Potential Indicators of e-Learning Process Capability

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Harnessing scarce resources is a common theme for most university managers. The effective application and utilisation of e-Learning resources is one of the current challenges facing many universities. The range of teaching approaches, material taught and student characteristics denies the identification of any single correct method for ensure effective use of resources. Elsewhere[1] the authors have explored the potential benefits of applying the Capability Maturity Model (CMM) to the field of e-Learning in an effort to identify an institutional framework that can provide a guide to effective development of e-Learning capability while still allowing for a variety of pedagogical approaches. In this paper we further consider whether the application of capability measurement techniques can usefully be adapted to e-Learning. The paper presents an illustrative example of a possible approach with consideration of potential practices that might be used to determine capability. The paper includes a brief discussion of the applicability and potential benefits of the methodology in the determination of university e-learning capability.

1 Introduction

One of the major problems that face any organization that attempts to make use of innovation is ensuring that value is achieved for the, often considerable, initial investment. The use of technology in university teaching is one area where significant resources are currently being applied in order to make use of e-learning innovations, however the value of this investment is still unclear[2,3]. Even within individual institutions the vast array of teaching approaches, material taught and student characteristics mean that many teaching staff need individual support that is expensive to provide at a level that motivates and supports change and the understanding of e-Learning opportunities.

Until recently the development of e-Learning capacity has often been based on the individual heroics of early adopters, resulting in a largely ad hoc institutional approach to improving the use of e-Learning. The challenge in stimulating the effective use of e-learning resources and approaches beyond early adopters is to identify the limitations of current practices and identify how strength in e-learning capability can be incrementally improved[4]. While this may seem obvious, it has proved particularly challenging given the need to cater for the increasing variety of pedagogical models, institutional policies and educational environments. Clearly, any framework that might guide improvement needs to support a multitude of practices and techniques.

An approach to improving organisational functions that has been used in software engineering is that of process improvement as embodied in the Capability Maturity Model (CMM)[5] and Software Process Improvement and Capability Determination (SPICE)[6,7] methodologies. These process methodologies have the advantage of focusing at a higher level than that of the work being done and are based on the idea that there are aspects of work that need to be done well, but that how the work is actually implemented will depend on the particular circumstances. This combination of overall guidance, while allowing for flexibility in terms of techniques used, suggests that process methodologies may have some

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utility in the area of e-learning[1], particularly for the development of a process improvement model that makes no attempt is made to proscribe teaching techniques, style or pedagogy.

While SPICE has been applied in the academic environment for the creation of software artifacts[8], the application of the methodology to the creation and delivery of e-Learning is novel and it remains to be seen whether the approach has sufficient merit to support institutional adoption. In an effort to further explore the suitability of these methodologies, this paper describes briefly how aspects of CMM and SPICE might be applied to the context of e-Learning by providing an illustrative example of how various aspects of the SPICE methodology might be utilised.

2 An e-Learning Maturity Model

Elsewhere[1], the authors have provided an initial discussion regarding the background and motivations for the creation and adoption of an e-Learning Maturity Model (eMM). This work has resulted in the model summarized in Table (1) below. Essentially, the model proposes that processes can be considered to operate at five levels of performance, with a sixth level indicating that the process is not performed at all. The levels are not concerned with how the particular tasks are done, but rather how well the process is performed and controlled.

e-Learning Maturity Model: Levels	
Level	**Focus**
5: Optimising	*Continual improvement in all aspects of the e-Learning process*
4: Managed	*Ensuring the quality of both the e-learning resources and student learning outcomes*
3: Defined	*Defined process for development and support of e-Learning*
2: Planned	*Clear and measurable objectives for e-learning projects*
1: Initial	*Ad-hoc processes*
0: Not performed	*Not done at all*

Table 1 e-Learning Maturity Model Levels

This model presents, we believe, a number of opportunities[1]:

i. Firstly, an e-learning model could provide a road map for higher education institutions looking to improve their e-learning processes. Most academics are familiar with the ad-hoc approach to e-Learning where development of resources and support of students have more to do with individual heroics than good institutional planning. While some tertiary education institutions have embraced e-Learning in a major way, many are looking for a clear model to guide their ongoing development of resources and enhance their support processes. It is clear that a series of signposts or a map that might guide institutional planners in areas of resource allocation and staff and student support has some merit.

