Managed Learning Environments and an Attendance Crisis?

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Abstract: Students who have the benefit of a Managed Learning Environment (MLE) are very appreciative of the facility to access lecture notes, practical and tutorial exercises and other learning resources. This access allows students to work independently and in many students’ eyes, obviates the need to attend all timetabled sessions. Should the lecturers be worried about this? Blended learning, with its mixture of online and face-to-face activities, allows for students’ different learning styles and for balancing external commitments. We report from a University in which the MLE, StudyNet, is extensively used on the majority of degree programmes and is regularly praised by the students. In this digital age the expectation of students is that all resources should be available electronically. However, a short survey identified a general unease among academics that these facilities adversely affect attendance and consequently student performance. Our broader study, at a mid-point in an academic year, investigated relationships between attendance, performance in assessed coursework and students’ preferred ways of working. We found that students rated the contact time very strongly but placed most emphasis on carrying out work for themselves. There was a mismatch between many students’ perceptions of their use of the contact hours and the evidence from attendance records. Overall, our study sheds some light on the complex relationships between blended learning, student behaviour, attendance, and attainment.

Keywords: Blended learning, attendance, Managed Learning Environment.

1. Introduction

Blended Learning at the University of Hertfordshire is seen as “a combination of established ways of Learning and Teaching and the opportunities offered by technology in order to improve students’ learning and increase flexibility in how, when and where they study” (Blended Learning Unit 2006). This allows for a mixture of class contact hours and e-learning activities for the students can carry out in their own time and location. The increase in the range of different learning activities for students has been in part facilitated by the development and extensive use of the University’s Managed Learning Environment, called StudyNet. Teaching strategies are moving from the traditional use of lectures and tutorials through to supporting the students through to a blend of traditional and online activities using a variety of media. There may be some tension in moving from established teaching practices to new approaches that claim to provide effective blended learning universally within an institution. Class-contact, such as a lecture, has been the principal way in which students are directed in their learning through a mixture of explanation, examples and guidance on reading and tasks. But providing lecture notes online, either before or after a class, can lead some students to believe that these notes are an adequate substitute for attending (and indeed the students are right in some cases!). The problem arises when a student does not replace the attendance with equivalent study, gets behind and finds subsequent work difficult to follow. This is not a new situation and first appeared with the availability of photocopying facilities, but it can be exacerbated by the ready availability of online resources. Students may find it easy to file away such information without engaging with it.

Attendance does not necessarily mean engagement, but lectures are not necessarily just about transmitting information and can involve a variety of activities depending on the topic, size of group, and other activities associated with the course (Oliver and Conole, 2002). Seminars, tutorials and practical (laboratory) sessions provide opportunity for interaction with the tutors and with peers. Learning is a social activity in which learning is enhanced by belonging to a community of practice (Wenger in (Smith 1999)). This interaction can be achieved through good use of electronic discussion forums and online activities to construct knowledge, but this is difficult for large groups and needs intensive nurturing by the online tutor. The social phenomenon of community can be put to good use in support of online learning (Brook and Oliver 2003), but in a blended learning context the sense of belonging will come from contact with lecturers and peers. We agree that “the flexibility of technology based instruction and the social interaction of traditional education are now available through blended learning” (Harriman 2004).

Lecturers often regard attendance as an essential component contributing to a student’s success, as it provides the opportunity for engagement with...
the subject material and for timely feedback. Equally important is the sense of belonging to a learning community and mutual support from other students. Colby (2004) found a direct correlation between attendance and attainment, and this correlation was corroborated in a parallel study at a different institution by Burd and Hodgson (2005). If a course team is unhappy about the level of student attendance and looking for a likely culprit, the availability of resources on the MLE can seem a possible option. In section three we describe the reaction of lecturers to posting resources on an MLE.

Our study is based on a first year programming course, which is designed as a series of learning activities, heavily focused on the student carrying out programming tasks to reinforce the concepts. This paper presents some of our findings at a mid-point in an academic year. In this paper we report on the conduct of four investigations:

- An initial survey in induction week on students’ expectations of a Computer Science degree
- A survey of academic staff attitudes to the MLE and attendance
- A survey of students’ perceptions of their studying behaviour
- An analysis of students’ use of the classroom discussion facility provided by the MLE

2. Background

Programming 1 is an introductory programming course for students on the BSc in Computer Science aiming to develop the student’s competence in programming. Class contact includes 2 one-hour lectures to the whole cohort, with a one-hour tutorial and a one-hour practical in small groups with a tutor. The lectures and a textbook outline concepts but also demonstrate programming activities. The practical and tutorial sessions allow students to engage in programming activities with tutors providing help when they get into difficulties. The use of StudyNet is a key element in the delivery of the course and contributes to a blended learning approach by providing the materials needed for self-study. Although students are encouraged to attend, all teaching material (other than the textbook) is posted on StudyNet, together with solutions (after a suitable interval) and the use of a class discussion forum on StudyNet is encouraged. StudyNet is also used for posting self-tests and specimen assessments as well as general feedback and administrative information.

Attendance at class contact sessions, reading the textbook or accessing resources on StudyNet do not in themselves guarantee success on this course. To develop the skills, students must engage in programming and much of this needs to be done in their own time. Unfortunately, programming can be a very unforgiving activity; very minor errors in syntax can mean that nothing works. To correct problems, the student must have the correct model of how the computer will behave, and a precise knowledge of how the instructions must be written. The inability to identify the causes of problems, and how to put them right, can lead to much frustration so timely and appropriate feedback is essential. Fortunately, programming is a computer-based activity and can provide its own feedback. Program development environments include software, which check whether a program is syntactically correct. Compilers not only detect syntax errors but also provide diagnostic information on the nature of those errors. In addition, programs can be executed and so there is a practical way of testing whether a program is functionally correct and performs according to specification.

With compilers providing feedback, it would seem that personal attendance might not be essential. However, computer-based feedback is restricted in nature and students still need to understand the rather cryptic error messages, identify what is causing the errors and know how to correct the errors. In addition, programmers are poor at fully testing their own programs; typically testing some of the obvious functionality but not identifying all of the situations, which may cause a program to fail. So computer-based feedback systems are useful to students who have some idea of what they should be doing, but are of limited value to those who don’t. Finally, there are usually a number of ways in which a program can be written, and there are no automated feedback systems, which can assess the quality of a program design. There is then still a need for personalised diagnostic and explanatory feedback. Traditionally such feedback has been provided during practical and tutorial sessions requiring student attendance. However, an MLE can be used to provide some of this feedback electronically via email, discussion forums and by posting solutions or guidance, providing information and timely feedback outside scheduled class contact time.

3. A survey of lecturer’s reactions to one aspect of an MLE

We conducted a short email survey of lecturers within our Faculty. The survey comprised one question:

“Do you think that the availability of lecture notes and other resources on StudyNet is the..."
MLE] adversely affects students’ attendance?"

We received 37 responses. Table 1 provides a summary of the responses. The table indicates that a clear majority of these lecturing staff think that StudyNet has affected student attendance.

Table 1: Summary of lecturers’ responses to survey

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes: StudyNet adversely affects student’s attendance</td>
<td>28</td>
<td>76</td>
</tr>
<tr>
<td>No: StudyNet does not adversely affect attendance</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Qualified: StudyNet may adversely affect attendance</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td></td>
</tr>
</tbody>
</table>

A number of respondents provided additional comments. For example, one respondent wrote:

“I strongly suspect that for some students the fact that they have all the slides, notes etc will mean that they think they have all the relevant material and it is only when they come to revise from those materials that they realise they cannot make head nor tail of the slides”

And another respondent wrote:

“Yes, I have had one student explicitly say that they do not come to lectures because they can get the (excellent) study guides for the course from StudyNet”

A third respondent explained that they thought other factors were also affecting attendance, such as the tuition fee contribution and the pressure on students to earn while they study. Other comments were about the need to adapt lectures so that there was added value for students in attending, which they would not gain from just accessing the notes or slides. This suggests that the MLE should be changing the way in which courses are being delivered, which is consistent with the aim of blended learning.

4. A survey of students’ perceptions of attendance and related factors

At a mid-point in the academic year, we asked students on the first-year programming module to complete a short questionnaire. The questionnaire asked students to self-assess their progress on the module, to self-assess their attendance, and to provide their opinions on their use of several resources and their involvement in several activities. 116 students (~ 50% of the cohort) completed the questionnaire. Of these responses, 100 students identified themselves allowing us to compare their responses on this questionnaire with other data we have collected.

4.1 Perceived attendance vs. actual attendance

Figure 1 presents box-plots of students’ perceived attendance vs. their recorded attendance at practicals and tutorials.

Perceived attendance is ‘measured’ on an ordinal scale of five possible responses: attended a few sessions, attended some sessions, attended about half the sessions, attended most of the sessions, attended almost all of the sessions. We have normalised the recorded attendance to take account of the fact that we have some missing data for some teaching sessions, and other teaching sessions were cancelled or re-scheduled e.g. due to illness, other University activities etc. The box-plot is useful for illustrating the range of actual attendance against perceived attendance. The most notable inconsistency is with those students who perceive that they have attended most of the time (the fourth category on the y-axis of the box-plot). The reality is that half of these students have attended less tutorials and practicals than 60% of the time.

![Figure 1: Box-plots of perceived attendance vs. actual attendance](image)

4.2 Perceived attendance at lectures and attendance at tutorials and practicals

We were interested to find out whether students were selective in the sessions they attended. The work carried out in practicals and tutorials could arguably be carried out in a student’s own time, but the lectures could not be so easily replaced.
Table 2 presents a cross-tabulation of students’ perceived attendance at lectures, and their perceived attendance at tutorials and practicals. The table indicates that students are consistent in their attendance of the two types of sessions; in other words, a student either attends lectures and tutorials/practicals, or doesn’t attend lectures and tutorials/practicals.

**Table 2: Cross-tabulation of perceived attendance**

<table>
<thead>
<tr>
<th>Attendance at lectures</th>
<th>A few</th>
<th>Some</th>
<th>About half</th>
<th>Most</th>
<th>Almost all</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A few</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Some</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>About half</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Most</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>12</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>Almost all</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>10</td>
<td>54</td>
<td>73</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>6</td>
<td>17</td>
<td>24</td>
<td>63</td>
<td>115</td>
</tr>
</tbody>
</table>

We need to be careful with this data as it represents students’ perceptions. For example, an alternative interpretation of Table 2 is that when students were responding to the questionnaire they wanted to be consistent in their answers, and also didn’t necessarily want to think too deeply about their responses. As a consequence, students may have decided to provide similar answers to both questions without necessarily thinking in detail about whether their patterns of attendance were different for the different types of sessions.

### 4.3 Recorded attendance and student assessed performance

At the time of writing this paper, students had completed the first three of five assessments. These assessments consisted of: a practical test under exam conditions, a written test under exam conditions, and a programming assignment that was validated with a practical test under exam conditions. Figure 2 presents a scatter-plot of students’ recorded attendance (at tutorials and practicals only) against their total assessment mark for the first three courseworks. The scatter-plot clearly indicates that there is no obvious association between these two variables.

![Figure 2: A scatter-plot of percentage attendance vs. total assessment mark](image)

On the basis of the figure, it is clear that at mid-point in the academic year, attendance does not seem to be an indicator of student (assessed) performance. This should not really be surprising when one considers the range of factors (for example, see sections 4.5 and 4.6) that influences the amount of work that a students’ do on the module.
4.4 The impact of StudyNet on attendance

To gain some insights into the impact of StudyNet on attendance we asked students to indicate what affect they thought StudyNet had on their attendance. Table 3 provides a summary of the students' responses.

Table 3: Students' perceptions of the impact of StudyNet on attendance

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>I don't attend many lectures because I can get the notes from StudyNet</td>
<td>6</td>
<td>6.3</td>
</tr>
<tr>
<td>I don't attend many practicals/tutorials because I can get the notes</td>
<td>14</td>
<td>14.6</td>
</tr>
<tr>
<td>I attend some teaching sessions but appreciate also having the materials on StudyNet</td>
<td>61</td>
<td>63.5</td>
</tr>
<tr>
<td>Regardless of my attendance, I also actively use class discussion on StudyNet</td>
<td>15</td>
<td>15.6</td>
</tr>
</tbody>
</table>

Only a small percentage of students (6.3% and 14.6%) acknowledge that StudyNet affects their attendance. Many students (63.5%) respond that StudyNet provides additional benefits. Interestingly, however, only a few students (15.6%) seem to take advantage of the most innovative and interactive aspect of StudyNet i.e. the classroom discussion. The results of Table 3 complement the results of Table 5, where the student perception seems to be that lectures, tutorials and practicals (with their associated resources) are more useful than StudyNet resources in general and classroom discussion in particular.

4.5 Obstacles to working on the module

Our main interest is in the possible affects of attendance on student performance. We are conscious that, of course, a wide range of other factors may be affecting student performance. Related to this, student's lack of attendance at lectures, tutorials and practicals could be compensated for by considerable work being conducted in their own time. Conversely, the only time and effort that students are expending on the module may be to attend the lectures, tutorials and practicals. Consequently, to gain some insights into what other activities, commitments etc. are affecting students' engagement with programming, we asked: What influences the amount of work you do on the programming module? Table 4 summarises students' responses to our question.

Table 4: Influences on the amount of work done on the module (ranked)

<table>
<thead>
<tr>
<th>Category</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>The need to work on other modules</td>
<td>70</td>
<td>38</td>
</tr>
<tr>
<td>Social life</td>
<td>31</td>
<td>17</td>
</tr>
<tr>
<td>Personal commitments</td>
<td>30</td>
<td>16</td>
</tr>
<tr>
<td>Paid work commitments</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>Whether my friends are also working on programming</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>I can't understand programming</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>I don't enjoy programming</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>183</td>
<td></td>
</tr>
</tbody>
</table>

Based on the table, the need to work on other modules on the degree programme is the most frequently reported influence on the time and effort being directed to programming. But notice also that, taken together, social life, personal commitments and paid work commitments account for 46% of the responses. There are some complex issues here requiring more attention.

