Enhancing quality in e-Learning by knowledge-based IT support

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ABSTRACT

Advancements of technology help in providing effective decision-making and problem solving in many aspects of life. Amongst the available technologies, Information Technology (IT) is one of the leading technologies in effectively utilising the scarce resources to encounter the gap between solutions provided by existing methodologies and demands of society. This paper identifies qualitative parameters and IT support for the parameters. These parameters are used to evaluate the effectiveness that can be enhanced through given IT support to gain maximum advantages of e-Learning methodology. Based on a result of a survey made for the selected parameters, a new knowledge-based e-Learning prototype is implemented. The article also presents the implementation framework, sample screen and results of quality surveys for existing and modified methodologies for e-Learning.

Keywords: e-Learning; quality parameters; IT support; knowledge base.

QUALITY IN e-LEARNING

In order to increase effectiveness in learning process, several approaches have been developed besides traditional education. Effectiveness of education system depends on the degree of quality it exhibits. Traditional learning models like classroom teaching and distance learning have their own limitations. It is increasingly becoming hard to maintain the standards of education due to limitations of infrastructure, finance and other resources including skilled manpower. Learning empowered through Information Technology (IT), to some extent ensures high quality learning by providing necessary information, step wise assistance, and advises for decision-making in cost-effective ways. e-Learning is the acquisition and distribution of multimedia knowledge by electronic means, specifically by networks of computers via variety of channels and technologies. e-Learning technology is an infrastructure that emphasises on online delivery of information and hence accelerates learning process. Major components of an e-Learning system are: subject experts, media developers, instructors, editors, designers, and technical experts (Kanedran, Johnny & Durga 2004). The advantages like availability of high quality information on fingertips, timely advice, and effective representation of information can be achieved with e-Learning technique. Prime objectives of the technique providing facility of e-Learning are as follows (Unwin 2003):

• To ensure that access to high quality information is integrated into course provision;

• To equip e-Learners with the information skills to exploit that information;

• To provide appropriate assistance to e-Learners in information-searching; and

• To address the related communications and costing issues.

Various e-Learning systems and models have been developed so far to encash the above said advantages. Zahm (2000) described multimedia computer-based training (CBT) via CD-ROM or as a Web download. Urdan & Weggen (2000) shared that e-Learning covers a wide set of applications and processes, including computer-based learning, web-based learning, virtual classrooms, and digital collaborations via internet, intranet, and extranet. Schreiber & Berge

(1998) and Gotschall (2000) proposed that online learning is a technology-based learning to make information currently available for direct access. In his work, Hall (2000) proposed distance learning as planned interactive course using e-Learning concept to teach technical skills effectively. However, the quality can be further improved by adopting knowledge-based approach for e-Learning. Traditional computer-aided software is typically a full-fledged system based on database providing only static presentation of information. Such systems lack personal attention and learners do not get motivated, as there is lack of guidance. The software should be user friendly, easy to operate (mainly in native language), able to present information dynamically in multimedia, and capable to explain its own decision-making. In short, the strategy needs to satisfy different user groups in different ways by identifying the user's interest and level.

This article discusses technological support through IT for the field and identifies major quality parameters from learners' perspective through a survey on existing methodology at the site. This leads to requirement of a knowledge-based approach for the e-Learning. A prototype is designed and implemented, and a post-implementation survey is conducted to check identified parameters on newly adopted e-Learning methodology. Implementation details, structure of e-learning facility adopted at the site, and results from the survey on utilisation of the e-learning resources are also discussed.

TECHNOLOGY SUPPORT THROUGH I.T. FOR ENHANCING QUALITY IN E-LEARNING

It is clearly observed that, e-Learning systems emphasise on quality and effective presentation of information. It is important to acknowledge that quality of a learning process should empower and enable the learner in customised fashion. Though there is an uncertainty about the paradigm of e-Learning from learners' perspective and instructor/developer side, the parameters denoted here may help in determining effectiveness of the system i.e. learners quality needs can be described in various parameters associated with e-Learning process. According to Ehlers (2004), technical parameters seem to have status like hygienic factors i.e. if technical requirements are fulfilled, they do not raise the perceived quality very much - as they are taken for granted. Yet if the expected technical standards are not met, the learner's quality assessment decreases. These parameters are collected from experts' opinions, desired characteristics of ideal learning technology from a learner's perspective, and past history/reports of such platforms used in various organisations in nearby areas through fact finding methods. Selected quality parameters along with required IT support mechanism for e-Learning are described in Table 1 (sorted alphabetically).

