APPLICATION OF E-LEARNING MATURITY MODEL IN HIGHER EDUCATION

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Abstract

The maturity model derives from the principles of the Capability Maturity Model (CMM) of software, e-learning maturity model is a framework for quality improvement to apply the e-learning. The purpose of this research is apply the eMM to identify strengths and weaknesses, and to prepare recommendations of improvement for the e-learning. This research presents a contribution to the e-learning maturity model (eMM) with the inclusion a new Key Process Area the Accessibility. This model will be applied to a South American Higher Education Institution, with interesting results.

Keywords: maturity model, e-learning, accessibility.

1 INTRODUCTION

The quality of e-learning can be defined in many ways, showing stakeholders the complexity of the process and systems that conform to the higher education environment. Furthermore, to talk about quality, we should refer to known conceptions such as the concept of quality at software level.

The maturity model derives from the principles of the Capability Maturity Model (CMM) [1]. Capability maturity in software engineering is an approach of “common sense” for software and process improvements. The different levels of maturity, Key Process Area (KPA), features and practices have been discussed and reviewed in the research community.

The maturity models, instead of specifying a list of verifications or correct activity hierarchy, transform an organization’s capacity to identify their own priorities and standards of quality that promote systems that support continuous improvement in an active and continuous way [2]. Another model that was considered as a reference is the software maturity model, Software Process Improvement and Capability Determination (SPICE). SPICE is referred to as ISO/IEC 15504 Information technology – Process assessment. Additionally, SPICE is categorized into five different processes: customer-supplier, engineering, supporting, management and organization [3].

Based on CMM and SPICE [4], they propose the e-learning maturity model (eMM) as an option evaluate the maturity in the delivery of e-learning of higher education educational institutions, based on widely disseminated workshops that validate.

The purpose of this research is apply the eMM to identify strengths and weaknesses, and to prepare recommendations of improvement for the e-learning. This research presents a contribution to the e-learning maturity model (eMM) with the inclusion a new Key Process Area the Accessibility. This model will be applied to a South American Higher Education Institution, with interesting results.

1.1 Virtual Education Maturity Model

The virtual education maturity model pretends to be a framework of quality improvement by which higher education institutions could teach and compare their capacity to develop, deploy and support virtual teaching [4]. Some models such as the ones considered by some authors [5] demonstrate features such as independence of technology, good design practices, holistic model, tested model, working model, and free-distributing evaluation model, among others.

Some popular models mentioned by Cano [5] are Pick & Mix [6], the Online Course Design Maturity Model [7], the Four Stages of e-Learning [8], the e-Learning Capability Maturity Model [9] and the e-learning maturity model (eMM) [3], which will be explained later.
1.2 e-learning Maturity Model (eMM)

eMM is a framework for quality improvement. The main objective of eMM is to help institutional leaders to evaluate the maturity of an institution with regard to e-learning [10], and performing systematic improvements in the activities of e-learning in the institution. One aspect to consider is whether the institutions should effectively use the technology or if they should maintain its relevance in the coming decades [10], taking into consideration the risks and limitations of technology usage.

It cannot be compared to the concept of product quality or functionality in reference to education. The quality of education has many perspectives, moreover, it must be considered in its diversities and particularities. Therefore, considering the study performed by [10], the perspective that evaluates e-learning quality will be considered from the institutional point of view by combining external influences with the technical and organizational implementations of educational institutions.

2 METHODOLOGY

The eMM of [3] begins when CMM and SPICE are applied in the e-learning area with the objective of exploring whether or not similar ideas could be generated in the delivery of e-learning. In both the educational institutions and the companies, the results obtained by applying this model allow the institutions a way to identify weaknesses in the development, delivery and management of e-learning. Furthermore, it identifies necessary future resources and priorities.

According to [10], the capacity of eMM is based in the general concept of organizational maturity. Also, eMM applies the capacity of an institution to guarantee that the design, development and deployment of virtual education meet the needs of students, professors and the institution as a whole.

Additionally, the capability includes the efficiency of an institution to support the delivery of virtual education and support learning and teaching according to increases in demand and the change of employees. The capability is not an evaluation of the abilities or performance of the stakeholders; rather, it is a synergistic measure of the coherence and the environmental force that is provided by the internal individuals. An institution is more capable under the CMM because it has coherent systems that cover every key process of e-learning. Also, it helps professors and students to process activities, deliverables and systematic enhancement to earn predefined improvements.

The features of an institution for separation of global processes with the details could to be make difference depending on specific circumstances. This classification means that an analysis of e-learning capability could be performed independently, in which technology and pedagogy are applied.

