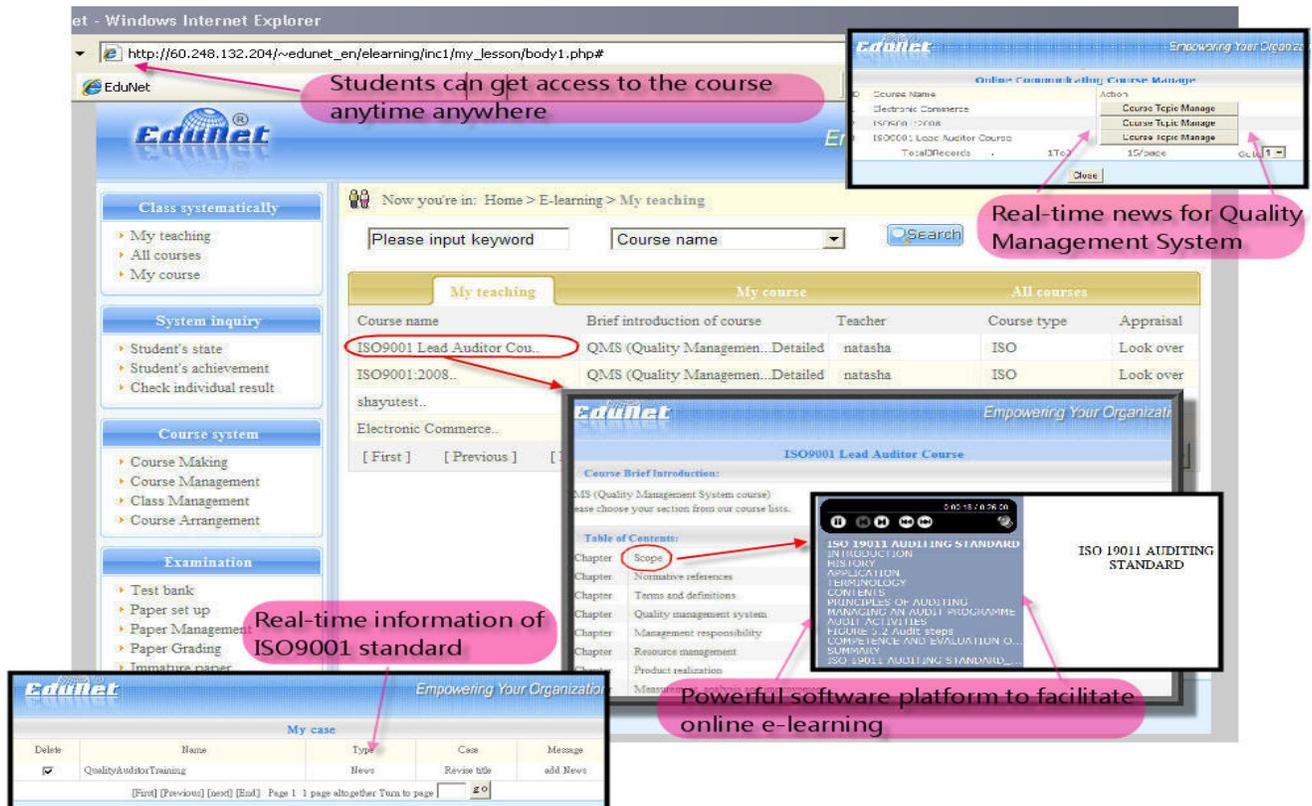
Together, they provide location and time flexibility for delegates. The final option is to use off-line interactive, multimedia training CDs derived from those on-line digital contents (Figure 4).

E-learning group

The resources in the learning community are shared

Figure 3. e-Learning Map for healthcare professional training. The learning style inventory is first provided for identifying each student's learning preference. The trainer then defines the specific agenda for each individual group for one learning style. Each learning map has different emphasis on "e-illustration", "e-workshop", "or "e-comprehension", to match the learning preference.

Figure 4. On-Line e-Learning for Healthcare Professional Training. Three alternative on-line applications are provided for delegates. One is the live broadcasting through the web-conference server for synchronous e-learning. The second is the on-line downloading through the stream server for asynchronous e-learning. Together, they provide location and time flexibility for delegates. The final option is to use off-line interactive, multimedia training CDs derived from those on-line digital contents.