These parameters are used to evaluate the advantages offered by IT for e-Learning from learner's perspective. IT parameters that offer maximum advantage and facilities can be enhanced through an interdisciplinary research and development to get optimum returns from the e-Learning technology.

Table 1: Selected quality parameters with required IT support mechanism

Quality parameter	IT support mechanism for e-Learning
1. Availability of material and question bank	Database files and tables Document files and rich text files
2. Availability of teacher/technology and collaboration	Internet and distributed systems
3. Consistency, regularity, and trustworthiness	Back-ups and manuals
4. Correct and fast evaluation of examination/homework	Computer programs, scripts, and macros
5. Efficient information retrieval	Efficient search techniques and filtering
6. Ease of documentation, cloning, and extensibility	With necessary hardware
7. Flexibility, Reusability, and frequency of revision	Through programme
8. Knowledge management and systems learning	Files, database, and knowledge base
9. Machine independence, portability, and scope of system	Independent programming languages and packages like java
10. Multimedia support and effective presentation	Multimedia and computer graphics
11. Performance (cost, time saving, etc.)	High processor ability of computing resources
12. Safety and security	Hardware locks and software validation in procedures
13. Specificity (level of content relevance and completeness)	Verification and validation by multiple experts
14. Support of standards	Software engineering models
15. Users ease of learning and user friendliness	Through user profile and interface in native language

EVALUATION OF IT SUPPORT: AN EXPERIMENT

A survey is conducted at Department of Computer Science, Sardar Patel University, India on implemented e-Learning facilities with the following objectives:

- To identify parameters to impart quality in e-learning;
- To determine the extent to which the defined parameters are suitable/important for imparting quality and hence to increase effectiveness of the overall learning process;
- To determine the degree of IT support and further scope for improvement in quality of implemented e-Learning infrastructure for the identified parameters; and
- To propose suitable (knowledge-based) e-Learning strategies as an effective IT supports.

Major activities of the surveyed department:

- MCA, PGDCA, Ph.D. programmes;
- Research and Development;
- Training programmes entrusted by academic institutes and industries;
- Extension services - providing software development on need basis; and
- Providing consultancy on need basis etc.

Infrastructure at the site:

The department is located in three-storied building and has e-Learning facility supported by 10 servers and 300 workstations amongst which few are high graphics workstations. The department has two multimedia auditoriums, 8 classrooms out of which, 4 are with multimedia projectors, 2 laboratories, a workshop, a multimedia seminar hall, conference rooms, server farm, and faculty and staff offices. The software resource includes various operating systems, development environments, programming languages, tools, and departmental application along with e-content developed for various courses.

e-Learning methodology adopted:

Presently, the department is utilising e-content developed for most of the courses taught. Such content shares databases and documents about learning and material through a centralised repository. 300 students of Masters of Computer Applications (MCA), 90 students of Post Graduate Diploma in Computer Applications (PGDCA), 40 students of Masters of Bioinformatics (MBI) are using the content for their studies. The databases contain different files containing information about faculty, supporting staff, infrastructure, students, and other basic resources. The documents contain lecture notes, questions, results, announcements etc.

Evaluation of e-Learning implementation:

The above-discussed implemented e-Learning system is accessed by all the staff and enrolled students of the department. A survey was conducted to get the feedback of students on the implemented system. A questionnaire was prepared and distributed to 100 final year MCA students in two batches. Out of the forms received back, 94 were found to be valid.

Importance level and satisfaction level of the quality parameters listed above are obtained from the users of e-Learning system implemented in the environment. The importance and satisfaction levels are scaled in Table 2.

Table 2: Importance and satisfaction level scales

| Importance scale	IT support scale
Not important at all=1	Negative=1
Unimportant=2	Not Much/No effect=2
Don't know=3	Moderate=3
Important=4	Highly affected=4
Very important=5	Compulsory=5

Survey results:

The Table 3 presents results of the survey conducted on the above listed quality parameters and degree of significance of the IT support.