ii. An accepted framework might also provide academics with the necessary means to encourage greater institutional involvement and provide University management with the framework necessary to frame long term institutional planning.

iii. Support for institutional planning might be enhanced by the ability of an institution or even a school to benchmark its current capability in an effort to identify and prioritize necessary improvements in its current practices. The lack of a unifying framework for e-Learning makes it difficult for institutions to compare themselves against other bodies in meaningful ways. Importantly the model would allow for different technical

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platforms, organizational models and pedagogical beliefs. This might aid inter- and intra- institutional collaboration by allowing entities to identify areas in which improvements may produce the most immediate value as well as establish a framework for collaboration on future initiatives.

iv. Perhaps most importantly, like the CMM, the model might form the basis for an ongoing discussion within the e-learning community with a view to identifying the key practices, heuristics or activities necessary for achieving improvements in e-learning activities.

The key to the CMM model is that it is designed to provide good engineering and organisational management practices "for any project in any environment"[9]. It achieves this through a structure that breaks each level into a number of process areas. Each of these process areas is in turn organized into a number of sections called common features, which are used to organise the key practices that accomplish the goals of the relative process areas. The model can more correctly be seen as a hierarchy as shown in Figure 1 below.

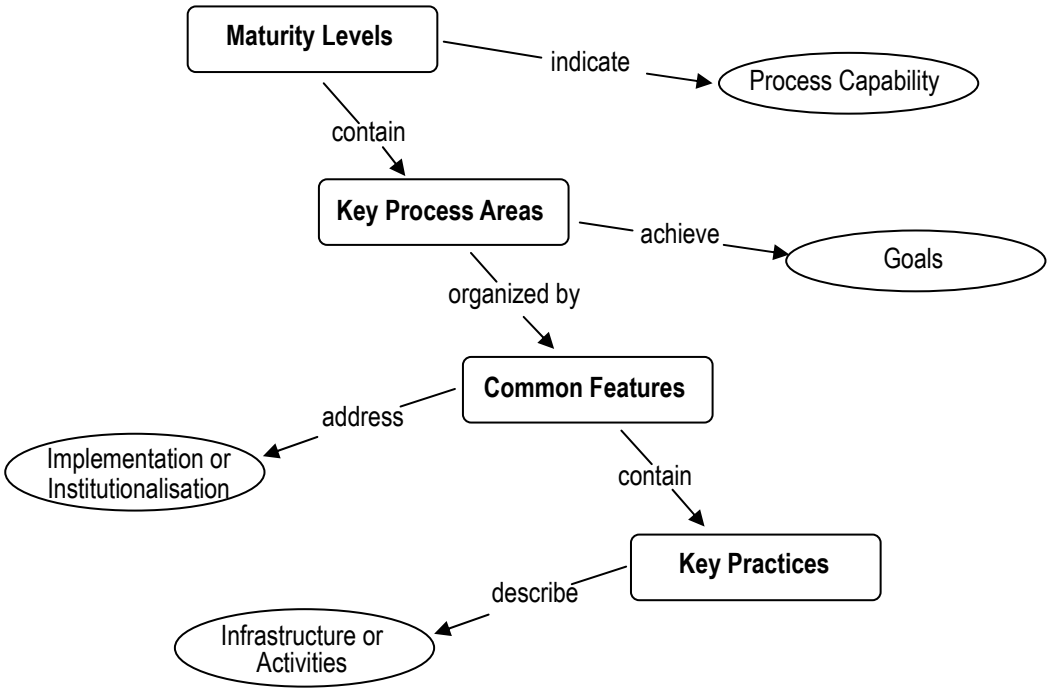

Figure 1 – Hierarchical Structure of the Capability Maturity Model[10]

The strength of this approach is that it allows the normative elements of the framework to be described at a sufficiently high level while describing the key practices that operate at those levels in an informative rather than normative manner. The major benefits of this structure is that while organisations might adopt the overall framework they need only adopt the relevant practices that are appropriate for their individual context and business approach. Within the CMM there are 5 maturity levels, 18 key processes and 316 key practices

The SPICE methodology extends the flexibility of the CMM by providing a framework for systematically improving processes while acknowledging that improvement in complex systems occurs gradually and simultaneously in different levels. Under the SPICE model, practices that result in improved process capability are explicitly identified for a number of categories that impact on the organizational process capability. Table (2) outlines the base categories used in SPICE version 1 that are used to order lists of practices such as *Identify customer needs* and *Develop software design*. A

process of research and consultation with the professional software development community conducted over several years resulted in the identification and acceptance of dozens of practices organized into the five base categories.