Figure 5. e-Learning group for healthcare professionals training. The resource in learning community is shared with everyone through the newsgroup server. The communication between the trainers and the learners and the interactive actions among the learners are realized through publications and discussions on the internet. An audio-video platform is provided for publishing learning "news" via speaker phone or cam viewing.

through the newsgroup server for everyone. The communication between the trainers and the learners as well as the interactive actions among the learners is realized through publications and discussions on the internet. An audio-video platform is provided for publishing learning "news" via speaker phone or cam viewing (Figure 5).

E-comprehension

The cases of knowledge application in some examples of vocational practices are provided through the server of scenario classes. The server has many interfaces for trainers to link various case studies in the forms of hypertexts, web-sites, flashes, quizzes, etc. (Figure 6):

E-Illustration

The learners are inspired by browsing a full illustration of

field application. A process flowchart of healthcare practices in field is provided in which each process step is furnished with reference work instructions, standard procedures and illustrated record sheets in the form of multimedia. A workflow server capable of processing multimedia is employed for such computational applications (Figure 7).

E-Workshop

The delegates are always divided into different groups; within-group and between-group workshops are provided. A specific procedure for on-line discussion and presentation has to be followed, and the trainer could guide each workshop to identify and illustrate useful knowledge resulting from the on-line collaborative learning (Figure 8).
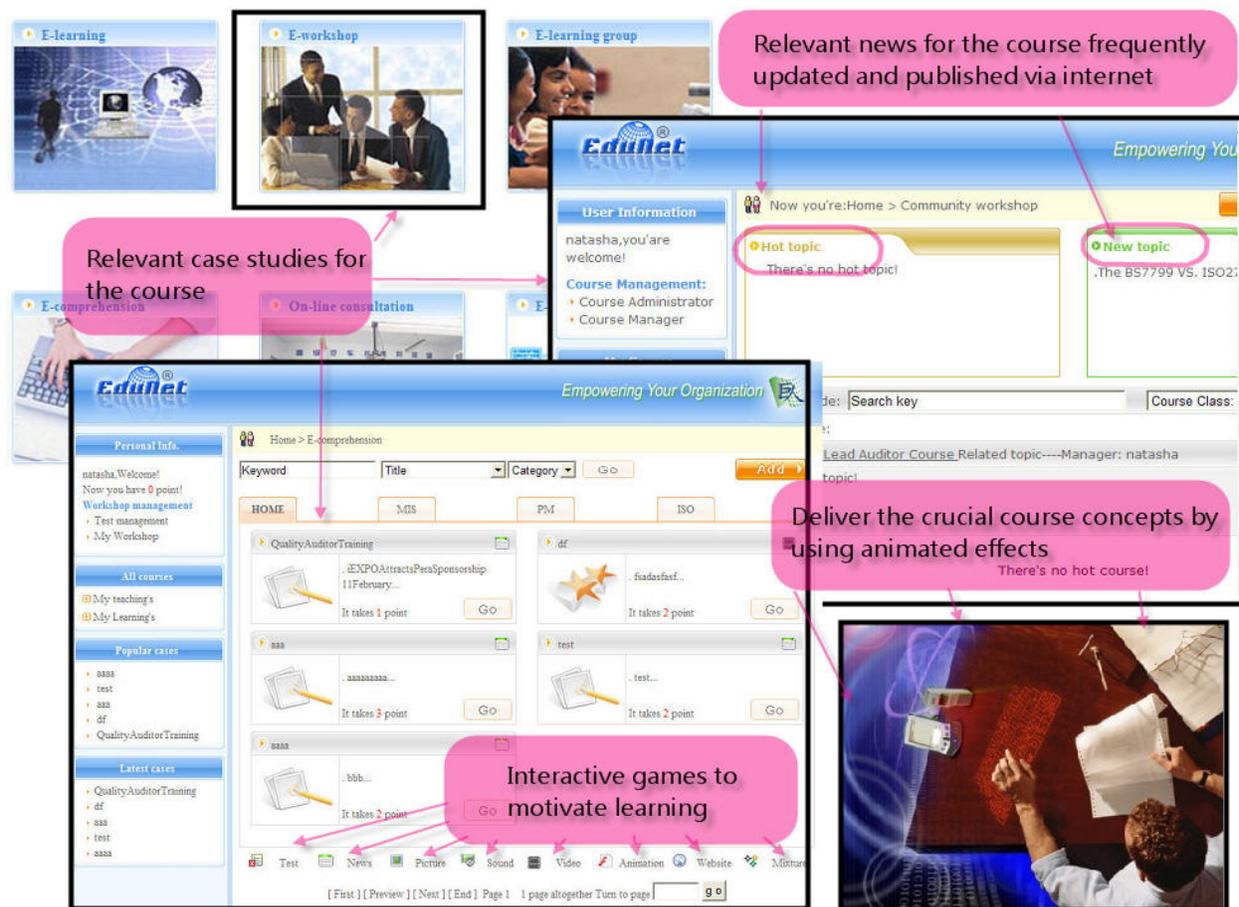
Figure 6. e-Comprehension for healthcare professional training. The cases of knowledge application in some examples of vocational practices are provided through the server of scenario classes. The server has many interfaces for trainers to link various case studies in the forms of hypertexts, web-sites, flashes, quizzes, etc.