Table 3: Results of survey on quality parameters and degree of significance of the IT support

Quality parameter	Average importance	Average IT support by existing techniques
1. Availability of material and question bank	4.5	4.0
2. Availability of teacher/technology and collaboration	4.5	4.0
3. Consistency, regularity, and trustworthiness	4.0	4.0
4. Correct and fast evaluation of examination/homework	4.0	2.0
5. Efficient information retrieval	4.5	3.0
6. Ease of documentation, cloning, and extensibility	2.0	4.0
7. Flexibility, Reusability, and frequency of revision	4.0	3.5
8. Knowledge management and systems learning	3.5	2.0
9. Machine independence, portability, and scope of system	3.0	3.0
10. Multimedia support and effective presentation	4.5	3.0
11. Performance (cost, time saving, etc.)	4.0	4.0
12. Safety and security	3.0	3.0
13. Specificity (level of content relevance and completeness)	4.0	3.0
14. Support of standards	2.0	2.0
15. Users ease of learning and user friendliness	4.5	3.0

From the above results, it can be clearly observed that the parameters like availability of basic resources e.g. technology, course material, question bank including documentation etc are well supported by the e-Learning methodology adopted. However, effective presentation and retrieval of information in different media help in achieving greater flexibility, which requires expertise. There is a need to customise IT support for the e-Learning methodology adopted, to continuously learn about learners' need and selection of material in a knowledge-based fashion. Evaluations of the answers are presently restricted to objective questions only. Moreover, there is a strong need to improve user interface so as not only multimedia facility can be made available but to make user to interact in their native language. This leads to the development of a knowledge-based e-Learning model to effectively address these issues. The prototype system is developed with limited content and implemented at the site to check feasibilities of the proposed design as denoted in the Figure 1 and for further experiments.

The following Figure 1 shows the modified structure of knowledge-based e-Learning services.
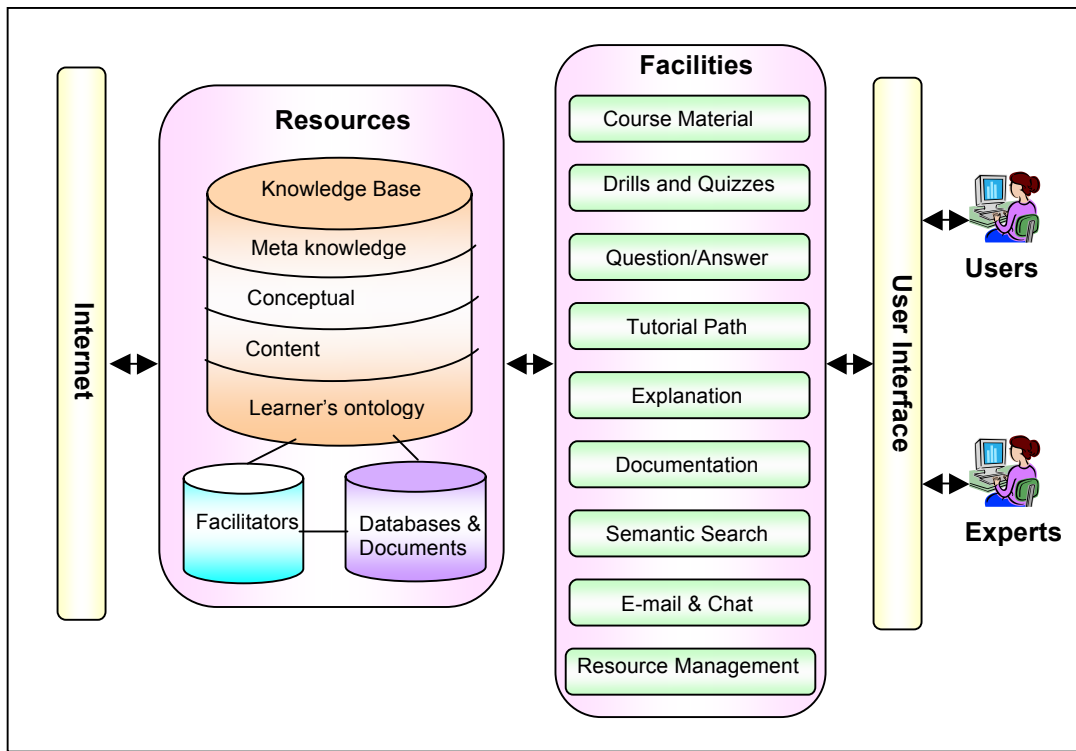
*Figure 1: Knowledge-based structure of the e-learning services*

Broad e-Learning structure (Moreale & Vargas 2004) adopted experimentally as described in Figure 1 is based on custom-made knowledge manifold architecture that consists of a number of linked conceptual information landscapes (context-maps), whose concepts can be filled with content (Ambjörn at al 2005). The system considers databases and necessary documents through knowledge base ontologies consisting of meta-knowledge, conceptual system, content-knowledge, vocabulary, and learners' knowledge. According to Stojanovic (2004) and Noy & Klein (2004), ontology is required to formally describe shared meaning of the used vocabulary (set of symbols). In fact, ontology constrains the set of possible mapping between symbols and their meanings (Stojanovic 2004; Noy & Klein 2004). The ontology provides the strategy for authorisation, content management, and information retrieval. An Ontology Service holds one or several ontologies and can be asked to return a whole ontology, or part of it (e.g. a sub-graph selected via some filter criterion), or can answer queries of the kind "give me all sub-concepts of concept *C*", "which properties are defined for concept *C*", "who authored concept *C*", etc. (Dolog at al 2004).