4.6 Students preferred ways of working

In order to gain some insights into how our teaching activities and resources are helping students learn about programming, we asked students the following question: Please rank the importance of the following factors [provided to the students in a table in the questionnaire] in helping your understanding of programming, from 1 (most important) to 9 (least important): Table 5 provides a summary of the students' responses. In the table, the percentage ranking indicates the proportion of students who assigned the activity or resource a ranking of 1, 2 or 3. For example, 63.5% of students indicated that practical exercise sheets were either the most important factor in helping them understand programming (a ranking of 1) or were close to being the most important (a ranking of 2 or 3). Conversely, using the same ranking, only 6.8% of students indicated that StudyNet discussion was the most important factor.

Table 5: Students' perceptions of the helpfulness of various activities and resources

<table>
<thead>
<tr>
<th>Percentage ranking highly important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical sheets</td>
</tr>
<tr>
<td>Practical classes</td>
</tr>
</tbody>
</table>
Interestingly, it seems that the more traditional activities and resources (i.e. practical exercises, lectures, tutorials, and related materials) rather than the more innovative activities and resources (i.e. BlueJ, StudyNet classroom discussion) are those considered most helpful by the students. In the case of StudyNet classroom discussion, the results reported in Table 5 are particularly surprising as we have evidence that indicates students actively use StudyNet, particularly during coursework’s (see section 5). In the questionnaire, students were asked to provide additional comments to explain their highest and lowest rankings. Table 6 provides some qualitative ‘depth’ to Table 5. The comments show clearly that the students believe that carrying out the practical work for themselves is the most helpful way to learn, but some rely on staffed practical sessions and some prefer to work independently.

**Table 6: Examples of student’s comments on the helpfulness of particular activities and resources**

<table>
<thead>
<tr>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>“I rarely find the class discussion on StudyNet useful. Being lectured about programming doesn't mean you understand it, that's why the tutorials and practicals are important”</td>
</tr>
<tr>
<td>“I seem to learn the most from practical sessions, I do not have an internet connection and so do not use the discussion”</td>
</tr>
<tr>
<td>“Practical sessions most important because doing programming and being able to receive help when needed is very useful, discussion not useful because don't often read the comments”</td>
</tr>
<tr>
<td>“By having your lecture notes by your side will help you remember and imagine what's going on. Discussion is too public, for stupid questions one-to-one help is better”</td>
</tr>
<tr>
<td>“The book provides lots of practicals and information. My friends do not know much about programming”</td>
</tr>
<tr>
<td>Basically nothing is more important than having a go at the tasks yourself, so practicals are most important</td>
</tr>
<tr>
<td>Already comfortable with programming, so environment helps as I have never had a Java IDE before. Lectures are aimed at complete beginners so they cover (so far) material I already know</td>
</tr>
</tbody>
</table>

### 5. The use of a discussion forum to support coursework

In Table 3 and Table 5, students report that they do not make much use of StudyNet’s classroom discussion. We were surprised by this response, and so collected and analysed information on student’s actual usage of classroom discussion. Coursework 3 is an extended piece of coursework where the students had to produce a Java program, which meets a specification within a limited time. The timing of the assignment was such that the work had to be completed during the inter-semester gap; a time when there were no timetabled classes but students could be required to attend assessments in other modules. Table 7 summarises the use of StudyNet classroom discussion before and during the third assignment. The table clearly indicates there has been a dramatic increase in the number of threads and the number of postings to each thread. Interestingly, however, only 50 students have posted any messages (22% of the 232 students) and of those only 36 (16%) students posted more than one message. Of the 50 students who posted entries: 26 (52%) only posted queries, 5 (10%) only posted replies and 19 (38%) posted both queries and replies. This suggests that there is a relatively small group of students actively using StudyNet, although there may be a much greater number who choose to only read the messages.

**Table 7: The increased use of StudyNet**

<table>
<thead>
<tr>
<th>Threads</th>
<th>Postings by students</th>
<th>Posting by staff</th>
<th>Number of students posting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before assignment 3</td>
<td>30</td>
<td>79</td>
<td>24</td>
</tr>
<tr>
<td>During assignment 3</td>
<td>73</td>
<td>308</td>
<td>40</td>
</tr>
</tbody>
</table>
6. Demographic information on the students

Many intrinsic and extrinsic factors can affect a student’s participation on a degree programme or specific course. Very early in the academic year, we asked students to complete a questionnaire about why they chose to study for the computer science degree, what their interests are in computer science, what their experience is with programming, and other external factors that might constrain their attendance at teaching and learning sessions. 166 students completed part, or all, of the questionnaire. While the exact number of students registered on the degree is known at the time, this number is subject to change in the first couple of weeks of the academic year, as students change their minds and leave, and other students join etc. We estimate between 70% and 85% of students who continued on the degree programme completed the questionnaire.

6.1 Reasons for taking the degree

We presented students with a list of reasons for choosing to study on the degree programme, and we asked students to rank these reasons. The ranking was between 1 (most important reason) and 6 (least important reason) inclusive. Students often did not rank all of the reasons. We have treated these non-rankings as equivalent to a ranking of 6 (i.e. least important reason). Note that as students are asked to rank their reasons, they can only give one reason as the most important and this will affect the percentages within each reason. We found that:

- 50% of students ranked an interest in the subject as their most important reason (ranking of 1) with a further 13% ranking an interest in the subject as the second most important reason (ranking of 2).
- 31% of students ranked career prospects as their most important reason, with a further 40% ranking career prospects as their second reason. As noted above, the ranking of an interest has a knock-on affect on whether students can then rank career prospects as their most important reason. We found that of the 83 students who ranked interest in the subject as their most important, 52 then ranked career prospects as their second most important reason.
- 15% of students ranked (good) salaries as their most important reason for taking the subject, with a further 20% ranking it as their second most important reason.

The results reported above suggest that students have a combination of internal motivators (e.g. interest in the subject) and external motivators (e.g. career and salary prospects) for choosing to study the degree.

6.2 What is interesting about computer science?

We also asked students to indicate (by ranking) what subjects within computer science interested them. We needed to provide some general categories as students may not be aware of particular specialist areas in computer science (e.g. networking, databases, formal systems, compiler design, and even object-orientated technology). Again, students were asked to rank these categories. What is most relevant to the particular course we are describing in this paper is the interest in programming. We found that 17% of students were most interested in the programming aspects of computer science, with a further 17% ranking this as their second most important interest. The low level of interest in programming is a particularly significant result, given that programming is a compulsory element of the degree programme at Level 1 and Level 2. We asked students to indicate their previous experience in programming prior to university. Approximately 28% of students had no experience. The programming language with which students had most experience was VisualBasic, with 16% of students responding that they had “a little” experience, another 35% of students responding that they had “some” experience, and 14% of students responding that they had “a lot” of experience. 13% of students had “a little” experience with Java, with another 7% having “some” or “a lot” of experience. Java was the programming language taught on the programming module.

These results show that, although the students may be motivated to study Computer Science, many do not appreciate programming as integral to the discipline. This may be consequence of the curriculum followed in their prior Information and Communication Technology qualifications.

6.3 Other commitments

In addition to asking students about their internal and external motivation and interest in the subject of computer science, we also asked students about external constraints that might affect their ability to attend and study. Where there are constraints, technologies like StudyNet may be able to provide support. We focused on two constraints: paid work and personal commitments. We found that 88% of the students who
responded said that they either had or needed a job. The median average number of hours worked or expected to work was about 12.5 hours. 50% of the students who wanted or needed a job expected to do paid work for between 10 and 16 hours per week, with a further 25% of the students expecting to do paid work for between 16 and 25 hours. Such paid work represents a considerable commitment, particularly where students are expected (ideally) to be studying between 30 and 40 hours a week. 26% of students who responded indicated that they had major personal commitments. At this midpoint in their study, evidence to support the view that the presence of a MLE does impact on student attendance is inconclusive. Our survey shows that students themselves do not regard the availability of teaching resources on the MLE as a factor in their non-attendance. However, our investigations also show that students’ perception of the extent of their (fairly high) attendance is not supported by other evidence. There may be several reasons for this: students completing the survey may wish to present themselves in a better light, they may not be able to isolate their attendance on this course from their general attendance or be unable to separate out the different modes of attendance, or their perception of how well they are doing on the course may colour their perception of how well they attend.

In addition, factors other than the MLE such as timetabling may be important in determining the level of student attendance. Pearce (2005) analysed absenteeism among first year students and found that the main self-reported reasons were illness, lectures too late or early in the day, under the influence of drink or drugs, and having only one lecture in the day. Such factors may not only influence student attendance but also the amount of work done for the course and hence their success on the course. An internal survey of all Computer Science students at the University of Hertfordshire found that the biggest single contributor to absence from classes was travel/timetable restrictions (Baillie 2006). Also related to this factor, our complementary survey (see section 6.3) found that 88% of the students reported the need to work and 26% that they had major personal commitments. At this midpoint in our investigation, in contrast to the study by Colby (2004) and Burd and Hodgson (2005) another surprising result is that we found no correlation between attainment and attendance. Our survey shows that there are complex factors, which affect the amount of work done on the course. At a time when personal commitments and the need to work are making increasing demands on student time and making it harder to justify travelling to attend classes, the availability of web-based material may compensate for lack of student attendance. A study by Jefferies et al. (2004) found that 50% of students felt that StudyNet had improved the way they learn, and this is corroborated by our survey.

In the survey of student's preferred ways of working there is still extensive student support for traditional modes of delivery. It is not surprising that practical exercises are rated very highly, since the aim of the course is to develop practical skills and the practical exercises both provide opportunities to implement concepts and allow students to gauge their progress. However, the high ranking given to other traditional modes of delivery such as lectures, practicals and tutorials is surprising, especially when put alongside the student’s lack of attendance at these events. The use of the discussion forum increased considerably during an assessment with many sensible postings and responses from students. Whereas in the past a student would talk to a limited number of friends, the discussion allowed the whole cohort access to queries and replies. Although we could not find evidence to support the view that the MLE was causing a lack of attendance, there is some evidence to show that the MLE is changing the way both students and tutors work, even though this may not be supported by their reported perceptions. Attendance at timetabled class sessions may not be essential for motivated, capable students or if students can get the same quality of support in other ways. Many of the students in our group expressed opinions such as “I would rather work on my own at home without distractions” and again this is not surprising on a course where a student has to practice to develop their own skills especially since the programming environment itself provides valuable feedback.

However, lack of attendance can be problematic for those students who may need more intensive and personalised support. Lack of attendance by some of the students in a group can create...
problems for group identity; as attendance decreases so does the inclination for others to turn up. Some students need the discipline of regular attendance to keep focused on the work, and to gain access to help and feedback from tutors. Good attendance can also be a characteristic of a motivated student; Catley (2005) found that the best attendees were also those most likely to complete the online quizzes. Our intention, once we have obtained the final results for this cohort of students is to cross correlates these against attendance and use of the MLE to see if any patterns emerge. One further factor, which needs to be considered, is not just whether an MLE is available on a course but also how it is used. A study of lecturers’ reactions to StudyNet carried out in 2002/2003 by Thornton et al. (2004) found a number of ‘new innovators’ using MLEs in new and innovative ways and a majority of compliant adopters who could see the advantage of the MLE as an information source and as an administrative tool. The course which is the subject of this study is probably somewhere near the mid point of this scale. Currently, it tries to blend traditional modes with the opportunities afforded by technology, while not yet fully exploiting that technology. Given a different pattern of MLE usage and a course, which is different in nature, it may be that the effects of an MLE on attendance and crucially on student attainment may also be different.

8. Conclusions

Low student attendance cannot be attributed to the availability of learning resources on a Managed Learning Environment. It is not a new phenomenon for students to skip classes, and increasingly there are other demands on their time. The facility to access learning resources and so work in their own time and place is valued by students and may compensate for non-attendance. We did not find a correlation between attendance and course-work marks at the mid-point in the year. We did find that, while appreciating the facilities offered by an MLE, both staff and students value traditional modes of delivery.

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Benefits of e-Learning Benchmarks: Australian Case Studies

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Abstract: In 2004 the Australian Flexible Learning Framework developed a suite of quantitative and qualitative indicators on the uptake, use and impact of e-learning in the Vocational Education and Training (VET) sector. These indicators were used to design items for a survey to gather quantitative data for benchmarking. A series of four surveys gathered data from VET providers, teachers, students and their employers. The data formed baseline indicators that were used to establish organisational goals and benchmarks for e-learning. These indicators were the first known set for benchmarking e-learning in Australia.

The case studies in this paper illustrate ways in which VET providers have approached e-learning benchmarking, the benefits achieved and the lessons that they learned. The cases exemplify how VET providers have adapted the baseline indicators, how the indicators informed organisational plans and e-learning outcomes. The benefits of benchmarking are categorised under three purposes: reporting, performance management, and service improvement. A set of practical strategies is derived from the cases for consideration by other organisations interested in benchmarking e-learning services.

Keywords: e-learning indicators, e-learning uptake and outcomes, benchmarks, planning for e-learning benchmarking, case studies.

