COLLABORATIVE SUPPORT FOR THE DISTRIBUTED E-LEARNING SOFTWARE EVALUATION PROCESS

M Nordin A Rahman and S Iryani A Saany
University of Darul Iman Malaysia, KUSZA Campus
mohdnabd@udn.edu.my, syarilla@udn.edu.my

ABSTRACT

Evaluation of the software product is a part of the decision-making involved in accepting or rejecting information technology investment proposals. Thus, many higher education institutions which implement e-Learning software in delivering course content struggle to make formal decisions about investing in new e-Learning software. These institutions, especially their Information Systems Departments, need to introduce a systematic evaluation process, such as procedure, standards and guidelines, before investment decisions are made. Traditionally, this process has been done manually with the evaluator group gathering in a single meeting room and evaluating the target products on paper. Consequently, the cost in terms of traveling, scheduling, pre-meeting and post-meeting are increased. With the opportunities provided by the current information and communication technology infrastructure, this paper proposes a new procedural framework and life cycle for the distributed e-Learning software evaluation process. Furthermore, the relationship between participants and their tasks in the evaluation process will be defined and clarified. Based on this proposed model, a practical web-based tool has been developed and tested, and will now be described. Finally, the issues and potential research activities in the distributed e-Learning software evaluation process will be discussed.

KEY WORDS: Collaborative systems, e-Learning software, Software evaluations, Web technology.

INTRODUCTION

E-Learning software evaluation is a manual process of testing and validating the performance and quality of the software as well as a process to detect weaknesses. The obvious obstacle for evaluation is that it is difficult to implement properly, and if implemented wrongly it will give poor results in comparison with the effort expended. Besides that, the increasing complexity of eLearning content results in a demand for better evaluation techniques. E-Learning software evaluation is a continuous process that should be an integral part of the software engineering process. Therefore, the evaluation process needs a standard procedure, paradigm and automated tool to enhance the quality of e-Learning software products.

The collaborative organizational arrangements consist of networks and organizational units, linked by information technology in order to give coordination to their activities, combining their skills and resources to achieve common goals (Layzell, et al. 2000). It is strongly believed that web technology could facilitate the collaborative aspects of software development activities as well as the software product evaluation process. It not only introduces flexibility for evaluation process meetings, but also manages the distribution of evaluation documents, reports and recommendations prepared by evaluators.

In the last ten years, a large amount of eLearning software has been developed to facilitate virtual education. Many higher education institutions which implement e-Learning software in delivering their course content struggle to make formal decisions about investing in new e-Learning software technologies. Traditionally, this process has been done manually with the evaluators gathering in a single
meeting room and evaluating the target products on paper. Punter et al. (1997) point out that the need for an efficient and standard design and execution of evaluation process activities is an essential. Should this standard procedure be implemented in virtual management, the e-Learning software evaluation process can be improved in the areas of time taken, process delivery and costing.

In this paper we propose a model for collaborative support for the distributed e-Learning software evaluation process (CoSLEP). Generally, there are four important areas that could be supported by CoSLEP. The descriptions of these benefits are as follows:

- **Document handling** – Document can be accessed by multiple participants without having multiple copies; latest versions of documents are readily available; documents can be browsed online; the process of document updating such as creation, editing and deleting will be supported; all comments and issues addressed by all evaluators can be kept online and are available for all participants.

- **Private evaluation** – Evaluators can easily access checklists and other documents for referencing; comments and suggestions can be recorded online allowing quick access for other evaluators and data reporting.

- **Data collection** – Evaluation and recommendations can be collected automatically; useful information could be provided online; easy for evaluation manager to monitor the activity status of each stage in the evaluation process.

- **Projects archive** – Data gathered from previous evaluation projects enable the evaluation manager to plan future project activities such as choosing the appropriate evaluators and estimating the schedule and cost.

The paper is organized as follows: in the next section, the related works and management issues in the e-Learning software evaluation process will be reviewed. Section 2 describes the proposed model of CoSLEP including the process flow, evaluation participant details, architecture and its functionality. Finally, the conclusion and future research directions will be discussed in section 3.

**Related Works and Management Issues in the e-Learning Software Evaluation Process**

A key element in the software engineering process is measurement. Measurement is a complex process and it is very hard to define its quality attributes. ISO (1991) distinguishes six quality characteristics which can be defined as follows:

- **Functionality** is defined as the degree of existence of a set of functions that satisfy stated or implied needs and their properties. This quality factor is evaluated based on five sub-attributes: suitability, accuracy, interoperability, compliance and security.

- **Reliability** is defined as the capability of the software to maintain its level of performance under stated conditions for a stated period of time. Three sub-attributes are considered to evaluate this factor: maturity, fault tolerance and recoverability.

- **Usability** is defined as the effort needed for the use by a stated or implied set of users. The usability factor is estimated based on three sub-attributes: understandability, learnability and operability.