Process category	Brief description
Customer-Supplier	Processes that directly impact the customer
Engineering	Processes that specify, implement, or maintain a system and software product
Project	Processes that establish the project, and co-ordinate and manage its resources
Support	Processes that enable and support the performance of the other processes on the project
Organization	Processes that establish the business goals of the organization and develop process, product, and resource assets which will help the organization achieve its business goals

Table 2 Description of Process Categories for SPICE Version 1

In an e-Learning context attention obviously needs to be focused on a range of slightly different categories. Firstly it may be more useful to focus on students learning rather than customer/supplier relationships. This reflects one of the major differences between commercial and educational organisations in that the boundary between students as customers is, at best, a blurred one. Consequently we would suggest that the *Customer-Supplier* category be replaced with a *Learning* category that deals with the pedagogical aspects of e-Learning. While the first category is different, the development and co-ordination of e-Learning resources and applications can be closely related to the *Engineering* and *Project* categories in SPICE. However it is worth noting that the focus should be on overall process management rather than the stricter sense of process management inherent in software engineering practices. In an effort to reflect this broader approach we would suggest that these categories might better be considered as *Development* and *Coordination.* With Support activities included both in *Learning* and *Coordination*, the opportunity exists to raise the status of evaluation. We believe that the *Evaluation* of e-Learning activities is a key element of quality control in educational settings and as such we believe it warrants increased attention in any new framework. Finally, we would suggest that organisational strategic planning remains important regardless of the environment.. With these changes in mind, Table (3) outlines a possible reworking for an e-Learning context.

Process category	Brief description
Learning	Processes that directly impact on pedagogical aspects of e-Learning
Development	Processes surrounding the creation and maintenance of e-Learning resources
Co-ordination	Processes surrounding the oversight and management of e-Learning
Evaluation	Processes surrounding the evaluation and quality control of e-Learning through its entire lifecycle.
Organisation	Processes associated with institutional planning and management

Table 3 Description of Process Categories for an e-Learning Capability Measure.

Each of these process categories can be considered in turn to identify the process areas and key practices that belong to each process category. Breaking down the categories into processes and then into the practices simplifies the analysis of, what otherwise, would be complex considerations. This allows an institution to consider its current performance and identify specific areas for improvement at a finer level of detail than that provided by the CMM model alone.

3 Practices of e-Learning Process Capability

One of the advantages of the SPICE approach is that it breaks large, often complex, processes down into smaller, focused individual practices. The assessment of each practice is then conducted independently of others, and it is a common result that organizations will be assessed at a high level for some practices while performing less well in others. The particular challenge in applying the ideas behind the SPICE model thus becomes *"are there common practices or ways of creating e-learning resources and learning environments that are accepted, useful and able to be described in a way that others can adopt them and improve their own e-learning capability?"*

While it may be considered premature to actually propose a framework at this early stage, it is often helpful to have a concrete example to better appreciate where a methodology like SPICE may have value. In order to initiate a discussion and consideration of this idea, the authors have applied the SPICE approach to a single category of relevance to e-Learning – student learning. Many of the existing SPICE categories and practices are directly relevant to e-Learning resource creation and support, however the relationship with students is not that of a customer/supplier and so there are some SPICE practices which are not helpful in the academic teaching context.

In creating the processes and practices listed in Table (4) the authors have depended on their own experience and a few published works[11,12,13]. It is important to note that these are provided for the purposes of illustrating the current discussion and, if the methodology is to have value, a far wider body of research and breadth of experience would need to be incorporated. When considering the items listed in Table (4), it is important to realize that the practices are not prioritized, merely listed. As well, the description of a practice should not prescribe a particular pedagogy or teaching approach.