1. Introduction

Over the last six years, the Australian Government has invested over $95m to enhance e-learning in the vocational education and training (VET) sector. This investment was based on the espoused benefits of e-learning. There is much anecdotal evidence and some research to corroborate the benefits of e-learning and provide support for the return on investment in e-learning technologies (see Block and Dobell, 1999; European Commission, 2000; Phillip, J., Phillip, P. and Zuniga, 2000; Roffe, 2002). However, there is variance in how such benefits are measured. Benchmarking for e-learning is very much in its infancy in Australia. In 2004, the Australian Flexible Learning Framework developed a set of twelve indicators to benchmark the uptake use and impact of e-learning in the VET sector. It was the intention of the Framework to develop the indicators, test these and make them available for users to adapt these to establish organisational goals and benchmarks for e-learning. The purpose was not to impose the benchmarking activity or use the indicators for comparison between institutions. Data against these indicators were used by VET institutions to assess the benefits of e-learning using the benchmarks at the organisational level, within their own contexts. A national dataset against the benchmark indicators was populated during 2005 and forms a baseline that illustrates trends in the uptake and impact of e-learning and the use of e-business services.

This paper reports three case studies that illustrate ways in which VET providers have approached e-learning benchmarking, the benefits they experienced and the lessons that they learned. The cases exemplify how VET providers have adapted the baseline indicators, how the indicators informed organisational plans and e-learning outcomes. Benefits of the benchmarking exercise served three purposes: reporting, performance measurement, and service improvement. A set of practical strategies is derived from the cases for consideration by other organisations interested in benchmarking e-learning services.

2. e-Learning

The last decade has seen a significant expansion in e-learning technologies for enhanced access to education and training in Australia. E-learning is conceptualised in a number of ways. Essentially, it is about the transmission of learning content using information technology and often refers to delivery using intra or Internet. The actual learning which involves identification of information, conceptualising and making meaning to enhance user’s knowledge base, understanding and skills, as well as finding the time and space for learning is left to the individual. Henry (2001) explains that the total e-learning solution comprises the integration of three elements: content, technology and services. His concept is also underpinned by the assumption that learners will be responsible for the cognitive tasks that will lead to learning. A leading researcher, Laurillard (2001), cautions that the way in which teaching is approached should be considered more important than the technology medium. This point is supported by Butson (2003) who stresses that technology is
limited in helping learners to understand how to think.

There are compelling arguments for e-learning. “E-learning, when done well, can be as good or better than being in the classroom. It offers students a rich, compelling, and motivating experience” (Neal 2001). According to Roffe (2002) e-learning not only enhances access, but improves engagement, enhances learning, extends experiences in exploring, and empowers the learners to take responsibility for scheduling and managing the learning journey. His claims assume that the learner already has the skills and attributes to use the technology and adequately contextualise, integrate and apply the content to create new knowledge and understanding, and be transformed by the experience. Many organisations recognise the benefits of e-learning because it provides just-in-time, contemporary learning and can be accessed from any site using the right technology (Roffe, 2002). It is seen as a cost effective approach to facilitating learning to large groups using information and communication technology. The content could be personalised and is embedded in a learner centred framework. Many e-learning programs are interactive and can be updated rapidly. These and similar benefits were acknowledged in Young’s (2002) research on the first major benchmarking study of e-learning organisations in the United Kingdom.

Initial investments in e-learning are costly, hence the performance, quality, usage, effectiveness and efficiency as a learning solution is of interest to many. However, the current research base informing evaluation of e-learning from a wide range of stakeholders or comprehensive return on investment remains limited. Despite the paucity in this field of research benchmarking exercises are used by organisations to define a level of performance, and identifying or establishing good practice to improve on that performance (Butson 2003). According to Dublin (2004 p294) there are six fundamentals to ensure that e-learning is used by learners and embraced by the organisation. These fundamentals are premised on the understanding that e-learning is about:

- Becoming invisible; interwoven into the very fabric of your organisation and its culture.
- Providing pro-active support for e-learners (and their managers) through communication, promotion and marketing
- Creating an organisation that genuinely values learning.

The above are familiar to Ettinger, Holton and Blass’s (2005 p289) research with 29 companies who were e-learning pioneers. Ettinger et al. (2005) identified six key factors that underpinned e-learning:

- Delivering what the business needs
- Putting the learner at the heart of e-learning
- Providing high-quality content and technology
- Gaining support at senior levels for e-learning
- Providing pro-active support for e-learners (and their managers) through communication, promotion and marketing
- Creating an organisation that genuinely values learning.

Most organisations implementing e-learning do so with a view to improving learning services, thereby achieving certain business goals (e.g. Ettinger, Holton and Blass 2005, Dublin 2004, Roffe 2002, Young 2002). These organisations believe that improving learning services improves business outcomes. E-learning solutions have been known to support strategic outcomes (Fry, 2001). Many educational institutions seek e-learning solutions to maintain or enhance their market position in a highly competitive environment with declining public subsidy. E-learning services relates mainly to the management of e-learning as opposed to e-business. To distinguish between e-learning and e-business, the 2005 E-learning Benchmarking project adopted the following definitions: E-learning uses electronic media to deliver flexible vocational education and training. It includes access to, downloading and use of web, CD ROM or computer based learning resources in the classroom, workplace or home. It also includes online access to and participation in course activities (e.g. online simulations, online group discussions), directed use of the Internet for learning and research purposes, structured learning-based email communication and online assessment activities. E-learning does not include email dissemination of course information, email communication between a teacher/trainer and learner on a single learning issue, or online administration of learning activities.

The following definition of e-business was adopted by the Benchmarking project: E-business services include client support and administrative services offered by training organisations that are delivered or supported by information and communications technologies. For example: online publication of general course information and relevant policies, regulations and strategies; online enrolment; online payments and electronic
forms; online access to student records; online library services; online information on student support services; online access to and delivery of student support services; and online access to results.

The Australian Government considered e-learning a significant vehicle in transforming the VET business of teaching and training in more responsive ways. This became the key imperative for e-learning initiatives implemented through the Australian Flexible Learning Framework.

3. E-learning in the Australian VET sector

While information technology revolutionised the delivery of education and training, virtues of e-learning have principally modernised flexible delivery in the Australian VET sector. Investments in e-learning technologies were aimed at improving quality and access, fostering innovation and increasing flexibility in service provisions. Since the 1990s the Australian Flexible Learning Framework (Framework) has invested substantially and supported the uptake of e-learning through a range of national, state and organisational initiatives. Some initiatives provided professionals with access to the latest e-learning products and resources. To ensure that VET professionals are adequately equipped to meet a highly technology-driven learning environment the Framework has provided high quality professional development opportunities and support networks.

Until 2005, no consistent sets of data were collected to assess the level of uptake and outcomes of e-learning in the VET sector. A benchmarking approach was undertaken to assess the return on investment in e-learning.

4. Indicators for benchmarking e-learning

Over 250 indicators for e-learning were identified in an environmental scan of Australian and international research and education agencies (Australian Flexible Learning Framework, 2004). However, literature surrounding benchmarking on e-learning is very limited. Interest in data about return on investment in e-learning in terms of uptake, use and outcomes on VET clients and providers inspired the Framework to develop and trial a set of 12 indicators that informed three areas of interest:

- Uptake and outcome of e-learning in the VET system
  - % of VET unit enrolments that use e-learning.
  - % of VET providers offering units that use e-learning.
  - % of VET learners who through e-learning have increased skills and confidence in using information and communication technology (ICT).
  - % of VET learners who through e-learning have or expect to have improved employment outcomes.
  - % of VET clients who believe e-learning and e-business gave them flexibility in when, where and how they engaged with VET.
  - % client satisfaction with e-learning experiences in VET.

- Uptake and impact of e-business
  - % of VET providers offering e-business client, support and administrative services.
  - % of VET clients using e-business client, support and administrative services offered by providers.
  - % Client satisfaction with e-business experiences in VET.

- Uptake, use and outcomes of e-learning on VET teachers and trainers
  - % of VET teachers/trainers delivering units that use e-learning.
  - % of VET teachers/trainers who through e-learning have changed teaching practices in the design, development and delivery of units.
  - % of VET teachers/trainers who believe increased access to e-learning resources has improved teaching and learning outcomes (Australian Flexible Learning Framework, 2005, p.6).

5. Benchmarking survey

National surveys using the 12 indicators were conducted with students, employers, training organisations, teachers and trainers across Australia. A convenience sampling approach was used for the national survey. Networks of the Framework were utilised to access the samples in each State (6) and Territory (2) in Australia. An online survey was completed by 1000 VET students from 100 training organisations across all States and Territories in Australia. The students represented public as well as private training organisations. Computer assisted telephone surveys were completed by 400 employers or their representatives from all States and Territories. Representatives from 400 Registered Training Organisations completed print based surveys. They represented 100 large, private and enterprise training providers and 200 small training organisations. One thousand VET teachers and trainers from 100 training organisations (public and private) across all
States and Territories supplied data by completing an online survey. The data and findings of the survey provided a baseline for VET stakeholders to benchmark their services and provisions and inform decision-making processes at organisational and State levels. (For further details see flexiblelearning.net.au/e-learningindicators).

6. The case studies

Three case studies reported in this paper exemplify how different institutions approached e-learning benchmarking, the benefits they achieved and lessons they learned. The cases focus on different purposes for benchmarking. The first case study relates to the process of conducting a survey with young learners aged 15-19 years and learners with a disability to collect data against identified indicators for benchmarking. The second study focused on collecting data for evaluation, monitoring and reporting to inform the Institute’s stakeholders (Board, managers, teachers, student support staff, administration staff and industry) about performance, planning, implementation and future directions for e-learning. The third case study concentrated on collecting data on the usage and quality of its online learning services to inform managers and teachers and to plan the next stage of development and improvements. The purpose of the case studies was to provide examples of how VET providers were organising benchmarking activities. A panel of the Framework, using a set of criteria, selected the sites. Rather than including well-established providers with significant advancements in e-learning, the panel sought sites that were relatively new to e-learning. This meant that providers with less established e-learning systems would be able to easily relate to the cases in this study. These examples were included to inspire other providers to engage in e-learning benchmarking. Participation in the case studies was voluntary.

The case studies in this paper focused more on the management of e-learning as opposed to e-business. Each case study ‘aligned’ it’s benchmarking exercise against the indicators developed by the Framework. As such, the indicators and data sets are not exactly the same, however, have a degree of comparability. Considering the distinct peculiarity of each site, it would be erroneous to make any direct comparisons using the quantitative data against the indicators. Quantitative data collected by each site remained commercial-in-confidence. Data for the three case studies reported in this paper was collected from face-to-face and telephone interviews with the project managers and their e-learning support staff in each site. Data for the first case study was gathered from the project reports and interviews with two project managers. The second case study was prepared using data from the project documents (plans and reports) and interviews with three staff at the training organisation. Data for the third case study was gathered from the project report and an interview with the project manager.

6.1 Case study 1: e-Learning for target learner groups – youth and learners with a disability

The 2005 e-learning for Target Learner Groups (ELTLG) focused on young people in the 15-19 age group (including VET in Schools, disengaged youth and school-based apprenticeships), and learners with a disability. The main aim was to improve employment-related training opportunities and employment skills through the use of appropriate e-learning programs and resources. This case study trialed the survey process with young learners in selected organisations spread across Western Australia, New South Wales, Victoria, South Australia and Queensland. Fifty-two youths and fifty-four students with a disability responded to items on the survey which was made available on-line. The URL address for the survey was provided to trainers in each of the participating states to encourage their students to complete the survey.

6.1.1 Benefits of the survey

The datasets for this survey verified anecdotal data about young learners and those with a disability. Quantitative data was presented to managers to make informed decisions about e-learning services for young learners and learners with a disability. The data informed decision making for organisational planning and allocation of resources. Knowledge about how e-learning tools and technologies can be better used to assist learners is essential to improve services and course delivery to enable young learners and those with a disability to participate fully and equally in VET. When combined with data from other sources such as the networks and intranet usage statistics, a holistic picture of the service provisions emerged. The data enabled teachers to monitor, evaluate and reflect on the impact of changes in teaching strategies and choice of content and resources. Teachers gained confidence from the positive responses from students about e-learning tools and technologies. Benchmarking data provided support staff with information about communication and support strategies that involve e-learning tools and technologies, and the use and appropriateness of these services. The information is then used for
future planning and development of e-support services.

6.1.2 Lessons about the survey process

The trialling of the survey presented several learning experiences that can be used to improve the process and achieve a better return rate.

“We expected this to be an easy task, but learned that just placing the survey online and expecting students to fill them out does not get us far,” explained Bruce Entling, project manager.

The project highlighted the importance of detailed planning, networking and regularly keeping in touch with those assisting with administering the survey. There was evidence of low literacy problems levels among some young learners and these presented problems with reading and interpreting the survey items. The survey with youths noted some variation in the way e-learning and e-business were conceptualised. Not all students participating in e-learning had regular access to technology or to the internet. If it is available only during the contact hours or only in classrooms, a time period needs to be negotiated with the survey administrators to allow participants to complete the survey during these times. The context and environments in which e-learning for young learners takes place is diverse.

6.2 Case study 2: Building sustainability – performance indicators for educational delivery

E-business systems and facilities at the Hunter Institute of TAFE were put in place to facilitate and serve organisational business goals. e-Learning structures support blended learning which is most appropriate for learners from the catchment served by the Institute. Together, the two were set up to provide quality client services that contribute to sustainable regional development. Benchmarking is used to measure how e-business and e-learning impact on the institute’s service delivery. The indicators are used to collect data for evaluation, monitoring and reporting to inform the Institute, its Board and other stakeholders about performance, implementation issues and future directions. The set of key indicators used by Hunter Institute maintained a balance between practicality in collection and analysis, usability of the data, and costs. The process is inclusive of all stakeholders including the Board, managers, teachers, student support staff and the local community. The institute is mindful of its learners and their communities’ readiness to embrace technology and e-learning. Hence decisions informed by the benchmarking data consider the context of the learners, and the local communities and industries. Data sets against the agreed indicators are analysed at multiple levels to report on findings at the Institute, faculty, unit and team levels. The data sets offer options for:

- Monitoring performance using time series data
- Comparisons with other TAFE institutes in New South Wales
- Comparisons with other registered training organisations and best practice examples nationally and internationally.