Results from focus group discussion

The result of functions on the focus group discussion on the effectiveness, applicability and usability of each applied hybrid e-learning was summarized in Table 4 according to the server performance aspects modified from Lim et al. (2007)'s research.

Results of questionnaire

The relevant result of hybrid e-learning is further validated by using the questionnaire of satisfaction survey. The effects of the gender, QMS responsibility and final exam of the learners on hybrid e-learning can be tested by using the t-test, as shown in Table 5. The results showed that the effect of gender on the hybrid e-learning is insignificantly different. However, the learning performance and the satisfaction for learners with QMS responsibility are significantly different.

The one factor analysis of variance (ANOVA) is used to test the effect of education, computer operating time and career position on the relevant results of hybrid e-learning. In Table 6, the results indicate that education, computer operating time and career position on the hybrid e-learning are significantly different. The computer operating time with more than 50 h can significantly affect the On- and off-line learning and the exercise. The effect of education on the e-learning group is significantly different.

Results of trainee survey

The results of the t-test and ANOVA analysis of the feedback rom 46 delegates who attended three of the hybrid e-learning training courses showed different degrees of satisfaction for different hybrid e-learning applications. Among them, e-illustration with practical cases of quality management in the field of medical care
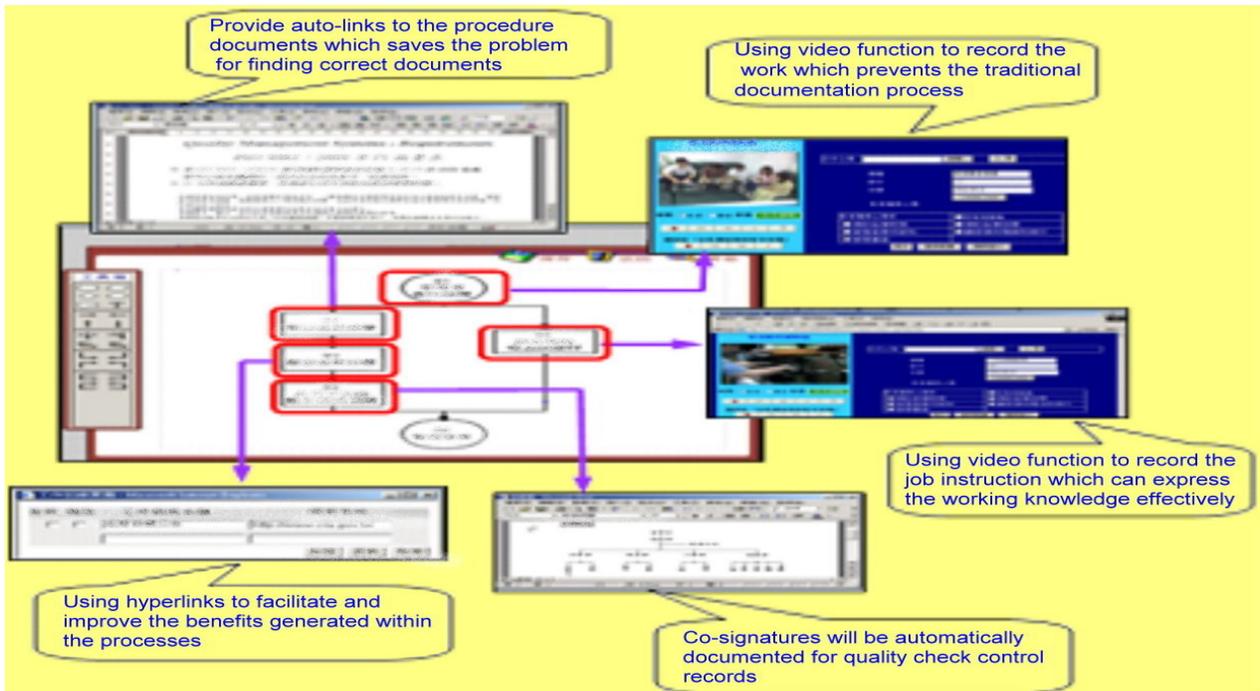
Figure 7. e-Illustration for healthcare professional training. The learners are inspired by exhibiting the complete field application process. The objective of applying targeted body knowledge and those key procedures in field application are presented through the index of each process step. A workflow server capable of processing multimedia is employed for such computational application.