Knowledge base of the system also considers metadata as the total sum of what one can say about any information object at any level of aggregation, considering that an *information object* is anything that can be addressed and manipulated by a human or a system as a discrete entity (Tony, Anne & Mary 2005). This property of metadata helps in enabling effective search of resources across multiple repositories, since dealing with descriptive surrogates of resources is easier than dealing with the resources themselves (Alsultanny 2006).

To meet the learner's objective of utilising the system, system should 'know' its users. For this purpose, the target learner's ontologies are also stored in a knowledge base. Similarly, domain knowledge is also an important requirement for the system. The conceptual system provides the framework of the system.

Using the knowledge base and existing database, the system offers facilities like effective course material presentation, quizzes, drills and questions/answers, documentation provision, etc. through facilitator programmes. Moreover, the system also supports semantic search, explanation, evaluation, and knowledge management through well-designed user interface. Teachers may use the e-content facility to demonstrate course topics in classrooms, which makes their teaching more effective. The system has facility of notice board, chat and mail through internet connection.

Figure 2A shows how the domain knowledge representation about a topic can be represented internally. Here, an example of integer array is given. Arrays are the basic unit of any programming language encompassing same size and same type of elements under a common name. Figure 2A explains that array A is a kind of variable of integer type represented as A[i], where I represents the index of referred variable within the group. This is semantic representation of topic 'arrays of programming language' in knowledge structure. Such semantic representation have their well-defined representation criteria and reasoning schemes, so further management and explanation becomes easy. Similarly, all the topics of the tutorial can be represented in suitable knowledge representation schemes to access the system in knowledge-based way. Figure 2B and 2C presents sample screens presented to user for the programming language tutorial.
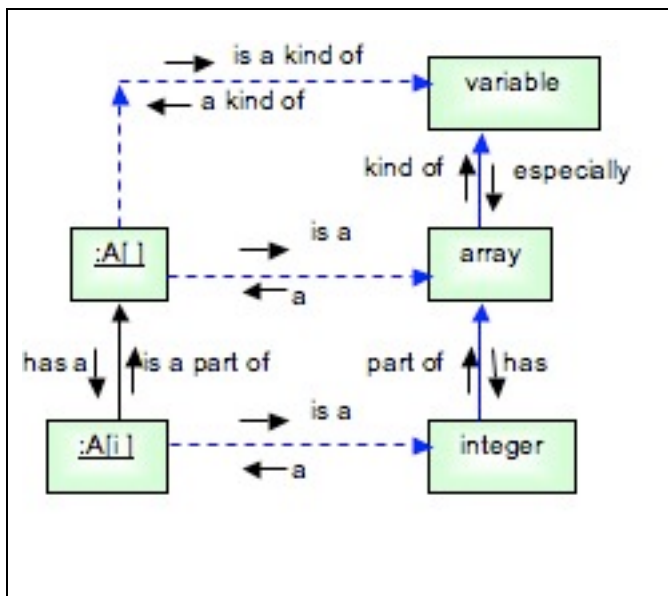
Figure 2A: *Representation of user-defined array of integer variables*
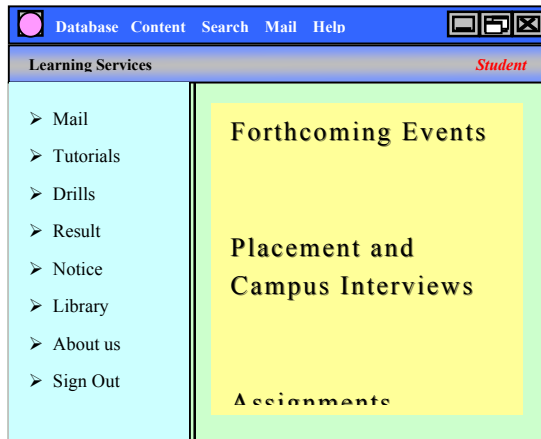
Figure 2B: Screen showing learning facility to a student
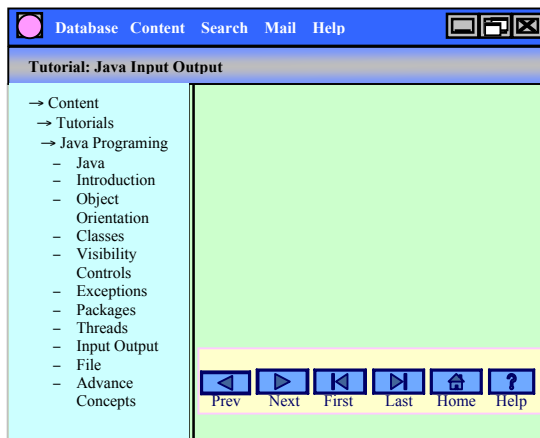
*Figure 2C: Screen showing programming language tutorial*