The institute does not compare the data sets between faculties largely because of the diversity in the student cohorts and their learning needs. Data sets against the performance indicators would be supplemented with data from evaluative case studies to obtain more contextual understanding about performance measures and the related outcomes.

6.2.1 Benefits experienced by the institute:

“The potential benefits of the data are recognised by some stakeholders who expressed interest in more data to make informed decisions. Others need more time to come on board,” said Louise King, Director, Educational Development.

The data verified anecdotal information; tested assumptions held by the stakeholders and informed economic decisions about resources and efficiencies. The benchmarking data informed decision-making at various levels by different internal stakeholders such as teachers, administrators, student support and management staff. At an organisational level, the data sets helped monitor performance against the Australian Business Excellence Framework standards and assisted with setting targets to exceed the average ratings of the standards, as well as monitor progress against agreed measures and goals. Data for the Hunter Institute is added to the central database for the whole of the TAFE New South Wales (NSW) network. The Educational Development unit provides data on a quarterly basis, enabling each team to monitor progress against each indicator. The survey data informs performance at the team level and provides recognition and encouragement to improve services and innovation. Teams that show improvements are recognised by their managers and the Institute. News of their outstanding achievements is shared with other staff and key industry partners who support their activities. The local community and industries that supports the activities of the institute recognise the Institute’s progress and support further improvements. This is important for our relationship with local industries and communities.
They all show pride in the achievements of the Institute," explained Louise King, Director, Educational Development. The project recognised the potential in undertaking benchmarking to improve products, content, and service development, professional development, change management for e-learning, IT planning, business planning and marketing.

6.2.2 Lessons from the impact of e-business and e-learning on service delivery:

Benchmarking takes a lot of time and planning. "One must not assume that the student support officer will have time to collect data on top of his/her normal duties," advised Louise King, Director, Educational Development. It is critical to be inclusive of all stakeholders to ensure progress at all levels without expecting everyone to come on board from the start. "Some individuals and teams need time and space. It is best to focus and start with those who are keen and ready," observed Louise King. Through this project, the survey team learned that a phased approach to cultural change at the organisational and community levels would improve engagement and commitment to the benchmarking exercise and goals of improving e-learning services.

7. Case study 3: Evaluation of Learnline

Charles Darwin University (CDU) is a dual sector institution with approximately 17,000 students and nine campuses located across the Northern Territory. Web-based learning was formally introduced in 2003 using a learning management system, called Learnline. Learnline integrates web-based learning, other e-learning resources and student administration data into a centrally managed system that is accessed by staff and students. The system is based on licensed Blackboard software and includes Horizon Wimba LiveClassroom and Voice Tools plug-ins, locally developed websites and blogs. Since the implementation of Learnline, the University has experienced a large increase in enrolments in units offered on-line. A very diverse group of learners spread across urban, regional and remote areas were able to access learning and training using Learnline. On-line delivery of higher education units were steadily increasing, but Vocational Education and Training units needed more input and improvements to encourage the move to blended and on-line delivery modes.

Prior to the evaluation of Learnline, there was no hard data available to show what helped or hindered staff moving to online delivery. Evidence about the usage and quality of its online learning services was needed. The university provided strategic support to carry out the exercise and funded an external consultant to undertake a survey of staff who were both users and non-users of Learnline. This initiative and support led to increased staff interest, support and participation in the evaluation. Eighty teachers (approx. 15% of academic staff) participated in the survey. The survey used a combination of focus groups, telephone and face-to-face interviews, and email surveys for data gathering. The response rate was high (more than 80%).

7.1.1 Benefits of the evaluation of Learnline

Data highlighted the specific areas of e-learning services that were considered satisfactory and those that needed further improvement. For example, the existing introductory staff training sessions for Learnline, were rated highly. On the other hand customised training in some subject areas, for some of the less commonly used features of Learnline, and for sessional and remote area staff were identified. The information helped with the review of professional development content and delivery and in shaping strategies for equipping teachers with the right sets of knowledge and skills so that the quality of online content and services to students could be improved. The data, which provided solid evidence on the performance of Learnline, was submitted to management to provide justification for additional resources such as IT hardware and software, and for staff time. This aligned well with the evidence-based framework that the university uses when making decisions. The findings gave an understanding of the advantages and disadvantages of collecting data against the indicators. There was much interest in the outcomes from teachers, CDU management and external networks of the university who were considering similar exercises. The university is now able to extract data on the use of e-learning in terms of the number units and access to those units. It now has data on a set of 24 indicators (3 on teaching and learning and 21 on course development, institutional support, course structure, faculty support, student support, and evaluation and assessment) that benchmark the quality of web-based learning resources. The findings of the survey inform and align with Northern Territory’s Flexible Learning Plan and the Australian Flexible Learning Framework.

7.1.2 Lessons from the evaluation of Learnline

The findings highlighted the need to allocate teaching staff with more time for the development of the online content, especially for new courses and units, or those undergoing major revisions.
8. Key benefits of e-learning benchmarking

All three case studies recognised the potential in undertaking benchmarking to improve products, content and service development, professional development, change management for e-learning, IT planning, business planning and marketing. Key benefits of undertaking e-learning benchmarking, as experienced by the case studies, are listed under three broad purposes: reporting framework, performance measurement and service improvement.

8.1 Reporting framework

E-learning benchmarking data provides real evidence that informs an evidence based decision making framework. Benchmarking datasets contribute to reporting frameworks by verifying anecdotal data and testing of assumptions held by the stakeholders. They provide real evidence of performance against the indicators. The datasets inform decision making at various levels by different internal stakeholders such as teachers, administrators, student support and management staff. They provide substantiate justification for additional resources such as IT hardware and software, and for staff time. Datasets inform decision making for organisational planning, efficiencies, effectiveness and allocation of resources. When combined with data from other sources a more holistic picture of the service provisions develops. Benchmarking data could be added to a larger database for future data mining by central agencies as well as other contributing organisations for comparisons and drawing evidence based conclusions. The datasets inform and align with strategic directions of the organisation, as well as State and National goals for e-learning.

8.2 Performance measurement

Monitoring progress using performance measurement is a common approach in all organisations. Datasets from benchmarking could be used to help monitor performance against existing standards, and assist with setting targets to exceed existing ratings of the standards, as well as monitor progress against agreed measures and goals. They inform performance at the team level and could contribute to internal recognition and reward systems. Outstanding performance stories could be shared with key stakeholders, advocates and supporting networks. Dissemination of high success and achievements increases staff confidence. Datasets provide a bearing on how particular groups of learners compare with others regarding common sets of services.

8.3 Service improvement

Analysis of benchmarking datasets could identify service areas that are highly regarded by clients and those that are limited and in need for improvement. Benchmarking data identifies specific areas for improvement to enhance services and course delivery. They enable teachers to monitor, evaluate and reflect on the impact of changes in teaching strategies and choice of content and resources. Datasets provide support staff with information about communication and support strategies that involve e-learning tools and technologies, and the use and appropriateness of these services. The information is then used for future planning and development of e-support services. Benchmarking data helps review professional development content and delivery and shape strategies for equipping teachers with the right sets of knowledge and skills so that the quality of online content and services to students could be improved. Datasets provide a point of reference to improve and be competitive as well as innovative in educational delivery.

9. Suggested strategies for e-learning benchmarking

The following strategies are drawn from lessons that the three case studies highlighted. They are grouped under three main actions for benchmarking: data collection, data interpretation and implementation of e-learning.

10. Data collection

- Allow flexibility in the way the survey is conducted to collect data. For those who do not have access to technology, hard copies of the survey should be supplied to be completed and posted back to the survey administrators. Some students being surveyed may like to complete these in their own time and place, others may like to do it in class with the teacher/trainer assisting with reading and interpreting the items.
- Support for those with literacy problems must be made available.
- Key terms such as e-learning and e-business should be defined clearly. Include examples of what constitutes e-learning and e-business.
- A supportive relationship with the trainers or teachers (administrators) of the survey would ensure improved response rates.

11. Data interpretation

Data must be interpreted within the contexts of the team, faculty and the organisation, to draw valid
conclusions or make comparisons. Interpretation of data may get clouded by focusing on embracing technology for e-learning. Serious consideration must also be given to client and staff capability and capacities to take up and use e-learning.

12. Implementation of e-learning benchmarking

- A clear change management process that considers the changing roles and responsibilities of all stakeholders will minimise confusion about task allocations and timelines for collecting, analysing, interpreting and disseminating data. A phased approach to introducing and implementing e-learning benchmarking would ease the cultural change. When planning for benchmarking managers need to engage and work in partnership with all stakeholders including IT, HR and management staff as active players, not just adversaries.
- Clearly defined goals and timelines should be communicated to all stakeholders so that they all know what and when to expect. Both, a change communications plan and a marketing communication plan are needed (Dublin 2004).
- Invest adequate time in planning and development of e-learning content.
- Include a framework of recognition and reward. According to Ettinger et al. (2005) a positive framework of recognition and reward enhances motivation.

The above strategies form a guide for others interested in undertaking benchmarking exercise to improve e-learning services.

13. Summary

The case studies in this paper illustrate ways in which VET providers have approached e-learning benchmarking, the benefits achieved and the lessons that they learned. These cases exemplify how VET providers in Australia have adapted the baseline indicators, how the indicators informed organisational plans and e-learning outcomes. The data sets obtained by the three case study sites informed three main organisational purposes: reporting, performance measurement, and service improvements. The benchmarking datasets provided evidence on current performance and progress as well as improvements in products, content and service development, professional development, change management for e-learning, IT planning, business planning and marketing. The experiences from the benchmarking exercises highlighted a set of strategies for others interested in e-learning benchmarking to gain the most benefits. Other users could adopt strategies for data collection, data interpretation and implementation of e-learning benchmarking at the organisational.

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References

Determining Areas of Weakness in Introductory Programming as a Foundation for Reusable Learning Objects

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Abstract: Teaching programming to novices has proved challenging for both learner and lecturer due to the abstraction and complexity of the subject matter. The work described in this paper is part of an EU funded Minerva project called TUPULO (Teaching Undergraduate Programming Using Learning Objects) which aims to address the challenges faced by novice programmers by providing them with an innovative learning tool. This learning tool that is currently under development and rollout incorporates a set of Reusable Learning Objects (RLOs) based on sound pedagogical principles and encapsulated in a Constructivist Learning Environment (CLE), which includes a meta-cognitive interface. The subject matter experts and instructional designers in the local academic partner institutions designed these learning objects. The outputs and findings of the TUPULO project will not only benefit learners in the partner institutions involved, but by being disseminated to the wider educational community, they will also help learners in the domain on a broader scale. This paper describes the preparatory work undertaken in order to establish a set of potential LOs for development based on the student's main areas of weakness.

When attempting to build learning objects for use in any domain the primary consideration should always be the needs and abilities of the learners. This paper describes the work done by the authors in conducting a user needs analysis in order to establish the key problem areas facing learners of introductory programming. A methodology for user needs capture and analysis was produced based on the set of user groups available at the Institutions and the needs of the users were captured and analysed. The methodology was devised to incorporate both quantitative and qualitative analysis of the information available to us regarding students. Exam scripts and corresponding results together with focus group discussions were used in order to ascertain perceptions regarding the course content, delivery, level of difficulty and areas of difficulty in programming. Additional institutional information such as students' leaving certificate points and Maths grade together with students' overall performance in other subject areas were used to investigate possible correlations. The analysis of this data provided some preliminary information on the ways in which students interpret various questions and their conceptual difficulties in understanding certain topics. This analysis leads to the final selection of programming topics for potential development as reusable learning objects.

Keywords: novice programmers, learning objects, programming pedagogy, meta-cognitive support

1. Introduction

Research literature and practical experience of subject experts indicate that teaching programming to novices has proven challenging for both learner and lecturer. Research supports the fact that students find programming difficult. Linn and Clancy (1992) found that "for programmers to develop competency, they need to have good problem solving skills and a thoroughly organised knowledge of a programming language". Problem-solving skills are central to developing competency as a programmer yet these skills seem to be inadequate in the incoming students. Riley (1981) concluded that many students entering college have problem-solving skills that are "woefully inadequate". Henderson (1986) notes that problem solving and analytical thinking are students’ major weaknesses in a computer science course. The implementation phase of programming presents additional problems for novice programmers. These include: syntax of the chosen language, programming constructs, development environment and testing and debugging.

In addition, novice learners fail to reflect on their approach to designing solutions to problems and less successful problem-solvers act but do not look and learn from their actions (Gage and Berliner, 1980). Reflection, self-analysis, self-assessment and articulation are essential for the development of the learner’s meta-cognitive and independent learning skills. Meta-cognitive skills are activated during learning, making learning easier and facilitating the transfer of learning. Fekete (Fekete et al 2000) and his colleagues acknowledge the importance of reflection in assisting students develop meta-cognitive skills. For example, by explicitly outlining subject goals, getting the students to maintain a reflective diary, students are encouraged to think about what they know, how they learned it and how well it matches the announced goals of a subject. A meta-cognitive interface will be incorporated into the learning tool to assist in developing these skills.
These skills are needed where habitual responses are not successful (Blakey and Spence, 1990) and problem solving is one area where it is necessary to develop these skills.