Figure 8. E-Workshop for healthcare professional training. The delegates are always divided into different groups and the within-group and between- group workshops are provided. A specific procedure for on-line discussion and presentation has to be followed, and the trainer guides each workshop to identify and illustrate useful knowledge resulting from the on-line collaborative learning.

Table 4. The focused performance of the hybrid e-learning.

Focused performance [32] \ Element	e-Illustration	e-Comprehension	e-Learning Map	e-Learning group	e-Workshop	On- and off-line lecturing
Training achievement	Not Significant(N/S)	****Help to pass final qualification exam.	N/S	*Help to exchange the understanding of course requirements	**Help to cognize the QMS practices in Healthcare	***Help to understand QMS in Healthcare
Transfer achievement	****Help to build up body knowledge of implementing QMS	**Help to calibrate cognition for implementation	N/S	N/S	***Help to understand the real practices	Help to identify those knowledge to be transferred to work filed*
Trainee motivation	N/S	N/S	****Help to lead learning according to personal preference	***Help to build up the sense and belonging to the learning group	**Help to have practices in community	*Help to appreciate the course objectives and values
Computer self-efficacy	N/S	***What you see what you get operation	**menu-driven interface	****Forum based, lifestyle group discussion	N/S	PowerPoint slides with audio streaming *
face-to-face instruction	**explore the QMS application knowledge in depth	N/S	***Understand to learning styles and learning preference	*understand the objectives and skills of learning group	****Immediate response and feedback	N/S
Instruction on-line	N/S	***illustrate the achievement of learning objectives	*provide the alignment for learning pace as well as sequence	**provide complementary learning space for extra guidance	N/S	****provide self-regulated learning pace and replication
Easy to use/ access	N/S	***Totally "one-click" operation	* menu driven interface	** Forum based, lifestyle group discussion	N/S	****Menu-driven and automatic pop-up content

Note: The number of "*" sign is to represent the significance level of resulted performance.

received the greatest attention and appreciation while e-comprehension with sample tests from the e-learning group consisting of delegates from healthcare organisations attracted the least attention. As for the resultant satisfaction, the effects of gender, age and career on hybrid e-learning are insignificantly different. Some significant differences correlated with the learning effects are noted below:

The QMS Responsibility for healthcare professionals correlated with the applications of e-Illustration and on- and off-line e-learning. Due to the common practices in healthcare, delegates with QMS Responsibility tend to have a greater commitment to picking up the content of e-Illustration and Online e-learning for practical application in healthcare organisations.

Whether or not delegates passed the training correlated with the e-Comprehension and e-Workshop. Delegates who passed the final examination tended to have greater involvement with the e-Comprehension and e-Workshop,

which incorporated some mock exams.

Delegates' educational background correlated with the e-Learning Group, especially for university graduates. Delegates with higher education tended to become involved more aggressively in e-Learning, but the unfavourable effects could possibly be due to the two-week duration, which is too short for the formation of the required feeling of belonging to a community.

The number of hours per week that delegates regularly used computers correlated with e-Workshop and on-line e-learning, especially for those exceeding 50 hours per week. Due to the computer skill requirements, participants with more hours using computers tended to be more interested in the e-Workshop.