3 ELEMENTS OF EMM

The capability is not only a function of whether the key process is directed. Capability is a summary of the evaluated activities in many dimensions that capture the organizational life cycle associated with every key process.

3.1 Key Process Area (KPA)

The current version of eMM divides the process into five categories related to the categories of SPICE. The KPAs of e-learning are learning, development, support, evaluation and organization [11]. All the processes are interrelated on any level, and particularly through shared practices and the perspectives of the five categories.

The learning category refers to the processes that are related to the pedagogical properties of virtual learning.

The development category refers to the processes of creating and maintaining virtual learning resources.

The support category refers to the processes that are related to the support of students and staff committed to virtual learning.

The evaluation category refers to the processes that are related to the control and evaluation of the quality of virtual learning in the whole life cycle.

The organization category refers to the processes related to the planning and organizational management.
3.2 Dimensions

eMM evaluates the capability of e-learning delivery in five dimensions [4] instead of the levels. Levels could show a hierarchical model in the process improvement. The use of eMM defines the dimensions as holistic capability. Every process is evaluated from the synergistic perspective of delivery, planning, definition, management and improvement, as can see in Fig 1.

![Diagram of Dimensions of eMM](image)

The **delivery** dimension refers to the creation and supply of the process results. Evaluations of this dimension are the objective of establishing the level, in which we can see the process to be operational inside the institution.

The **planning** dimension evaluates the employment of objectives and plans predefined in the development of the jobs in process. The employment of predefined plans potentially makes the processes more capable of being efficiently managed and reproducing them as a success case.

The **definition** dimension covers use of standards that are institutionally defined and documented. It also defines guidelines, templates and policies during the application process. Any institution that effectively operates in this dimension has clearly defined how it will perform a given process. It does not mean that the staff has this alignment.

The **management** dimension refers to how an institution manages the development process and assures the quality of the results. Capability inside this dimension shows the measurement and the control of the process results.

The **improvement** dimension gets the measure in which an entity uses formal approaches to improve the activities of the process. Capability in this dimension shows a culture of continuous improvement. The dimensional focus avoids the model setting a specific mechanism for the capability of development; it also helps to meet the objective of improving the capability of not being replaced with the artificial objective of gaining a higher maturity level.

3.3 Practices

Every process in the eMM could be disaggregated inside each dimension, in practices that define the way in which the results of the process could be reached by the institutions. The practices are oriented to get the fundamental essence of the different process dimensions as a series of elements that could be evaluated easily in an institution, given the context of every one of them.

It should be noted that all processes are interrelated in a way, particularly by shared practices and the perspectives of the five dimensions. As can see in Fig. 2.
3.4 Contribution to the eMM model

Web accessibility means that users with any impairment will use the web in equal conditions with other people. An accessible web design lets all people sense, understand, navigate and interact with the Internet, trying to overcome the physical barriers that cut off accessing the Web, including those users who cannot access because of their age [12]. Web accessibility is not only focused on people with permanent impairments, it is also focused on those people with temporary impairments. Web accessibility is also oriented to find possible technical problems such as a slow Internet connection that cuts off Web access in a proper manner [13].

There are many reasons to require an accessible website. One of the main reasons is the inclusion of a wide variety of users for education, employment, business, health, entertainment, etc. This requirement appears in the third principle of the Convention on the Rights of Persons with Disabilities (CRPD). The CRPD ratifies the rights of this vulnerable group and invites countries to be part of this social commitment [14].

According to the concepts previously explored, it appears that the necessity of accessibility inclusion is a special element that must be considered in e-learning delivery.

3.5 Accessibility Key Process Area

Due to the necessity of considering platforms and resources that incorporate a basic element such as the accessibility that guarantees users universal access to Web resources, it is proposed that accessibility should be included as another KPA Marshall [11]. We proposed to include this area to work together with learning, development, support, evaluation and organization. It will be included as a part of the process classification generated, which should be also evaluated in the eMM.

The levels of accessibility are recognized and established by the W3C and the WCAG 2.0 [12] such as principles, guidelines, conformity criterion and enough-recommended techniques, all of which work together to provide a guide as to how to create accessible content. Therefore, the accessibility dimension will be based on accessibility guidelines defined by the WCAG 2.0, and the main objective is to provide clear and standardized guidelines. So, the accessibility dimension will provide the authors with a guideline to create accessible content that helps people with different impairments. These guidelines cannot be validated, nevertheless, they constitute a framework that supports authors to understand conformity criterion and to implement the techniques in a better way.