The TUPULO project aims to address some of the challenges faced by novice programmers by providing them with an innovative learning tool, incorporating a set of Reusable Learning Objects (RLOs), based on sound pedagogical principles and encapsulated in a Constructivist Learning Environment (CLE). The Learning Objects will focus on the common areas of weaknesses that are determined by the User Needs Analysis. As indicated the Constructivist Learning Environment (CLE), the Learning Objects will encompass a meta-cognitive interface which will encourage the novice programmers to reflect, self-analyse and elicit articulation of the learner’s understanding of certain programming constructs. By eliciting articulation from the learner, the CLE is encouraging reflection “which is an important cognitive activity, critical for effective learning”. (Guzdial, 1994). The outputs and findings of the TUPULO project, by being disseminated to the wider educational community, will help learners in the domain on a broader scale, as well as promote the development and use of learning processes and resources that are both innovative and effective. One of the initial core activities of the TUPULO project when it commenced in October 2005 was to classify users according to their generic need, i.e. identify a target group and to conduct a User Needs Analysis. This paper describes these activities and draws conclusions from the research carried out in one of the academic partner institutions, which will inform and direct the remainder of the research project.

The objective of this phase of the project was to establish the target audience and the students’ major areas of weaknesses in undergraduate programming, so that they could be targeted and the appropriate Learning Objects could be designed and deployed. ITT Dublin conducted analyses of first year student examination scripts from the years 2003, 2004, 2005. These samples were broken down into sub-categories of, students in Semester 1 and students from Semester 2. The current student group from the academic year 2005/2006, at both first and second year level, were also surveyed in ITT Dublin and ITB to determine their perceptions of the courses, and ITT Dublin students were involved in focus group discussions. Table 1: Participating Academic Partners Numbers of Students Sampled

<table>
<thead>
<tr>
<th>Institution</th>
<th>Number of Students Sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITT Dublin</td>
<td>157</td>
</tr>
<tr>
<td>ITB</td>
<td>167</td>
</tr>
<tr>
<td>DCU</td>
<td>311</td>
</tr>
</tbody>
</table>

Table 2: Breakdown of Students Sampled at ITT Dublin

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Semester</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>2003</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td>2004</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>2004</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>2005</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>

This project focuses on a target audience of novice programmers in their first undergraduate year in third-level education. Three Irish third-level institutions, Institute of Technology Tallaght, (ITT Dublin), the Dublin City University, (DCU) and the Institute of Technology Blanchardstown (ITB), participated in the research, see Table 1. Samples of student data from each institution were used spanning three academic years, 2003, 2004 and 2005. These samples were broken down into sub-categories of, students in Semester 1 and students from Semester 2. The current student group from the academic year 2005/2006, at both first and second year level, were also surveyed in ITT Dublin and ITB to determine their perceptions of the courses, and ITT Dublin students were involved in focus group discussions.
User Needs Analysis, was to establish the students’ major areas of weaknesses in undergraduate programming. The identified audience could then be targeted and the appropriate Learning Objects and Constructivist Learning Environment would be designed and deployed. Although this paper primarily focuses on the analysis carried out in ITT Dublin, it is worth noting that the same study was carried out in the other two academic partner institutions.

Each participating academic institution carried out extensive research of their past first year students' examination scripts and analysed the results generated. Qualitative information was gleaned by carrying out surveys and focus group discussions. A comparison of areas of weakness across all three academic institutions was carried out in order to determine common problem areas. The learning objects were then subsequently designed and developed to specifically target the subject areas posing the greatest difficulty for programming students. The choice of content for the learning objects was constrained to some degree by the need to make the topics relevant to each of the partner institutes’ software development modules. The remainder of this paper details the extensive research carried out by ITT Dublin into first year students' Software Development examination scripts and presents an analysis of the results generated. The concluding section of this paper will outline the main points of interest from each of the three studies carried out in the partner institutes as part of the user needs analysis.

2.1 User needs analysis methodology
As a first step in the User Needs Analysis process, a User Needs Analysis Methodology was drafted and agreed with the participating academic institutions, as outlined in Table 3 below:

Table 3: UNA Methodology

<table>
<thead>
<tr>
<th>UNA Methodology</th>
<th>Institutional Information</th>
<th>Course Information</th>
<th>Technology used in teaching of same</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examination Scripts collation and analysis based on the following:</td>
<td>Students’ overall performance in other subject areas, where available</td>
<td>Syllabus, break down of topics and time allocated to same</td>
<td></td>
</tr>
<tr>
<td>▪ Categorisation of questions, based on topic</td>
<td>Leaving Certificate points where available</td>
<td>Teaching methodology, combination of lectures/ tutorials/ laboratories, other tools used</td>
<td></td>
</tr>
<tr>
<td>▪ Number and percentage of students who took questions per category</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ Students’ results per question, and sub-question, F, D, C etc.</td>
<td></td>
<td>Technology used in teaching of same</td>
<td></td>
</tr>
<tr>
<td>▪ Students’ overall performance in the paper</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The objectives of the UNA were to provide answers, which could address the following universal issues in undergraduate programming:

- Determine main areas of difficulty, ref Point 1 in table above
  - By scripts analysis and student survey
- Why are these areas difficult for students?
  - Student ability, Mathematical grade/Leaving Certificate Examination (Leaving Certificate Examination is the examination that Irish students take at the end of their secondary school education. They achieve Leaving Certificate points based on their performance). point correlation
  - By statistical analysis
- How taught, examples, practical work, teaching methodology
  - By student survey
- Is Software Development the only area of difficulty in the undergraduate course?
  - Ref point 3a. in table above
- If so what are the issues?
  - Problem – solving ability? (Ref Student Survey), How students approach the problems? No reflection on approach?
  - Is there a statistical correlation between only fail and Software Development?
  - Glean information from student survey, questionnaire and focus group discussion

2.1.1 Coding schemes
A coding scheme was generated in order to analyse the examination scripts, these codes were specific to ITT Dublin’s scripts and the other participating institutions used these codes and added their own specific codes as required, see Table 4 and Table 5.
2.2 Data collection, analysis and evaluation

A multi-method approach was adopted in this research in order to collect as much data as possible from a variety of viewpoints, which could then be analysed, and in which one could be more confident compared to using a single method approach. By triangulating the data collected by the different methods used, one can be more confident in the research findings, and the more the methods contrast with each other the more confident one can be in the findings, (Cohen and Mannion, 1997). The methodological triangulation included a survey, which included a self-completion questionnaire and focus group discussions, and an analysis of students’ examination scripts over a number of semesters from the participating academic partners. In carrying out the analysis of the software development examination scripts at ITT Dublin, a MicroSoft Excel™ spreadsheet was used to store the breakdown of results for each question and sub-question for each student. This data enabled the partners determine the main areas of weakness in terms of student performance. An analysis of this data was performed in order to gather the information required as specified in the User Needs Analysis methodology outlined previously. In addition to the examination script analysis, a survey was conducted to gather data about the students’ perceptions of software development. The survey involved first and second year students completing questionnaires and taking part in focus group discussions.

The main purpose of the enquiry was to:

- Determine the students’ perceptions regarding the area under study, i.e. software development
- Determine the students’ approach to designing software solutions

When designing the self-completion questionnaire, every attempt was made to ensure that it was clear and unambiguous. It was designed so that it would minimise potential errors from respondents and that it would engage their interest and elicit answers as close as possible to the truth. Once the questionnaires were collected, the data was entered into an Excel™ spreadsheet for analysis. In addition to the questionnaires, focus group discussions were conducted with the students. This technique has been shown to be particularly valuable as it gets at deeper attitudes and perceptions of the attendees in such a way as to leave them free from interviewer bias. In conducting the group discussions the facilitator’s guidance was kept to a minimum to maintain the criterion of non-direction. The respondent’s descriptions of their experience were allowed full expression, and the range of responses from the students was maximised. The nature of the group discussions facilitated a wide range of responses with the students being able to challenge and extend each other’s ideas.

2.2.1 Data collection, analysis and evaluation – semester 1

The authors conducted an analysis of first year student examination scripts from the years 2003, 2004, 2005, ref Table 2. The student sample chosen was a random sample of scripts, which were taken from the student population of each year. The analysis of the scripts for Semester 1 2003 indicated that the main areas of difficulties were questions based on the following topics, ranked in order of difficulty, based on student performance in the examination:

- 1 Dimensional Arrays
- 2 Dimensional Arrays
- Selection
- Pseudocode and Looping

The analysis of the scripts for Semester 1 2004 indicated that the main areas of difficulties were questions based on the following topics, ranked in order of difficulty, based on student performance in the examination:

- Code comprehension
- 1 Dimensional Arrays
Looping
Looping with Selection
The analysis of the scripts for Semester 1 2005 indicated that the main areas of difficulties were questions based on the following topics, ranked in order of difficulty, based on student performance in the examination:
- Looping/Theory
- Testing
- Looping with Arrays
- Code comprehension
An overview of these results is shown in Figure 1 below, the higher values indicating higher levels of difficulty.

![Figure 1](image1.png)

**Figure 1**: 2003, 2004 and 2005 Semester 1 Analysis of Examination Results (ITT Dublin) indicating main areas of difficulties based on student performance

In analysing the main topics of difficulty from each sample taken, the main areas of difficulties, in terms of programming constructs, for students in semester one in ITT were determined to be:
- Arrays
- Looping
- Selection

The survey at ITT Dublin consisted of a questionnaire and focus discussions. A total of twenty questionnaires were completed and returned. It should be borne in mind that the students who completed the questionnaires were not the same students whose data was included in the scripts analysis. However, they were randomly selected from the first and second year student population. In order to ensure that the students completed the questionnaires individually, their completion was supervised. The completed questionnaires were collected and their results analysed. The questionnaire was designed to gather information relating to the following research questions:
- Determine the students’ perceptions regarding their approach to designing software solutions

At ITT Dublin 75% of students surveyed either strongly agreed or agreed that software development was their most challenging module. At ITT Dublin, 90% of those surveyed either strongly agreed or agreed that problem solving ability impacts on their performance see Figure 2.

![Figure 2](image2.png)

**Figure 2**: Problem solving ability impacts performance (ITT Dublin)

Only 20% of students at ITT Dublin nearly always think about their approach in designing software solutions, see Figure 3, with 60% only sometimes thinking about their approach and a further 20% rarely or never thinking about their approach. This concurs with the fact that novices have meta-cognitive deficiencies and these skills need to be developed. Consequently, one of the more innovative aspects of the TUPULO project is the design of a meta-cognitive interface to provide an appropriate level of support for the learner in order for them to develop their meta-cognitive skills.

![Figure 3](image3.png)

**Figure 3**: Think about approach taken in designing solutions (ITT Dublin)

The students were asked to rank the difficulty level in a number of programming concepts, e.g. loops, arrays, selection. Only 5% of students perceived loops to be difficult with 95% of those surveyed perceiving them to be either not difficult or easy, see Figure 4.
When surveyed about the perceived level of difficulty of arrays, 60% of those surveyed found arrays to be either extremely or very difficult with only 40% indicating no difficulty with the concept, see Figure 5.

The students surveyed indicated no difficulty with the selection construct with 40% indicating that selection was not difficult and the remaining 60% perceiving it to be either easy (45%) or very easy (15%). In triangulating the results from the examination script analysis and the student questionnaires, bearing in mind that they pertain to different student samples, the main area of weakness from the script analysis, i.e., arrays, concurs with the students' perceptions of level of difficulty with 60% of students perceiving arrays as being extremely or very difficult. In terms of the students' perceptions, they rank looping next in difficulty, with 5% indicating difficulty, finally with selection, no one perceived this construct as difficult. These results concur with the results of the script analysis in their ranking of difficult programming topics, as follows:

- Arrays
- Looping
- Selection

2.2.2 Data collection, analysis and evaluation – semester 2

In semester 2 the course at ITT follows an object-oriented paradigm and the topics covered are object-oriented topics. The analysis of the examination scripts for Semester 2 2003 indicated that the main areas of difficulties were questions based on the following topics, ranked in order of difficulty:

- Polymorphism
- Getter/Setter Methods
- Object Creation and Method Calling
- Subclass Object Construction

The analysis of the examination scripts for Semester 2 2004 indicated that the main areas of difficulties were questions based on the following topics, ranked in order of difficulty:

- Polymorphism
- Methods
- Code Comprehension
- Object Creation and Method Calling

An overview of these results is shown in Figure 6 below, the higher values indicating higher levels of difficulty.

In semester two the main areas of difficulty at ITT over the period studied, in terms of programming constructs were

- Methods
- Polymorphism
- Objects

These results and areas of weaknesses are specific to ITT Dublin, given the sample of students' examination scripts analysed over the time period outlined.

Twenty-second year students at ITT Dublin completed questionnaires in order to determine their perceptions relating to topics covered in semester two. These students were not, as stated above, the same sample on which the script analysis was based. In relation to the students' perception of the level of difficulty of methods and parameter passing, only 20% of the students perceived these concepts to be either extremely or very difficult with the remaining 80% perceiving them to be not difficult or easy, see Figure 7.
However when surveyed regarding the perceived difficulty of polymorphism, 55% of the students surveyed indicated that they found it extremely or very difficult, see Figure 8.

In relation to subclass object creation 30% of those surveyed perceived this topic to be either extremely (5%) or very (25%) difficult. In triangulating the results from the script analysis for semester two and the second year student survey results, the following observations were made:

In semester two, the main areas of difficulty at ITT determined from the scripts analysis, were:
- Methods
- Polymorphism
- Objects

From the survey the students perceived polymorphism to be the most difficult topic with 55% of students perceiving difficulty. The students then perceived Inheritance to be next in difficulty with 35% of those surveyed indicating that they found the topic extremely or very difficult. Object construction and Subclass object creation both had a 30% perceived difficulty with Methods and parameter-passing producing a 20% difficulty, see Figure 7. The findings of both data analyses match in identifying the areas of weaknesses but the actual and perceived level of difficulty are different. The students perceived methods to be the least difficult but in the analysis of the scripts this topic was determined as one of the main area of weakness.