The infrastructure can be linked directly with the facilities like internet, other university programmes through video conferencing using EDUSET (educational Satellite), radio station/television programmes etc. However, for privacy and security reasons, presently the system is not linked with such facilities, but these facilities are separately made available through different server.

A similar survey is conducted for the modified e-Learning with the same parameter list so as to compare the modified e-Learning approach with the previous one. Following graph presents the comparison results between both the approaches.

Table 4: Results of survey the modified e-Learning

Quality parameter	Average importance	Average IT support by modified techniques
1. Availability of material and question bank	4.5	4.5
2. Availability of teacher/technology and collaboration	4.5	4.5
3. Consistency, regularity, and trustworthiness	4.0	4.0
4. Correct and fast evaluation of examination/homework	4.0	3.5
5. Efficient information retrieval	4.5	4.0
6. Ease of documentation, cloning, and extensibility	2.0	2.0
7. Flexibility, Reusability, and frequency of revision	4.0	4.0
8. Knowledge management and systems learning	2.5	3.0
9. Machine independence, portability, and scope of system	3.0	3.0
10. Multimedia support and effective presentation	4.0	4.0
11. Performance (cost, time saving, etc.)	4.0	4.0
12. Safety and security	3.0	3.0
13. Specificity (level of content relevance and completeness)	4.0	4.0
14. Support of standards	2.0	2.0
15. Users ease of learning and user friendliness	4.5	4.0
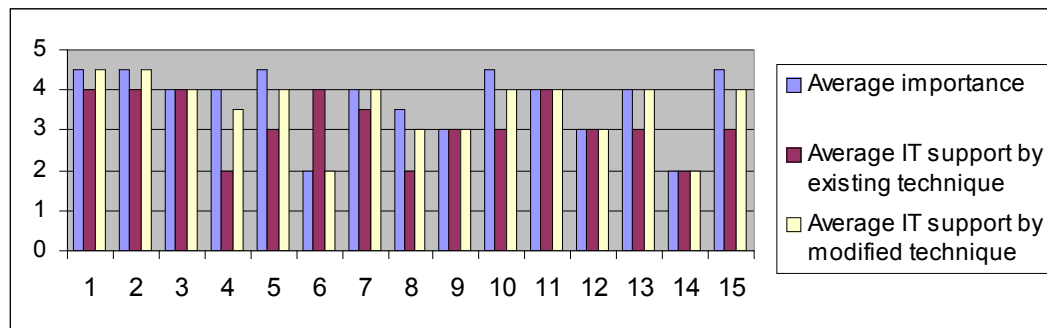
Figure 3: Comparison results of the approaches

CONCLUSION

IT is one of the effective tools to accelerate the learning process in highly customised manner. The two surveys conducted here indicate that the base technology and infrastructure to provide effective functionality are critical for successful implementation of the adopted e-Learning model. Various institutions maintain a variety of training resources to ensure a basic level of proficiency. The result of the surveys highlights the need of knowledge-based approach to achieve the advantages like effective retrieval and presentation, identifying users need, evaluation of users responses, and explanation and justification of the systems own decisions made to achieve high degree of quality. Institutions must be aware of evolving technical skill levels and adapt their resources accordingly to handle the shifting need for advanced technical and pedagogical training to ensure proper utilisation of e-Learning techniques. In addition to this, institutions offering the technology must continuously balance the growth in number of e-Learning courses with the changing dynamics of support structure.

Moreover, the development in e-Learning has to be oriented at the learner's needs and situation. The quality and orientation towards learners needs are critical factors to determine the effectiveness of the system. Successful IT implementation should address (i) general technical support; (ii) expanded information accessibility through resources; and (iii) mechanism system, to utilise the technical support and other resources. The quality factors denoted in this paper are also helpful in providing quality measures for e-Learning systems. This also helps in determining the impact of a given quality parameter for e-Learning systems and hence provides guidelines for successful development.

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