Conclusion

Like many forms of education, training for healthcare

Table 5. Effects of the gender, tuition and final exam upon the learners on hybrid e-learning by using t-test.

Factor	Variable	Category	Number of Sample	Mean	Standard deviation	t-value
Online e-learning	Gender	Male	8	3.7500	0.46291	-1.166
		Female	38	3.9211	0.35880	
	QMS responsible	Yes	28	4.5714	0.50395	4.791*
		No	18	4.5556	0.51131	
	Final exam	Pass	41	3.3659	0.62274	-0.117
		Fail	5	3.4000	0.54772	
E-learning group	Gender	Male	8	3.7500	0.46291	-1.684
		Female	38	4.0526	0.46192	
	QMS responsible	Yes	28	4.5357	0.50787	-0.129
		No	18	4.5556	0.51131	
	Final exam	Pass	41	3.2683	0.70797	-1.631
		Fail	5	3.8000	0.44721	
E-comprehension	Gender	Male	8	3.6250	0.51755	-2.301
		Female	38	4.0263	0.43414	
	QMS responsible	Yes	28	4.5000	0.50918	-1.918
		No	18	4.7778	0.42779	
	Final exam	Pass	41	3.4390	0.50243	-1.531
		Fail	5	3.8000	0.44721	
E-workshop	Gender	Male	8	3.8750	0.35355	-0.858
		Female	38	3.9737	0.28350	
	QMS responsible	Yes	28	4.4643	0.57620	-2.844
		No	18	4.8889	0.32338	
	Final exam	Pass	41	3.3659	0.62274	-0.117
		Fail	5	3.4000	0.54772	
E-illustration	Gender	Male	8	3.6250	0.74402	-2.272
		Female	38	3.9737	0.28350	
	QMS responsible	Yes	28	4.6071	0.49735	5.158*
		No	18	4.0000	0.00000	
	Final exam	Pass	41	3.3659	0.62274	-0.802
		Fail	5	3.6000	0.54772	
E-learning map	Gender	Male	8	3.6250	0.51755	-3.041
		Female	38	4.1579	0.43659	
	QMS responsible	Yes	28	4.5357	0.50787	-0.494
		No	18	4.6111	0.50163	
	Final exam	Pass	41	3.3659	0.62274	-0.802
		Fail	5	3.6000	0.54772	

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

professionals is increasingly competency-based. There is a growing use of e-learning that can be linked to competencies via a hybrid training model. As the need for constant refreshing, training and retaining of workers in healthcare organisations is increasing, both training effectiveness and efficiency have become strategically important within medical and healthcare settings. At the same time, the awareness of healthcare quality has promoted the adoption of QMS in healthcare organizations.

The international standard ISO/IWA1, which provides system guidance for implementing ISO 9001 for those who provide healthcare services, is going to be very beneficial if the true intent and precise interpretation of such a standard are comprehended by healthcare professionals. Indeed, without an effective mechanism

Table 6. Effects of education, computer operating time and career position on hybrid e-learning by using one factor ANOVA.

Factor	Variable	Category	Number of sample	Mean	Std dev.	P
Online e-learning	Education	Above University	14	4.5000	0.51887	
		University	28	4.5000	0.50918	1.000
		Below University	4	4.5000	0.57735	
	Computer operating time	Less than 10 h	14	4.5714	0.51355	
		11~30 h	9	4.1111	0.33333	0.001 *
		31~50 h	14	4.6429	0.49725	
		More than 50 h	9	5.0000	0.00000	
	Career position	Low Level	22	4.2273	0.42893	
		Middle Level	22	4.2727	0.45584	0.692
		High Level	2	4.0000	0.00000	
e-Learning Group	Education	Above University	14	4.0714	0.26726	
		University	28	4.3214	0.47559	0.001 *
		Below University	4	3.2500	0.95743	
	Computer operating time	Less than 10 h	14	4.5714	0.51355	
		11~30 h	9	4.1111	0.33333	0.006
		31~50 h	14	4.6429	0.49725	
		More than 50 h	9	4.8889	0.33333	
	Career position	Low Level	22	4.3636	0.49237	
		Middle Level	22	4.7727	0.42893	0.021 *
		High Level	2	4.5000	0.70711	
e-Comprehension	Education	Above University	14	4.4286	0.51355	
		University	28	4.1786	0.39002	0.026 *
		Below University	4	3.7500	0.50000	
	Computer operating time	Less than 10 h	14	4.6429	0.49725	
		11~30 h	9	4.2222	0.44096	0.191
		31~50 h	14	4.6429	0.49725	
		More than 50 h	9	4.5556	0.52705	
	Career Position	Low Level	22	4.4091	0.50324	
		Middle Level	22	4.8182	0.39477	0.018 *
		High Level	2	4.5000	0.70711	