A sample of the data, where Leaving Certificate Points, (results obtained from a State examination sat by all students at the end of second-level education), and other subject results were available, from ITT was input to a statistical analysis package, MINITAB™ for further analysis. A regression analysis carried out on students’ Leaving Certificate points and their final result in the Software Development examination indicated that there was a linear relationship between the two, \( p = .001 \). However, given the sample that was analysed, the relationship, \( R^2 15\% \), was not very strong, this area requires further research. A more significant relationship existed between a student’s final result in Software Development and the number of fails the student had in other modules. A significant \( p \) value of .029 was returned; indicating that a student’s result in Software Development is a useful result in predicting that they may have fails in other subjects. One can assert that the lower the Software Development result falls, the student is more likely to have more failures in other subjects.

2.3 Focus group discussions

As mentioned earlier the focus group discussion was the tool used for collecting qualitative data from a sample of the user group. These focus groups were facilitated by a moderator and again were done with a random group of 1st and 2nd year students. As larger focus groups can inhibit the participation by some members (Sherraden, cited in Shapiro and Wolff, 2001), the size of both focus groups was kept fairly small at 6-15 people. An interview guide as shown in the first column of Table 6 below was prepared in order to help structure the discussion. The first focus group consisted of 1st year students who were asked some general questions about their course using the above guide. The responses from the group were collated and are presented in the 2nd column of the table below:

<table>
<thead>
<tr>
<th>Table 6 Focus Group Guide and Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interview Guide</strong></td>
</tr>
<tr>
<td>Do you find Software Development the most difficult module in your programme?</td>
</tr>
<tr>
<td>Do you think that the ability to problem solve has a</td>
</tr>
</tbody>
</table>
The authors examined the set of responses to the focus group discussion with the 1st year group more closely in order to demonstrate whether they validate even further the earlier quantitative analysis conducted. When the relevant aspects of the focus group were compared with the earlier results of the quantitative analysis, there is significant agreement between both sets of results. For example, over 50% of the 1st year group agreed that the ability to problem solve has a major impact on Software Development performance. The survey conducted with a larger sample group showed 75% agreeing with this statement also. In the focus group over 50% agreed that they did not spend time away from the computer designing a solution while the survey showed 80% as sometimes, rarely or never designing before implementation. With regard to analysis of the examination scripts, arrays, looping and polymorphism emerged as the topics with the highest failure rates.

These three topics were also pointed to in the focus group discussions as areas that cause students the most difficulty from a conceptual perspective. It is interesting to note that on certain issues there was a substantial difference in opinion between the two student groups, which was reflected in their responses to certain questions in the focus group discussions. While 70% of the 1st year group registered that they found software development to be the most difficult module in their programme, only 43% of the 2nd year group felt this to be the case. There may be a number of reasons for this difference in opinion. Interestingly, students reported a greater level of comfort with the software development in 2nd year as opposed to how they felt about the module in 1st year. It could suggest that students in 1st year are still in the process of becoming used to programming which is a totally new subject that they would generally not have encountered before entering third-level.

Another point of note is that over 30% of the 1st year group would choose to study a programme, which contained no Software Development module, if given the chance. However, not one member of the 2nd year group would choose this type of programme. This seems to suggest that a significant number of 1st year students experience major doubts regarding their choice of programme. In contrast, students in the 2nd year group expressed a greater sense of enjoyment and satisfaction with software development and explained, “it is the ability to write bigger programs that actually do something”, “the project in 2nd year gives us lots of practice at writing Java”, “….more time spent on Java the better”.

Interestingly, with regard to the relationship between performance in Mathematics and the student’s ability in software development, neither group felt there was any link. Both groups also agreed that the most useful learning environment for them is the laboratories where they can spend time on solving practical exercises, worksheets etc, with the help of laboratory facilitators. This concurs with the constructivist approach in engaging the learner. The learning tool which was developed will be used online and in the laboratories. After conducting the focus group discussions, one overall observation from the authors’ viewpoint is the increasing amount of

<table>
<thead>
<tr>
<th>Interview Guide</th>
<th>1st Focus Group (1st Year)</th>
<th>2nd Focus Group (2nd Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>major impact on your performance in Software Development?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you think it is necessary to be good at Maths to perform well in Software Development?</td>
<td>Most disagreed</td>
<td>Most disagreed</td>
</tr>
<tr>
<td>Do you think that your performance in Software Development is linked to the result you got in Leaving Cert Maths?</td>
<td>Most disagreed</td>
<td>Most disagreed</td>
</tr>
<tr>
<td>When solving a Software Development problem, do you spend time away from the computer designing your solution?</td>
<td>50% agreed that they did not</td>
<td>70% agreed that they did not but may sketch an outline solution</td>
</tr>
<tr>
<td>What do you regard as the most difficult concepts in Software Development?</td>
<td>Looping and arrays from semester 1 Polymorphism from semester 2</td>
<td>Methods and general environment set-up from semester 1 Threads from semester 2</td>
</tr>
<tr>
<td>Which format do you find the most useful in learning Software Development?</td>
<td>Labs</td>
<td>Labs</td>
</tr>
<tr>
<td>a) Lectures? b) Tutorials? c) Labs?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If given the opportunity, would you choose to study a computing course, which had no Software Development module?</td>
<td>Over 30% said yes</td>
<td>100% said no</td>
</tr>
</tbody>
</table>
guidance and support needed to help 1\textsuperscript{st} year students overcome the initial hurdles and convince them of the more enjoyable and rewarding aspects of software development as described by the 2\textsuperscript{nd} year students.

3. Conclusion

The methods used for data gathering have been outlined and these include both quantitative, the scripts collation and the statistical analysis of same, and qualitative approaches such as the analysis of questionnaires and focus group discussion. A triangulation of both quantitative and qualitative measures was used to gather data. The measures used focused on gathering data that would be analysed in light of the research objectives. These objectives and their relationships to measures used are as outlined in Table 7:

\textbf{Table 7: Relationship between research objectives and data gathering measures}

<table>
<thead>
<tr>
<th>Research Objective</th>
<th>Corresponding Data Gathering Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine students' main areas of weaknesses in semester 1 and semester 2 of software development</td>
<td>Analysis of students' past examination scripts.</td>
</tr>
<tr>
<td>To gain insight into the students' perceptions of their approach to problem solving and design</td>
<td>Survey responses/ Focus group discussion.</td>
</tr>
<tr>
<td>Is Software Development the only area of difficulty in the undergraduate course</td>
<td>Statistical analysis of students' overall performance.</td>
</tr>
</tbody>
</table>

The data gathered pertaining to semester 1 topics in terms of the ranking of the areas of weaknesses across participating academic institutions, as determined by the user needs analysis, is outlined below in Table 8.

\textbf{Table 8: Ranking of the different areas of weaknesses in participating institutions}

<table>
<thead>
<tr>
<th>Areas of Weakness Semester 1</th>
<th>ITT</th>
<th>ITB</th>
<th>DCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrays</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Looping</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Selection</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Methods</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Problem-solving</td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

The data gathered pertaining to semester 2 topics in terms of the ranking of the areas of weaknesses, as determined by the user needs analysis, is outlined below in Table 9.

\textbf{Table 9: Ranking of the different areas of weaknesses in semester 2 in the participating institutions}

<table>
<thead>
<tr>
<th>Areas of Weakness Semester 2</th>
<th>ITT</th>
<th>ITB</th>
<th>DCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Polymorphism</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subclass object creation</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrays</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>GUI</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Object construction</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Object creation</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Having determined the main areas of weaknesses in the participating institutions, it was agreed to base the project's Learning Objects on some of the following areas:

- Arrays
- Looping
- Selection
- Methods
- Objects

The development of these Learning Objects is dependent on the time frame and scope of the project, and as such would be limited by those constraints. An initial prototype based on arrays was developed for review and discussion. An important feature of the project is to design and develop a meta-cognitive interface to develop the necessary reflective and self-analysing skills in novice programmers. As part of the meta-cognitive interface learners outline an initial approach to a concept/problem solution, reflect on what they knew initially and what they have learned and then review the approach initially adopted. By requiring the learner to articulate his/her approach, implicit knowledge becomes explicit, making the learning process more effective. The students’ approaches and reflections will be stored and these metacognitive traces will be captured to provide the lecturer/tutor with a valuable insight into the approaches adopted by the students and any particular areas of weakness.

This tool is scheduled to be rolled out from February 2007. An in-depth, cross-institutional evaluation of the educational impact of the RLOs with the supporting metacognitive interface, within the proposed learning environment, will be conducted. The evaluation will include an observational case study, quasi-experiment, student questionnaire and focus groups. An evaluation of a discussion forum will also be conducted as part of the evaluation phase. The data stored from the metacognitive interface will be retrieved and analysed. The data from the
different evaluation methods will be triangulated in order to draw conclusions. The findings of the project will be disseminated to the wider educational community. By wrapping a meta-cognitive interface around learning objects which target the novice programmers’ main areas of weaknesses, it is hoped to provide a comprehensive and innovative learning tool which addresses conceptual difficulties with programming constructs and at the same time promotes the learners’ meta-cognitive skills which are essential for learning in this domain.

References
Students’ Perceived Usefulness of Formative Feedback for a Computer-adaptive Test

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Abstract: In this paper we report on research related to the provision of automated feedback based on a computer adaptive test (CAT), used in formative assessment. A cohort of 76 second year university undergraduates took part in a formative assessment with a CAT and were provided with automated feedback on their performance. A sample of students responded in a short questionnaire to assess their attitude to the quality of the feedback provided. In this paper, we describe the CAT and the system of automated feedback used in our research, and we also present the findings of the attitude survey. On average students reported that they had a good attitude to our automated feedback system. Statistical analysis was used to show that attitude to feedback was not related to performance on the assessment (p>0.05). We discuss this finding in the light of the requirement to provide fast, efficient and useful feedback at the appropriate level for students.

Keywords: computer-assisted assessment, formative assessment, adaptive testing

1. Introduction

The primary purpose of formative assessment is to inform students about their strengths and weaknesses (Morgan et al. 2004, Brown et al. 1997). Formative assessment focuses on providing feedback to students in order that they have opportunities to improve their learning and performance. Formative assessment does not usually contribute towards the final grade of the module or course concerned. The term summative assessment is commonly employed to describe any assessment that contributes to the final marks for a module or course. Morgan et al. (2004), Brown et al. (1997) and Yorke (2003) suggest that formative assessment and consequent formative feedback have the potential to enhance the student learning experience, even to the extent that it might contribute towards student retention (Yorke 2001). However, larger cohorts and resulting workload pressures on academic staff often result in limited opportunities for formative assessment and feedback.

A potential solution to provide an adequate provision of formative assessment opportunities would be the use of computerised formative assessment and feedback. Positive results for this approach have been reported by Charman (2002), Sly and Rennie (2002) and Steven and Hesketh (2002). In this paper we present our approach to the provision of automated formative assessment and feedback using a computer-adaptive test (CAT). Clearly, a critical consideration was whether or not the students found it useful, and this is the focus of this paper.

2. Computer-adaptive testing

Computer-adaptive test (CAT) is a form of computer-assisted assessment where the level of difficulty of the questions administered to individual test-takers is dynamically tailored to their proficiency levels. In general terms, a CAT usually starts with a question of medium difficulty. Correct responses will usually cause a more difficult question to follow. Conversely, an incorrect response will trigger a less difficult question to be administered next. CAT software applications are based on Item Response Theory (IRT). IRT is beyond the scope of this paper and the interested reader is referred to Lord (1980) and Wainer (2000).

Wainer (2000), Conejo et al. (2000), Fernandez (2003), Brusilovsky (2004) amongst others have reported on the benefits of the CAT approach across a wide range of educational settings. This paper focuses on a CAT software prototype designed, implemented and evaluated at the University of Hertfordshire (Lilley et al. 2004). The CAT software prototype introduced here comprises a graphical user interface, an adaptive algorithm based on the Three-Parameter Logistic (3-PL) model from IRT and a database of questions. The database of questions is employed to store information about question stem, distractors, key answers, topic area, recommended revision task and values for the parameters required by the 3-PL model (Lord 1980, Wainer 2000). One of the central elements of the 3-PL model is the level of difficulty of the question being answered by the test-taker. For questions with no historical data, an initial value of the difficulty parameter for each question is
defined by subject domain experts ranging from -3 (lowest) to +3 (highest). The expert calibration is based on Bloom’s taxonomy of cognitive skills (Bloom 1956) as illustrated in Table 1. The level of difficulty estimate is updated after every assessment session based on student performance per question. In general terms, questions that are answered correctly more often have their difficulty ranking lowered and questions that are answered incorrectly more frequently have their difficulty levels increased.

Table 1: Guidelines for expert calibration

<table>
<thead>
<tr>
<th>Difficulty (b)</th>
<th>Cognitive skill</th>
<th>Skill being assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3 &lt;= b &lt;= -1</td>
<td>Knowledge</td>
<td>Ability to recall taught material</td>
</tr>
<tr>
<td>-1 &lt;= b &lt;= +1</td>
<td>Understanding</td>
<td>Ability to interpret and/or translate taught</td>
</tr>
<tr>
<td>+1 &lt;= b &lt;= +3</td>
<td>Application</td>
<td>Ability to apply taught material to novel situations</td>
</tr>
</tbody>
</table>

In previous work, we were able to show that the CAT approach is a useful and fair way of assessing students (Lilley and Barker 2003, Lilley and Barker 2004) and that the combination of adaptive testing and automated feedback provides an interesting opportunity to individualise feedback (Lilley et al. 2005). Our approach to the provision of individual feedback is summarised in the next section of this paper.