The guidelines are supported under the following principles:

**Perceivable** - Information and user interface components must be presentable to users in ways they can perceive.

**Operable** - User interface components and navigation must be operable.

**Understandable** - Information and the operation of user interfaces must be understandable.

**Robust** - Content must be robust enough so that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.

The content accessibility guidelines are described and detailed in the evaluation template.
4 MATERIALS

The Escuela Politécnica Nacional (EPN) of Ecuador has been considered as a case study; it is, according to the country’s authorities, the first institution of higher education in Ecuador. EPN has currently implemented the Moodle platform, which is configured on version 2.9. This platform provides virtual education services to university staff through virtual classrooms that function as support tools to back up the on-site learning [15].

In order to build the evaluation for institution considered for this case study is very important to emphasize that the analysis was performed with the information provided by the institution posted on their website, the access to the online platform, and the corresponding dependencies.

The institution works with Moodle 2.9, which is a complex system based on different modules. The interface can be personalized using themes. The current content can be uploaded by the professors or students. For this reason, it is impossible to say that is not accessible [16]. Moodle is aligned to the WCAG 2.0 guidelines; nevertheless, considering that it is an open source, there is not enough documentation. Also, it is aligned to the ATAG 2.0, so it helps to improve the accessibility of content produced with Moodle. The user interfaces are dynamic and interactive, and Moodle follows the recommendations of ARIA to support technologies such as screen readers.

According to the previous considerations, the necessary evaluation can either be considered a formal evaluation using evaluating tools, or performing a qualitative evaluation according to the experts’ criterion, which are set out below.

Based on the experts’ criterion, the process was focused on the evaluation of the new accessibility KPA. Furthermore, the experts should know and should be linked strongly to the complete organization and processes of the institution.

The evaluation was performed by three professors from the institution, all of who had more than 10 years of experience. The professors know about e-learning and accessibility and have been teaching many subjects, which is why they are the experts in the subjects.

The information evaluated belongs to the classrooms that is published on the virtual platform in b-learning modality.

The objective of this research is to provide guidelines to improve the quality and sustainability of online education in the institution, based in the reality of the institution by identifying strong and weak points to learn and improve.

5 EVALUATION PROCESS

The evaluation process follows the eMM framework as follows:

Selection of experts with knowledge of virtual education and accessibility.

Selection of subjects to be evaluated.

Training the experts about the eMM model to be evaluated and the criterion to be evaluated. Familiarizing the experts with the evaluation templates.

Practice formulations that relate to every process, two at least for every process. This conforms to the majority and more detailed part of the methodology. This part can be performed in workshops or work groups, or can at least be confirmed by the experts’ group.

Practice evaluations are related to every practice that should be evaluated until the average of the values are achieved; this value will be the value from the experts that is exposed in the template of the eMM.

In the evaluation process, every expert performed the evaluation by assigning a numerical value between 1 and 5: 1. not adequate; 2. partially adequate; 3. largely adequate; 4. fully adequate; 5. N/A. It can be considered to be a long process.

Evaluation of every process with the values of the practices correspond to the calculated average. The same that must be registered in the template with all the thirty-five processes of the eMM model and the twelve processes of accessibility.
6 RESULTS

The obtained results have been quantified in numerical form instead of by colors; the objective is to be able to quantify the results by applying the maturity model eMM. The numerical equivalence representing the value is specified at the end of the process list.

Table 1. eMM Processes[10].

<table>
<thead>
<tr>
<th>Defined processes in eMM</th>
<th>Delivery</th>
<th>Planning</th>
<th>Definition</th>
<th>Management</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1. Learning objectives guide the design and implementation of courses.</td>
<td>3 3 3 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2. Students are provided with mechanisms for interaction with teaching staff and other students.</td>
<td>3 2 2 2 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L3. Students are provided with e-learning skill development.</td>
<td>4 4 4 3 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L4. Students are provided with expected staff response times to student communications.</td>
<td>3 2 2 3 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L5. Students receive feedback on their performance within courses.</td>
<td>2 2 3 3 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L6. Students are provided with support in developing research and information literacy skills.</td>
<td>2 2 2 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L7. Learning designs and activities actively engage students.</td>
<td>3 2 3 2 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L8. Assessment is designed to progressively build student competence.</td>
<td>4 4 4 3 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L9. Student work is subject to specified timetables and deadlines.</td>
<td>4 4 4 4 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L10. Courses are designed to support diverse learning styles and learner capabilities.</td>
<td>2 2 3 3 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Learning: Processes that directly impact on pedagogical aspects of e-learning