to deliver the body of knowledge of ISO/IWA1 to those healthcare professionals in the field, the value of applying ISO 9001 such as QMS in healthcare could be very limited. The proposed hybrid quality training for healthcare professionals is to resolve this problem in the healthcare sector.

In this paper, it is proved that the hybrid e-learning system incorporating those principal learning theories is favourable and capable of meeting the ultimate training goals of QMS in healthcare organisations, and that the proposed application could generate a comprehensive model for training healthcare professionals with less limitation in terms of time and location. As QMS training in healthcare organisations involves increasing demands and the training effectiveness is still being improved, we have illustrated an innovative way to train healthcare

professionals with less cost and greater effectiveness. The hybrid e-learning model in this paper is recommended to replace a portion of the live course sessions in an accredited ISO/IWA1 training course so that the cost/benefit ratio in training healthcare professionals by QMS can be greatly improved.

Moreover, taking the effects of healthcare professionals' career position, QMS responsibility and the use of computers into account, we have found the proposed model is more effective for those with QMS responsibility at the management level and more efficient for those who have frequent access to computers. Thus, more benefits in the application of the proposed hybrid training model are likely to be achieved if we provide incentives for those mid-level healthcare professionals who would have career interests in the quality management of healthcare

Table 6. Contd.

e-Workshop	Education	Above University	14	4.5714	0.51355	
		University	28	4.5000	0.50918	0.911
		Below University	4	4.5000	0.57735	
	Computer operating time	Less than 10 h	14	4.4286	0.51355	
		11~30 h	9	4.0000	0.00000	0.024 *
		31~50 h	14	4.5000	0.51887	
		More than 50 h	9	4.6667	0.50000	
	Career position	Low Level	22	4.4545	0.50965	
		Middle Level	22	4.3636	0.49237	0.500
		High Level	2	4.0000	1.41421	
e-Illustration	Education	Above University	14	4.5000	0.51887	
		University	28	4.4643	0.50787	0.974
		Below University	4	4.5000	0.57735	
	Computer operating time	Less than 10 h	14	4.7143	0.46881	
		11~30 h	9	4.2222	0.44096	0.057
		31~50 h	14	4.5000	0.51887	
		More than 50 h	9	4.7778	0.44096	
	Career position	Low Level	22	4.5000	0.51177	
		Middle Level	22	4.4091	0.50324	0.836
		High Level	2	4.5000	0.70711	
e-Learning Map	Education	Above University	14	4.5714	0.51355	
		University	28	4.5357	0.50787	0.734
		Below University	4	4.7500	0.50000	
	Computer operating time	Less than 10 h	14	4.7143	0.46881	
		11~30 h	9	4.5556	0.52705	0.719
		31~50 h	14	4.7857	0.42582	
		More than 50 h	9	4.6667	0.50000	
	Career position	Low Level	22	4.1818	0.39477	
		Middle Level	22	4.6818	0.47673	0.002 *
		High Level	2	4.5000	0.70711	

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

services. Likewise, setting up a course prerequisite for delegates to achieve a certain level of computer skills and experiences is another way to improve the degree of efficiency.

Finally, from the perspective of fitting into the present Internet economy, it is suggested 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 whereby participants jointly create pragmatic knowledge during the training sessions. As the IT platform allows those healthcare professionals to present and exchange their skills and experiences concerning specific quality subjects pertaining to healthcare service provisions and enables them to record this presentation and exchange, the learning process itself will result in intensive knowledge in resolving quality-related problems in healthcare organisations. Using the same principle, the author suggests that the hybrid training content in digital form could lead to the development of more off-line digital knowledge in portable media, and expand the benefits of organisational learning in the medical and healthcare fields.

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