An Example: Learning Category The processes belonging to the *Learning* category are:	
Identify student needs	
i.	**Identify graduate attributes**. Determine the desired abilities and attributes of students who graduate from the course and any associated programme.
ii.	**Identify learning objectives**. Document and provide in advance for students the subject materials, student behaviors and other goals that the course has. Ensure that these are defined in ways that can be verified by direct observation or measurement.
iii.	**Identify current level of student understanding**. Determine the general level of ability of students in the areas being taught as well as the supporting disciplines. Identify any areas which students are lacking in necessary background knowledge or skills needed for the course.
iv.	**Identify student characteristics that impact on teaching and learning**. Determine the general characteristics of students prior to the commencement of teaching including language ability, access to technology, time and place availability and disabilities.
Provide learning resources	
i.	**Define requirements for learning resources**. Prepare a description of the requirements for any resource that will meet the particular needs of students.
ii.	**Identify pre-existing resources available for use**. Determine whether resources exist already which can be used or modified to meet the particular defined need.
iii.	**Provide students with a context for meaningful use of the resource**. Ensure that students are provided with sufficient background information or preparation that they can place any resource within a meaningful context and make effective use of it in their learning.
iv.	**Select educational technology**. Determine what technologies will be used to support the delivery of course resources and student interaction. Ensure that the requirements of use of any technology are consistent with the student characteristics determined in STU.1.4. Ensure that technology is selected for its educational benefits and not just for its own sake.

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STU.3 Support student use of learning resources	
i.	**Define structural aspects of the course**. Determine what level of formal structure will be used in the delivery of the course and how students will be paced and supported in the use of the structural elements. Ensure that the structure of the course supports effective student time management.
ii.	**Adopt conscious roles for instruction/teaching**. Determine what role(s) will be used for instruction of the students based on instructional theory and fit to the student needs identified in STU.1.
iii.	**Use a defined pedagogical approach**. Select and apply pedagogical strategies which are based on current and relevant educational research and which are well suited to the particular learning environment.
iv.	**Provide opportunities for meaningful feedback and interaction with students**. Select learning activities for the course that encourage students to engage in a range of meaningful interactions with teachers and other students. Ensure that students are given opportunities to work together and provide support to each other. Provide students with prompt and regular feedback that builds and maintains student confidence in the ongoing student-teacher relationship.
v.	**Prepare students in advance**. Ensure that students are prepared in advance of the use of any educational resource or technique that they might not be familiar with.
vi.	**Encourage active learning**. Ensure that the design and delivery of the course encourages students to actively engage with the material rather than passively receive and recall supplied material.
vii.	**Support diversity and variety**. Provide materials in a range of formats and delivery types to support different student learning styles and maintain motivation and interest.
viii.	**Support student technology use**. Ensure that students are able to obtain prompt and effective support for their use of technology required by the course.
Assess student performance	
i.	**Use a defined assessment approach.** Identify and document the programme of assessment that will be used in the course and ensure that students have adequate warning of the assessment expectations and techniques applied.
ii.	**Build student capability.** Ensure that assessments are achievable for students and build upon skills and knowledge already acquired. When difficult or unusual forms of assessment are used, ensure that the students have opportunities to practice and develop confidence in their ability to complete the assessment successfully.
iii.	**Provide a clear relationship between course material and assessment.** Make clear links between the teaching materials and resources and the assessment with consistency in materials and assessment technique.
Evaluate student learning	
i.	**Conduct evaluations.** Provide students with regular opportunities to reflect and provide feedback on the teaching and learning experience.
ii.	**Incorporate evaluation feedback.** Use the feedback obtained from both formal and informal evaluations of teaching to improve the quality of student learning. Ensure that students are aware that changes are being made in response to evaluation feedback.

Table 4 An Example e-Learning Process Category: Learning category

Organizations are assessed under the SPICE model as to how well they are performing each of the practices at each of the modified levels of the CMM model. Performance of each practice is assessed with a four-point scale:

i. N: not adequate;
ii. P: partially adequate;
iii. L: largely adequate;
iv. F: fully adequate.