Development: Processes surrounding the creation and maintenance of e-learning resources

Support: Processes surrounding the support and operational management of e-learning
Evaluation: Processes surrounding the evaluation and quality control of e-learning through its entire lifecycle

E1. Students are able to provide regular feedback on the quality and effectiveness of their e-learning experience.
1 1 1 1 1

E2. Teaching staff are able to provide regular feedback on quality and effectiveness of their e-learning experience.
1 2 2 2 2

E3. Regular reviews of the e-learning aspects of courses are conducted.
1 1 1 1 1

Organization: Processes associated with institutional planning and management

O1. Formal criteria guide the allocation of resources for e-learning design, development, and delivery.
2 2 3 2 1

O2. Institutional learning, and teaching policy and strategy explicitly address e-learning.
2 2 2 1 1

O3. e-Learning technology decisions are guided by an explicit plan.
2 2 2 2 2

O4. Digital information use is guided by an institutional information integrity plan.
2 2 2 2 2

O5. e-Learning initiatives are guided by explicit development plans.
2 2 2 2 2

O6. Students are provided with information on e-learning technologies prior to starting courses.
1 1 1 1 1

O7. Students are provided with information on e-learning pedagogies prior to starting courses.
1 1 1 1 1

O8. Students are provided with administration information prior to starting courses.
2 2 2 1 1

O9. e-Learning initiatives are guided by institutional strategies and operational plans.
2 2 2 2 2

Accessibility: Processes that directly affect the accessibility aspects of the platform and the e-learning resources of the Institution.

A1. Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language.
2 2 2 2 2

A2. Provide alternatives for time-based media.
1 1 1 1 1

A3. Create content that can be presented in different ways (for example simpler layout) without losing information or structure.
1 1 1 1 1

A4. Make it easier for users to see and hear content including separating foreground from background.
1 1 1 1 1

A5. Make all functionality available from a keyboard.
1 1 1 1 1

A6. Provide users enough time to read and use content.
2 3 3 2 2

A7. Do not design content in a way that is known to cause seizures.
1 1 1 1 1

A8. Provide ways to help users navigate, find content, and determine where they are.
1 1 1 1 1

A9. Make text content readable and understandable.
2 2 2 2 2

2 2 2 1 1

A11. Help users avoid and correct mistakes.
1 1 1 1 1

A12. Maximize compatibility with current and future user agents, including assistive technologies.
1 1 1 1 1

Table 2. Evaluation Scale.

<table>
<thead>
<tr>
<th>Evaluation scale</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not practiced / not suitable</td>
<td>1</td>
</tr>
<tr>
<td>Partially suitable</td>
<td>2</td>
</tr>
<tr>
<td>Largely suitable</td>
<td>3</td>
</tr>
<tr>
<td>Totally suitable</td>
<td>4</td>
</tr>
<tr>
<td>Do not evaluate</td>
<td></td>
</tr>
</tbody>
</table>
7 CONCLUSIONS

The conclusions of the research carried out are detailed as follows:

The eMM model is a useful tool that provides detailed information on institutional capacity for e-learning delivery; therefore, it is of use to authorities and decision makers.

The evaluation process requires the collection of evidence with the active participation of an institutional contact, which is done by someone who is physically in the institution or by someone who stays for a short period of time. That person must know and be aware of the variety of ways in which the e-learning manifests itself in the institution evaluated.

From the process carried out by applying the eMM model in the institution, a level of maturity is demonstrated as partially adequate in the area of learning processes between processes L1 and L9, considering that it is the highest value of maturity level of all the groups of processes.

This indicates that pedagogical aspects such as the planning of learning outcomes and feedback and guidance by teachers are moderately solid processes within this area of learning. There is a need, therefore, for the institution to strengthen elements such as support systems.

The areas of support, evaluation, organization and accessibility of the processes establish an inadequate level of maturity, which indicates that everything has to be done in reference to these areas of process; consequently, it will be necessary to emphasize specific recommendations given to each process.

In general, the two columns on the right side within each block set low values of 1-2 for the management and optimization capabilities in the institution. This lack of ability suggests that the institution is not collecting information systematically, and then using this information to improve its systems and processes to support e-learning. Addressing this lack of capacity requires resources, leadership and an effective change strategy.

The processes of O2 to O9 have a high degree of maturity, which express the strategic and operational activities of the institutions that are aware of the objective of virtual education or e-learning.

REFERENCES