3. Automated feedback

The web-based automated feedback application consists of three sections. The overall score, a summary of student performance per topic area and a personalised revision plan. Figure 1 illustrates the overall score and summary of student’s performance per topic area sections. Both performance indicators were estimated using the CAT software prototype introduced in section 2.

Figures 2 and 3 show examples of personalised revision plans. For each question answered incorrectly by a student, the relevant revision task is retrieved from the database and listed as part of the personalised revision plan. Although based on the question’s stem, revision tasks do not duplicate the questions. It can be seen from Figures 2 and 3 that the revision tasks involve a range of activities including: writing programs from scratch, reviewing specific lecture or tutorial learning materials and using external resources such as the software vendor online library. In so doing, it is expected that students will be encouraged to learn in different ways.

As discussed in section 2, one of the aims of a computer-adaptive test is to match the level of difficulty of the questions to the proficiency level of individual students. Because students differ in proficiency levels, they are presented with a personalised set of questions. By having one revision task per question, the automated feedback tool introduced here is capable of offering individual students with a set of revision tasks that match their current level of ability within the subject domain. This ensures that less able students are not provided with revision tasks that are too hard and therefore bewildering or frustrating. Similarly, more able students are not presented with revision tasks that are
unchallenging and therefore de-motivating. The underlying idea is to provide students with realistic challenges, given that one of the aims of formative assessment is to direct students “to go beyond the current boundaries of knowledge” (Yorke 2003).

4. The study

A group of 76 Computer Science undergraduates participated in a formative assessment session using our CAT software prototype as part of their regular assessment for a programming module. The participants had 40 minutes to answer 40 objective questions within the Visual Basic.NET subject domain. The questions were organised into five topic areas, namely ‘Representing data’, ‘Classes and Controls’, ‘Functions and
Procedures’, ‘Controlling program flow’ and ‘ADO.NET’.

In this study, the proficiency levels ranged from -3 (lowest) to +3 (highest). The proficiency level mean was -0.03 (SD=1.02, N=76). All 76 participants received feedback on performance using the automated feedback application described in section 3. It was therefore important to investigate the perceived usefulness and ease of use of the automated feedback application.

4.1 Perceived usefulness and ease of use of the automated feedback application

In order to investigate the perceived usefulness and ease of use of the automated feedback application, the participants were invited to complete a questionnaire in which they were asked to rate a series of statements using a Likert scale from 1 (Unlikely) to 5 ( Likely). A group of 49 participants from the original group participated in the evaluation and their responses are summarised in Table 2. An important assumption of our work was that formative assessment to be useful should be timely, support individual development and informs students about their strengths and weaknesses. The results presented in Table 2 show that the application was favourably received by the participant students – on average students thought the feedback approach to be quick and capable of providing useful information for individual development. In addition, the application was perceived as easy to use.

In Table 2, it is interesting to note that the participants deemed the performance per topic as a better indicator of how successfully they have learned than the overall score. One reason for this could be that the former is broken into different topic areas, providing a clearer indication of what has been achieved. However, anecdotal evidence from students suggests that the reason for this is the possibility to gauge how well they have performed in comparison with their fellow students as shown in Figure 1.

Table 2: Students’ perceived usefulness and ease of use (N=49)

<table>
<thead>
<tr>
<th>Item</th>
<th>1 Unlikely</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Likely</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The &quot;Your Score&quot; section would be useful at providing information on how successfully I have learned</td>
<td>0</td>
<td>3</td>
<td>9</td>
<td>25</td>
<td>12</td>
<td>3.94</td>
<td>0.827</td>
</tr>
<tr>
<td>2. The &quot;Your performance per topic area&quot; diagram would be useful at providing information on how successfully I have learned</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>25</td>
<td>13</td>
<td>3.98</td>
<td>0.829</td>
</tr>
<tr>
<td>3. The &quot;Step-by-Step Personalised Revision Plan&quot; section would be useful at providing feedback for individual development</td>
<td>0</td>
<td>2</td>
<td>10</td>
<td>18</td>
<td>19</td>
<td>4.10</td>
<td>0.872</td>
</tr>
<tr>
<td>4. Using the application would enable me to receive feedback on performance more quickly</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>12</td>
<td>22</td>
<td>4.04</td>
<td>1.04</td>
</tr>
<tr>
<td>5. Using the application would be effective in identifying my strengths and weaknesses</td>
<td>0</td>
<td>1</td>
<td>12</td>
<td>15</td>
<td>21</td>
<td>4.14</td>
<td>0.866</td>
</tr>
<tr>
<td>6. I would find the application easy to use</td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>14</td>
<td>25</td>
<td>4.29</td>
<td>0.842</td>
</tr>
</tbody>
</table>

The results in Table 2 suggest that students’ perception of the automated feedback provided was good. Students on average found it useful in understanding how successfully they had learned, they found the revision plan helpful. The application was easy to use and the automated feedback was fast and effective in identifying strengths and weaknesses. It was also important to investigate whether or not there was any statistically significant correlation between student performance on the test and perceived usefulness of the feedback application. The student performance results and the feedback application’s usefulness ratings were subjected to a Spearman’s rank order correlation. The results in Table 3 show that there is no statistically significant correlation between student performance and perceived usefulness of the application. This was an important finding, since it is possible that attitude to feedback was related to performance on the assessment. Performing well or badly on an assessment might influence attitude to feedback and introduce bias into the score. Someone performing badly might be less impressed with feedback for example, than someone performing well. The lack of any
relationship between performance and attitude supported our view that the feedback was acceptable to all students irrespective of their performance.

Table 3: Spearman's rho correlation between perceived usefulness of the feedback provided and assessment performance (N=49)

<table>
<thead>
<tr>
<th>Item</th>
<th>Proficiency Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The &quot;Your Score&quot; section would be useful at providing information on how successfully I have learned</td>
<td>Correlation Coefficient 0.000 Sig. (2-tailed) 0.998</td>
</tr>
<tr>
<td>2. The &quot;Your performance per topic area&quot; diagram would be useful at providing information on how successfully I have learned</td>
<td>Correlation Coefficient -0.065 Sig. (2-tailed) 0.658</td>
</tr>
<tr>
<td>3. The &quot;Step-by-Step Personalised Revision Plan&quot; section would be useful at providing feedback for individual development</td>
<td>Correlation Coefficient 0.110 Sig. (2-tailed) 0.453</td>
</tr>
<tr>
<td>4. Using the application would enable me to receive feedback on performance more quickly</td>
<td>Correlation Coefficient 0.129 Sig. (2-tailed) 0.378</td>
</tr>
<tr>
<td>5. Using the application would be effective in identifying my strengths and weaknesses</td>
<td>Correlation Coefficient 0.031 Sig. (2-tailed) 0.834</td>
</tr>
</tbody>
</table>

The participants were divided into three groups according to test performance, namely ‘low’, ‘average’ and ‘high’. The data was then subjected to a Kruskal-Wallis test to assess the significance of any differences in attitude between these groups. The results of this statistical analysis are shown in Tables 4 and 5 below. No significant differences were found between the attitudes of students performing poorly, averagely or highly, supporting the view that the automated feedback application was perceived as being useful, regardless of student performance.

Table 4: Kruskal-WallisTest (N=49)

<table>
<thead>
<tr>
<th>Item</th>
<th>Chi-Square</th>
<th>df</th>
<th>Asymp. Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The &quot;Your Score&quot; section would be useful at providing information on how successfully I have learned</td>
<td>0.235</td>
<td>2</td>
<td>0.889</td>
</tr>
<tr>
<td>2. The &quot;Your performance per topic area&quot; diagram would be useful at providing information on how successfully I have learned</td>
<td>1.309</td>
<td>2</td>
<td>0.520</td>
</tr>
<tr>
<td>3. The &quot;Step-by-Step Personalised Revision Plan&quot; section would be useful at providing feedback for individual development</td>
<td>0.924</td>
<td>2</td>
<td>0.630</td>
</tr>
<tr>
<td>4. Using the application would enable me to receive feedback on performance more quickly</td>
<td>0.440</td>
<td>2</td>
<td>0.803</td>
</tr>
<tr>
<td>5. Using the application would be effective in identifying my strengths and weaknesses</td>
<td>0.369</td>
<td>2</td>
<td>0.832</td>
</tr>
</tbody>
</table>

Table 5: Kruskal-WallisTest (N=49)

<table>
<thead>
<tr>
<th>Item</th>
<th>Student Performance</th>
<th>N</th>
<th>Mean Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The &quot;Your Score&quot; section would be useful at providing information on how successfully I have learned</td>
<td>Low</td>
<td>17</td>
<td>25.44</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>18</td>
<td>25.69</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>14</td>
<td>23.57</td>
</tr>
<tr>
<td>2. The &quot;Your performance per topic area&quot; diagram would be useful at providing information on how successfully I have learned</td>
<td>Low</td>
<td>17</td>
<td>26.35</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>18</td>
<td>26.36</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>14</td>
<td>21.61</td>
</tr>
<tr>
<td>3. The &quot;Step-by-Step Personalised Revision Plan&quot; section would be useful at providing feedback for individual development</td>
<td>Low</td>
<td>17</td>
<td>22.47</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>18</td>
<td>26.28</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>14</td>
<td>26.43</td>
</tr>
<tr>
<td>4. Using the application would enable me to receive feedback on performance more quickly</td>
<td>Low</td>
<td>17</td>
<td>24.38</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>18</td>
<td>24.03</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>14</td>
<td>27.00</td>
</tr>
<tr>
<td>5. Using the application would be effective in identifying my strengths and weaknesses</td>
<td>Low</td>
<td>17</td>
<td>23.65</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>18</td>
<td>26.39</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>14</td>
<td>24.86</td>
</tr>
</tbody>
</table>
5. Summary and discussion

This paper is concerned with the use of a computer-adaptive test and automated feedback in a formative assessment context. The work reported here is an extension of a previous study by Lilley, Barker and Britton (2005). In this study, a web-based application was employed to provide students with feedback on performance in a summative assessment context. The present work offers a new perspective by reporting on the perceived usefulness of the adaptive approach and subsequent automated feedback in a formative assessment context.

It has been argued that formative assessment and feedback are central to learning. Despite the predicted benefits of formative assessment, increased class sizes often mean that the opportunities for formative assessment are limited or that the amount of tutor feedback from assessed work is reduced. The use of computer-based and online assessment is also increasing generally in Higher Education, as well as at our university. Feedback from such tests is usually restricted to providing the answers to the questions, with worked examples, either in a handout or at a remedial session in a lecture or in small groups. We argue that our approach to providing feedback provides individual feedback at exactly the level of performance for each student. Feedback provided at a level too high for a student is less than useful if they do not understand basic concepts. Equally there is no point in providing feedback on questions that a student already understands and can answer. With a CAT, students are tested at the boundary between what they understand and what they do not know. This is an important boundary as at this level students have good motivation, neither being discouraged by questions that are too hard, or demotivated by questions that are too easy. We suggest that by providing feedback at this level, we are not only correcting errors in understanding, but also we are able to provide links to what individual students need to achieve next in order to increase their understanding of a topic. In this way feedback is being used as scaffolding, helping students to move from what they already know into areas of uncertainty in a steady and measured way.

It is also interesting to note that in a summative assessment undertaken by the same group of students on a related topic a few weeks later, using the same CAT software and feedback application, the proficiency level mean for the summative assessment was 0.21 (SD=1.42, N=76). The mean performance was therefore higher in the summative assessment than that in the formative assessment shown above, (-0.03, SD=1.02, N=76). A paired-samples t-test was used to examine any significant differences in the means for the proficiency level obtained for both assessment sessions. The results of this analysis showed that the observed differences between the proficiency level means were significant and that the differences could not be ascribed to chance alone (t = -2.112, df= 75, Sig. 2-tailed = 0.038). We may speculate as to possible reasons for this difference in performance between the formative and summative assessment sessions. It is likely that students considered the formative assessment as a way of identifying strengths and weaknesses and providing them with information on which topics they should prepare for the summative assessment. In this case it may be argued that the formative assessment had achieved its objectives, as performance was shown to be improved in the later summative test.

It is also possible, of course, that students were more likely to revise for a summative test than for a formative one. Another possibility is that students adopt different strategies during the test and that they are more meticulous in their approach when taking summative tests.

References


A Web Based Intelligent Training System for SMEs

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⁵University of Economics, Poland

Abstract: It is widely accepted that employees in small business suffer from a lack of knowledge and skills. This lack of skills means that small companies will miss out on new business opportunities. This is even more evident with respect to the adoption of Internet marketing in Small and Medium Enterprises (SMEs). This paper reports a pilot research project TRIMAR, which aims to develop a web-based intelligent training system to aid small business employees in their learning and decision-making regarding the use of the Internet as a new marketing medium. TRIMAR attempts to contribute to the wider debate on the content and style of training most suitable to small businesses. It aims to identify the training needs of small businesses for Internet marketing at a pan-European level and to seek the most effective ways to address training and support needs with web-based systems. Based on training needs analysis carried out within five European countries: UK, Germany, Poland, Slovak Republic and Portugal, a web based system for gaining Internet marketing knowledge and skills was constructed. The system consists of three major subsystems: Self Assessment Tool (SAT), Training Modules (TM), and a Case Retrieval System (CRS). Various users through an online questionnaire tested the system. The initial feedback revealed that the case base training approach delivered on the Internet provided a highly appropriate training medium for SMEs.