Completion of an assessment results in the generation of tables for each process like those in Figure (1), which indicate how well the particular process is being performed. Weaknesses can then be quickly identified and addressed by the

organization. This flexibility also extends to the selection of which practices are assessed, as not all will be relevant to the particular organizational context and assessments can be tailored to help organizations address particular strategic or operational objectives. The resulting table of diagrams has the virtue of clearly suggesting areas where performance has been assessed as wanting, allowing for careful consideration of where to focus scarce resources for improving capability.

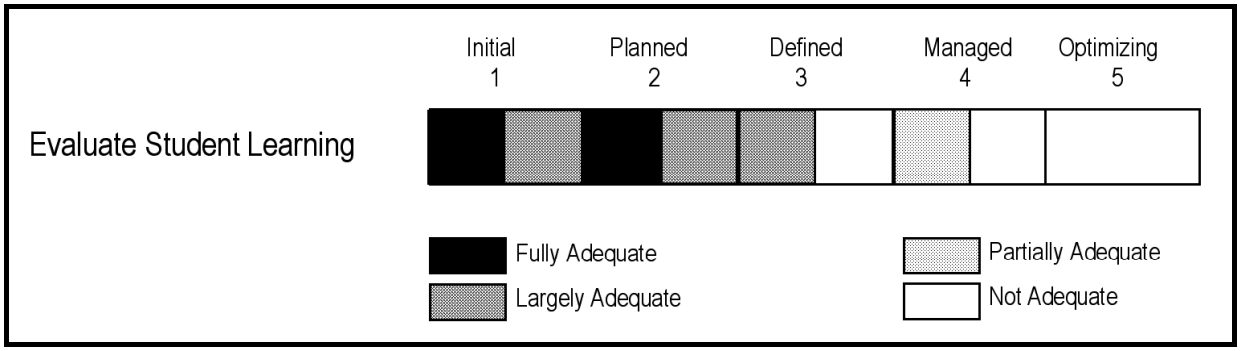

Figure 2 - Example of a SPICE style assessment of a single process

Obviously the value of the model depends on the quality and robustness of the heuristics that are incorporated. While the items provided in Table (4) are illustrative, they can certainly be improved and many important areas remain to be addressed. When developing and refining the original SPICE practices the following tests (among others) were applied[6]:

- Are the process attributes that were chosen the characteristics that tend to make a process more capable?
- Do the process attributes cover all the relevant capabilities defined at each level?
- Are the process attributes defined so as to be independent of each other?
- Is this set sufficient to characterize a range of capabilities?
- Do the process attributes represent the “universal truths” of process capability?
- Are the process attributes genuinely applicable to any process?

While these have been applied by the authors, it is acknowledged that the final set of practices in this area would be subject to robust debate and is likely to be much more extensive.

4 Discussion

The idea that e-learning success can be obtained by the simple application of a self-help book of pre-packaged solutions is something that most practitioners would regard as laughable. The approach presented in this paper is not an attempt to do this, but rather to explore a potential framework that could be used to stimulate discussion and improvement in a complex field. Process methodologies are controversial even in the area of software engineering where they were developed[14,15] and they are certainly not universally accepted. Despite that, it is clear from the popularity of heuristics such as Chickering’s[13] “seven principles” that those working in e-learning feel that there are common ideas which can be usefully applied in many, if not all, e-Learning situations. Indeed, an obvious criticism of the model is that it merely codifies in a complex (dare we say less-readable) way, yet another set of heuristics. Where the approach presented adds value however, is that it provides a technique for applying the heuristics that can be robust and reproducible. Application of the SPICE assessment procedures also results in the collection of evidence that can be used to support the use of scarce institutional resources for further improvement in a structured way.

One other area in which the model may quickly show a benefit is in its use as a way of organizing the diverse collection of ideas and heuristics in the e-learning literature so that individual practitioners or teams can conduct informal self-assessments. Feedback from such experiments will provide a valuable input into the evolution of the model presented and also ensure that new heuristics can be identified and codified for testing and use.

Much work yet remains if process methodologies are to be usefully applied in the e-learning domain. There is clearly a need to incorporate a wider and deeper range of experience and there is also the need to test the application of the ideas in a wide range of institutions and teaching contexts. An obvious first step is the establishment of collaborative research programmes aimed at collected quantitative and qualitative evidence of the utility of the model presented.

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