- **Efficiency** is the relationship between the level of performance of the software and the amount of resources used, under stated conditions. This quality factor is evaluated based on two sub-attributes: time behavior and resource behavior.

- **Maintainability** is the ease with which a computer program can be emended if an error is encountered, adapted if its environment changes or enhanced if the customer desires a change in requirements. The maintainability factor is assessed based on four sub-attributes: analyzability, changeability, stability and testability.

- **Portability** is the ability of the software to be transferred from one environment to another. To estimate this quality factor four sub-attributes are considered: adaptability, installability, conformity and replaceability.
Besides the technical quality measurement proposed by ISO (1991), educational effectiveness attributes also need to be considered. There are no broadly accepted models and attributes for assessing this aspect (Stamelos et al., 1999) and this quality measurement is not discussed in ISO (1991). However, Bilalis et al. (2002) suggest several quality attributes of educational effectiveness which can be summarized as: easy to remember, easy to use, presentation method, screen design, redundancy, aesthetics, terminology, controls, navigation, feedback, consistency and multimedia presentations.

To deliver good content and manage the courses offered, the educational institution must make the right investment in appropriate new software and hardware technologies. Hence, careful decision making on new technologies is essential for an organization (Brown & Wallnau, 1996). As a result, a number of approaches and techniques for e-Learning software evaluation have been introduced. Before an evaluation is started, the organization must have a clear process requirement. This process requirement needs to be defined and clarified before an evaluation process can be established. Stamelos et al. (2000) and Stamelos et al. (1999) outline the main requirements of software evaluation as follows:

- Partial automation of the software evaluation process
- Suggestion of a software evaluation model according to the type of the problem
- Support of the selection of the appropriate multi-criteria decision aid method
- Assistance provided by expert modules which help the evaluator in assigning values to the attributes of the software evaluation model
- Consistency check of the evaluation model and detection of possible critical points
- Management of past evaluation results in order to reuse them in new evaluation problems

In the evaluation of software, Cronholm & Goldkuhi (2003) always recommend starting with the planning process, which decides upon the issues of scope, the evaluation level, time, resources and the participants. The evaluation process is started after the planning stage has been completed (Figure 1).

Figure 1

The general evaluation process

Evaluation of a software technology is a sequential and predefined process. Hence, in order to produce good quality in management, ISO (1991) proposes a standard process procedure for evaluation of software products. The standard process procedure is presented in four steps: analysis of evaluation requirements, specification of the evaluation, designing and planning the evaluation and the execution of evaluation. The descriptions of activity relationship between evaluation participants (developers, acquirers and evaluators) and evaluation phases are as follows:

- Evaluators – Describing the objectives, defining the scope and the measurements, documenting the procedures to be used, obtaining results from performing actions to measure and verify the software.
Acquirers – Establishing purpose and scope, defining the external metrics and corresponding measurements, planning, scheduling, performing documentations, evaluations and analysis.

Developers – Defining requirements of quality and feasibility, quantification of quality requirements, planning of evaluation during development, monitoring of quality and controlling during development.

From a study carried out by the authors, several problems and management issues have been found in the current face-to-face e-Learning software evaluation process. These issues can be categorized as follows:

- Poor facilities and environments – meeting rooms have only desks, chairs and whiteboards as meeting facilities, although office workers are usually using computers and computer networks in their personal working environments.
- Lack of document management – evaluation materials (e.g. evaluation check list, user manual, etc.) need to be shared, retrieved easily and kept consistently.
- Management techniques – e-Learning evaluation process management is still an ongoing and indistinct area of research. The process needs specific tasks assigned, which must be coordinated to ensure better evaluation results.
- Tool support – to acquire an established process management, flexible and reliable computer tool support is an essential.
- Evaluation staff management – evaluation participants come from various locations, departments and backgrounds. Thus, the problems of arranging face-to-face meetings might occur.
- Evaluation process knowledge base – previous evaluation project reports and related documents must be recorded in a knowledge repository so that they could be used for guidance and reference for future evaluation projects.

THE CoSLEP MODEL

In this section we outline the main concepts of CoSLEP including the process flow, participants, architecture and functionality.

The Process Flow

CoSLEP involves five sequential phases: {planning, orientation, private evaluation, consolidation, decision} (Figure 2).
In the following, we describe the activities involved in each phase:

- **Planning** – Coordinating multiple participants who are working on a distributed project is a tough task and this could frequently lead to some management problems. Therefore, it is crucial to embrace effective planning and management. In the planning stage, the evaluation manager (evaluation process leader) tailors the template evaluation process such as evaluation goal, names of phases and participants, categories of evaluation criteria and preparation of support materials such as checklists and e-Learning software descriptions. Besides that, the evaluation manager has to schedule properly the duration time for the evaluation process and the communication channels among evaluation participants. The e-Learning software author(s) needs to present supporting materials for the evaluation process such as user manuals and software specifications to evaluation managers. Authors also have to answer the related questions of evaluation managers before an orientation is started. On completion, the evaluation is started and the participating evaluators are informed about their evaluation tasks.

- **Orientation** – In this phase, evaluation participants are prepared for private evaluation. The evaluation members can access the background information on the evaluation process and the products which are being evaluated. The e-Learning software authors (systems developer) need to provide enough background to evaluation members in order to facilitate their understanding of the software functions.

- **Private evaluation** – At this stage, team members individually evaluate and examine the e-Learning software, its functions and related materials. They create issues, suggest actions and make any other appropriate comments. When an evaluator has declared the end of the private evaluation, the issues, actions and comments will be recorded and a notification message sent to the evaluation manager. Furthermore, at this stage the evaluation manager could monitor the performance of each evaluator and could take necessary action if there are problems. The private review normally terminates when all evaluators have marked all systems functions as reviewed. The evaluation manager now may move on to the consolidation phase at any time.
Consolidation – After the private evaluation is completed, the evaluation manager must combine the issues, actions and comments reported by evaluators in order to generate a consolidated list of annotations and comments. This process is called consolidation. The interconnected activities performed during the consolidation phase are as follows:

- Evaluation managers need to retrieve and collect all evaluation reports produced by evaluators
- Evaluation managers need to determine (verify) the acceptance and classification of issues, actions and comments. Evaluation managers may be assisted or advised by some invited evaluators and authors.

Decision – At the end of the consolidation process, evaluation managers will produce an evaluation specifications report (ESR) which is based on the verified issues, actions and comments given by evaluators. The ESR will be submitted to the Information Systems Steering Committee (ISSC) or the organization top management before any decision can be made.

Evaluation Participant Details

The e-Learning software evaluation process may need people of different backgrounds. They will bring different perspectives, experiences and knowledge which are needed in order to obtain an independent view of the software. The people (team members) who will perform the evaluation can be divided into five categories: {authors, evaluation managers, evaluators, course experts, independent evaluators}. Figure 3 illustrates the process use case diagram that shows the relationship between evaluation team members and their tasks in the CoSLEP model. Below are the details of the team members in the evaluation process:

- **Evaluation manager** – must be very technically competent to lead the evaluation process. He/she paces the meeting, coaches other participants, deals with evaluation scheduling and disseminating materials before the evaluation process. Evaluation managers can also be evaluators of the e-Learning software.
- **Authors** – people or software house representatives primarily responsible for creating or supplying the e-Learning software. They will provide information about the work product during the evaluation process.
- **Software evaluators** – a group of people who are responsible for reviewing and analyzing the technical aspects of e-Learning software such as its functionality, reliability, usability, efficiency, maintainability and portability. The Systems evaluator must also be a person who is familiar with the web and the design of pages.
- **Course experts** – a group of professionals with knowledge of the content area to evaluate the quality and adequacy of the contents, materials provided by the software using an appropriate learning pedagogy.
- **Independent evaluators** – a group of people who can give a liberal (unbiased) opinion about the software. They may be undergraduate/graduate students and/or institution executives.
The Architecture

The distributed e-Learning software evaluation process is a team activity involving the project’s members, suppliers (authors) and representatives and the upper management of the educational institution. In a virtual team environment, information flows must exist between distributed evaluation members and should be coordinated efficiently. The team members located at different sites often face the problem of communication and coordination. To be both effective and profitable, distributed e-Learning software evaluation teams require a basic communications infrastructure. All members of the team should be connected via a high-speed computer network which provides electronic mail, electronic conferencing and file sharing services (Lanubile, 2001). High reliability of the network is vital in order to keep team members working cooperatively and concurrently. Figure 4 shows the CoSLEP tool architecture. To achieve the maximum result in terms of simplicity of use and deployment the following systems specifications would be selected:

- **Client side** – the use of common Internet-based application clients such as browsers (e.g. Microsoft Internet Explorer 5), e-mail readers (e.g. Microsoft Outlook) and e-conferencing tools (e.g. Microsoft NetMeeting).
- **Server side** – all application functions will be developed by using server-side components (PHP language) and transaction data (e.g. project management data and evaluation context) will be stored in database management systems (MySQL).

We believe that with the approach and technologies used in the development of our collaborative tool for the distributed e-Learning software evaluation process, some benefits will be achieved such as encapsulating data processing, promoting simplicity in the maintenance process, multi-access and security.
The Functionality

Based on the main activities defined in the e-Learning software evaluation process, a practical web-based prototype has been developed. In this section, several selected screen shots and their functionalities will be explained. Figure 5 envisages the screen used to register a project. This screen is one of the screens in the planning phase. On completion, the evaluation manager needs to register team members and material support. The tool provides an access control mechanism (ACM) to restrict access to systems objects and their attributes. The ACM will control specific operations and data attributes or material that can be accessed. Meanwhile, Figure 6 illustrates the screen used to upload the material support used by evaluators in the private evaluation phase.
In the *private evaluation* phase, the participating evaluators execute their tasks and report any comments as annotations to the appropriate element in the e-Learning software or products. In this phase, evaluators generally make use of online material support provided by evaluation managers. The comments made by individual evaluators will be recorded into the evaluation project database. Figure 7 shows the screen shot used by evaluators to insert their comments into the database. When the evaluators complete the evaluation, a notification of evaluation status is updated into the evaluation project database. The evaluation is based on two types of quality attributes. The first type considers the technical aspects suggested by ISO (1991). The second is the educational effectiveness attributes proposed by Bilalis, et al. (2002).
In the *consolidation* phase, evaluation managers need to retrieve and printout the evaluation comments made by the evaluators. The CoSLEP tool generates two reports in this phase to assist the evaluation manager in making a consolidated list of annotations and comments. The tool generates these reports in PDF format automatically. Figure 8 and Figure 9 show the individual comments by an evaluator and a project summarization comments report respectively. Based on these reports, a formal discussion with several invited evaluators is done and finally the ESR will be produced. After a decision has been made by the ISSC, the evaluation manager will close out the project and all project content will be archived for future reference.
Figure 8

**Individual comments report on project evaluation**

![Individual report](image1.png)

<table>
<thead>
<tr>
<th>Quality Attributes</th>
<th>Sub Quality Attributes</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionality</td>
<td>Satisfaction</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Interoperability</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Compliance</td>
<td>Satisfactory</td>
</tr>
<tr>
<td></td>
<td>Security</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>Reliability</td>
<td>Maintain</td>
<td>Satisfactory</td>
</tr>
<tr>
<td></td>
<td>Fault Tolerance</td>
<td>Satisfactory</td>
</tr>
<tr>
<td></td>
<td>Recoverability</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>Usability</td>
<td>Understandability</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Learnability</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Operability</td>
<td>Good</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Time behavior</td>
<td>Good</td>
</tr>
</tbody>
</table>

Figure 9

**Project summarization comments report**

![Project report](image2.png)

<table>
<thead>
<tr>
<th>Technical Aspect</th>
<th>Very Good (%)</th>
<th>Good (%)</th>
<th>Satisfactory (%)</th>
<th>Bad (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionality</td>
<td>0.30</td>
<td>100.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.30</td>
<td>100.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Usability</td>
<td>0.30</td>
<td>100.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Efficiency</td>
<td>0.30</td>
<td>100.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Collaborative systems provide an improvement in terms of distributed work but potentially they could create chaotic environments for their users. Some problems such as miscommunication, unawareness issues, task overlapping and misinterpretation might emerge. Distributed work requires more discipline to keep track of documents and deliverables (Layzell et al., 2000). Therefore, to create a smooth management and process flow, we propose a general evaluation process cycle to suit our model. Figure 10 depicts the general state diagram for the e-Learning software evaluation process cycle. The diagram provides a clear representation of the dynamic behavior of the virtual evaluation process as interaction occurs. Besides having a good management structure for a project, it is also essential to have a senior manager overseeing teams on different sites in order to help minimize conflicts and reduce procedural differences (Layzell et al., 2000).

**CONCLUSION**

Face-to-face evaluation meetings typically provide a natural way of negotiating and collecting opinions in the process of e-Learning software investment. The problem is that these meetings can also cause resource problems, i.e. they waste time and are difficult to arrange. A shift to a more flexible type of meeting is thus an understandable alternative. Web technology provides excellent opportunities for the distributed e-Learning software evaluation process and collaboration among evaluation team members. In this paper, we have proposed a collaborative support for the distributed e-Learning software evaluation process, which supports virtual management and online recording and reporting. The systematization and generalization of the procedural activities involved in e-Learning software evaluation have been re-engineered in order to conform with collaborative management. For efficiency of management, the organization and relationship among evaluators and their tasks have been established. We believe that in the future, the CoSLEP tools could be extended to incorporate the following features:

- Automatic detection and evaluation of technical quality aspects such as functionality, reliability, usability, efficiency, maintainability and portability
- Distributed meeting support (e.g. the use of video conferencing) instead of the use of Microsoft NetMeeting and Microsoft Outlook.
The stamping of temporal aspects such as valid time and transaction time into CoSLEP phases will help evaluation managers monitor and manage evaluation processes in a more effective manner.

Should CoSLEP integrate with other decision support systems, it would help higher institution management to perform decision-making efficiently.

For the purposes of integration with other applications, the approach of the XML (Extensible Markup Language) database should be introduced. XML is an open standard for describing data and is suitable for a data integration environment.

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