Keywords: intelligent web-based training, Internet marketing, SMEs, training needs analysis, case based reasoning

1. Introduction

The Internet is described as the SME’s gateway to global business and markets (Liikanen, 2001), and e-business technologies are expected to allow SMEs to gain capabilities that were once the preserve of their larger competitors. SMEs are regarded as significantly important on a local, national or even global basis and they play an important part in the national economy. The lack of anticipated engagement in e-business by Small and Medium sized Enterprises (SMEs) is a rising concern to the UK government and service providers alike. Development of information and communications technologies has resulted in the emergence of new directions in marketing policies and activities. The Internet has become an attractive information tool for marketing (Chaffey et al., 2002; Coupey, 2001; Dann, 2001; Reedy, et al., 2001). Decision makers from Small and Medium Enterprises (SMEs)¹ based in European countries face difficulties while implementing and utilising the Internet for marketing. The difficulties in question result from – in the majority of cases – a lack of the knowledge and skills that are necessary to introduce and carry out marketing in an enterprise. Therefore it is necessary to provide managers with up to date knowledge on Internet marketing and to develop skills that are indispensable. This situation is reflected in a survey conducted within the EU funded TRIMAR project. To meet the SMEs demands an intelligent Internet training and consulting system that supports an introduction of Internet marketing in SMEs has been created within TRIMAR. This paper describes how the TRIMAR project attempted to improve the skills shortage and knowledge deficiency in SMEs by developing an intelligent web-based training system with a case study based approach.

2. Objectives and rationale for developing the TRIMAR system

The TRIMAR project seeks to contribute to the wider debate on the content and style of training most suited for those running and working in SMEs. It also aimed to identify the Internet...
marketing training needs of small businesses in the five EU countries: UK, Germany, Poland, Slovak Republic and Portugal. The research attempted to achieve the following objectives:

- Assess the current status of SMEs’ training needs in Internet marketing in five EU countries;
- Determine specific areas in Internet marketing in which SMEs require training; and analyse similarities and/or differences in SME training needs in the five countries;
- Collect, analyse and report detailed cases from SMEs in participating countries and present as individual SME internet marketing case studies;
- Store the cases in a database and develop a case based approach for searching and matching cases in a web based training system;
- Develop a web based training and support system for Internet marketing by SMEs.

Once an organisation puts itself on the Internet (by creating a website), it becomes instantly ‘visible’ and accessible to millions of people. It would be unwise to expose the SME through the Internet unless careful measures and strategies are adopted because the increased visibility makes accessing the SME much more immediate and the shop window and back-up support and response structures must be in place before the web site goes ‘live’. An unsatisfactory Internet presence may actually prove to be detrimental to the development of a business. If used effectively, for SMEs, the Internet can provide a “gateway” to international markets and overcome many barriers to internationalisation commonly experienced by small businesses. Therefore, the organisation should focus on its needs, strategy and direction before venturing on to the Internet for marketing and publicity purposes.

3. The internet marketing training needs of SMEs

The Internet provides exciting new opportunities for SMEs to extend their business to the global market place. However, introducing Internet marketing into SMEs and combining both off-line and on-line marketing campaigns is not an easy process (Chaffey et al., 2002). This process requires that decision-makers and marketing specialists acquire new skills. Surveys and focus groups conducted by the authors with SMEs revealed that:

- SMEs are not equipped with the necessary expertise to deal with culture-based market differences such as consumer and market characteristics.
- They do not have experience of world market characteristics and do not know how to adapt their companies to the converging global market place in terms of products, promotion and distribution.
- They have no knowledge of how other SMEs are operating on the Internet and which Internet marketing models are available and that they may already be unwittingly adopting.
- The managers would like to learn from successful experiences of other SMEs and adopt best practices identified from Internet marketing case studies within their sector.

The project aimed to investigate the training and decision support needs for adopting Internet marketing in SMEs. For the purpose of this research, a FAME database or similar register of companies in the participating countries (UK, Germany, Poland, Slovak Republic and Portugal) was used. The register was filtered for SMEs in the service sector. The TRIMAR team conducted a questionnaire survey in the five EU countries. Telephone and face-to-face interviews were also conducted where questionnaires did not elicit much response from the various companies. The surveys involved 190 enterprises. They revealed that most small businesses were generally not aware of the power of the Internet as a marketing tool. More than half of the respondents evaluated their level of Internet marketing knowledge and skills as low and insufficient. Most respondents believed that lack of knowledge and in-house expertise were the major barriers to effective implementation of Internet marketing strategies and operations, and that training of managers and employees could considerably contribute to their marketing success. Managers expressed their interest in the provision of a web-based training system to aid their learning and knowledge acquisition.

There was a clear and identified need to provide training to SMEs to increase their skills and knowledge base in the area of Internet marketing. In a recent study, Sambrook (2003) focuses on lifelong, electronic and work-related learning and suggests that SMEs and Higher education must strengthen links to increase the skills and knowledge base and suggests that “there is a need for more effective use of ICTs to help overcome the problems of remoteness and to stimulate e-commerce and e-learning, given that around 90 per cent of small firms use computers”.

Introducing Internet marketing requires that decision-makers and marketing specialists acquire new skills. While admitting their lack of skills and knowledge in embracing the Internet as a new media for marketing activities, most of the
respondents believed that training of managers and employees in Internet marketing could considerably contribute to their marketing success and they could achieve further benefits. The suggested subjects and the demand for training courses as indicated by SMEs are presented in Table 1.

**Table 1**: Training needs and training levels for Small and Medium Enterprises in Internet marketing

<table>
<thead>
<tr>
<th>Training needs</th>
<th>UK</th>
<th>Germany</th>
<th>Poland</th>
<th>Portugal</th>
<th>Slovak Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing company on the net</td>
<td>Not required</td>
<td>Intermediate</td>
<td>Beginner</td>
<td>Not required</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Awareness of opportunities</td>
<td>Beginner</td>
<td>Beginner</td>
<td>Beginner</td>
<td>Advanced</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Website marketing functions</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Website Performance monitoring</td>
<td>Beginner</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Advanced</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Testing, evaluation, maintenance</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Beginner</td>
<td>Advanced</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Website Marketing tools/techniques</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Building customer relation on net</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Internet marketing models</td>
<td>Beginner</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Beginner</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Internet marketing mix</td>
<td>Beginner</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Internet Marketing strategy</td>
<td>Beginner</td>
<td>Beginner</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Database and direct marketing</td>
<td>Beginner</td>
<td>Not required</td>
<td>Intermediate</td>
<td>Not required</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

The statistical results are summarised using the labels beginner, intermediate and advanced to focus attention on the patterns that emerged for levels of training and training needs. The majority of training is required at the beginner and intermediate level with few respondents requesting advanced level training in the majority of the training areas listed. The respondents from the Slovak Republic showed a clear need for training at the intermediate level in all the training areas listed, and this illustrated a level of consistency between the requirement to balance technical and business Internet marketing training needs. Overall, UK and Portugal have followed similar trends whereas Germany and Poland have shown similar traits. This is surprising, as one would assume the more parallel economies of UK and Germany on the one hand, and Poland and Portugal on the other, to display similar patterns. The survey evidence of requiring different training levels on Internet marketing training provision among partner countries raised challenges on how to cater the training needs of different user groups. This issue was duly considered in the design of the TRIMAR system.

4. E-learning on internet marketing for SMEs

E-learning has various forms, definitions and many classifications (Servage, 2005), including asynchronous, synchronous, instructor led, web based instruction, distance, mentor supported and many other descriptions. Each of these types may use a unique combination of delivery, technological and design issues, leadership, structural and cultural issues, and pedagogic frameworks (Gunasekaran et al., 2002, Trentin, 2002, Russel, et al., 2003, Morrison, 2003, Zhang and Nunamaker, 2003, McPherson and Numes, 2006). However, at the present time there is little reported in the e-learning and management learning literature on the appropriate methodology applied to the combinations of design, content management, interaction styles and implementation of a web based training system for SMEs. Further, there are a number of choices an SME has to make in choosing which e-learning system is most appropriate for their learning needs and Roffe (2004) describes “two important dimensions for small firms” which are “authenticity” and “personalisation”. “Authenticity for clients can extend beyond accuracy,
comprehensiveness, and normal institutional quality assurance methods. The learner needs to have confidence in the program and to perceive relevance in the content. A program on how a company can market over the Internet, for example, may be accurate in describing the necessary steps. It might be comprehensive in coverage by touching on all the current issues and have relevance insofar as it matches content to the knowledge of the group to which it is targeted. The program may offer formal educational credit. Nevertheless, authenticity can still be lacking if the learner does not believe that the situations, steps, solutions, and cases are realistic and true-to-life. Building a level of credibility in the program involves adopting approaches that anchor the learning program in an authentic context; this means content with cases to which a client can relate. The goals need to be personal and meaningful. The subject content needs to engage the learner with tutor support that is stimulating and timely. The approach needs to lead learners logically to work on their own real-life implementation. As the business environment is dynamic, each of these components must be reviewed and revised to maintain authenticity.

Our system exhibits authenticity by exploring the possibility of using case based approaches to enhance training and learning, the survey asked “in what way would you prefer to learn about Internet marketing”? 40% of respondents selected “presentation of case studies”. This evidence indicates the willingness of SMEs manager to learn from the previous lessons and experiences of other businesses, and suggested that the system to be adopted should incorporate a case study based approach. The content would have increased value because it would relate directly to the actual experiences of other SMEs and the quality of the cases would be high because the content would be analysed, explored and a conclusion about the success of the SMEs Internet marketing strategies would be formulated before it was reported in the case database.

Further, the survey findings suggested that the system should include the “personalisation” dimension by providing a self assessment tool to aid the SMEs learning by customising their learning pathways. Roffe (2004) suggests that “personalisation can be achieved through diagnosing the needs of an individual or analysing the learner’s objectives, existing skill sets, interests, career objectives, job profiles, attainment, and style. Individual tracking with repetition of certain topic areas and assessment can aid personalisation, as an invitation to join specific groups for aspects of collaborative learning. All of this can establish an individual profile for a particular learner to address specific learning needs”.

The above preferences undoubtedly result from numerous advantages of e-learning, which are of special importance to SME employees (Lehtonen et al., 2002; Oliver, 2002). E-learning solutions overcome the limitations of traditional teaching processes and reduce costs of knowledge acquisition in enterprises. E-learning systems guarantee learners’ controlled access to indispensable knowledge in the most suitable time, either from work or from home. This form of training does not require managers to leave their workplace and thus they are not excluded from everyday duties and decision-making processes. Moreover, e-learning ensures individualisation of teaching processes due to adjustment of the scope, intensity, pace, and level of the programme to the needs of the SME and the decision maker. Furthermore, e-learning allows for repeated usage of the knowledge delivered and individualised access to source material and supplementary support. Additionally, decision-makers may undertake further training to improve their knowledge for given decision making situations. However, in developing an e-learning system in Internet marketing for SMEs a number of challenges arose such as, communicating around certain issues such as pinpointing the (academically) relevant characteristics of particular SMEs, and the time it takes to build a training programme whilst ensuring the materials and content are current and maintain perceived relevance (Bersin and Associates, 2005).

The most important part of the development phase was having regular meetings with the participating SMEs to help inform the design process (Moon et al., 2005), and Johnston and Loader (2003) suggest that “factors such as constant consultation on design and delivery, half-day workshops organised for SMEs in the area of training design, and business focus will encourage SME participation in training and speed the knowledge elicitation process”. It was also important to have structured discussions with SMEs using focus groups and interviews because as is described by Taran (2006), “SMEs have a tendency to over-communicate” so it was important to have a moderator present to keep discussions about the proposed training themes and system design focused and objectives on track.

5. Architecture of the TRIMAR system

In responding to SMEs training and decision support needs, one of the major outcomes of the TRIMAR project was the provision of a web-based
intelligent training and support system using a case based approach. The general architecture of the system is shown in Figure 1 and consists of three major modules:

- Training Modules (TM).
- Case Retrieval System (CRS).
- Self Assessment Tool (SAT).

**Support of learning and decisions making in Internet marketing**
- Assessment of the level of knowledge and skills
- Acquisition of knowledge
- Development of decision making skills
- Support for solving problems

**Figure 1. Architecture of the TRIMAR system**

5.1 **Self assessment tool (SAT)**

Aspects of Internet marketing are frequently overlooked. The rationale behind developing the SAT was for it to serve as a mechanism for bringing these factors into consideration in a balanced and structured way. By the development of such a tool we could ensure that all respondent companies were giving sufficient credence to the assessment of particular aspects of Internet marketing. A review of the literature and of the Internet did not yield any equivalent Internet tool or framework. One of the basic elements of learning is structured direction of learning and self-assessment of knowledge and skills, and with this in mind the SAT module was designed to assess the knowledge of users in the field of Internet marketing (Goluchowski and Ziemba, 2003). The SAT module provides access to online tests, facilitates passing subsequent stages of the training and enables tracking, managing and reporting users self-assessment process and results. Web-based training has the potential to provide users with personalised training materials, but first of all, preliminary determination of their levels of knowledge on any selected topic was obtained. This enables the system to direct users to an appropriate lesson at an appropriate level, That is what SAT is responsible for within the TRIMAR system.

The functionality of the desired system was drawn from assessment of Internet learning systems such as Blackboard that are known to be widely and successfully used (Gunasekaran, 2002). Other functional adaptations were made to the system to make it suitable for use by the target organisations. For example:

- A user should be given detailed information on completion of each test taken (date and time, test duration, number of questions, number of correct answers, exact indication of correct and wrong answers);
- A user should be pointed to or provided with additional information that would inform a selected question – this information and explanation come from the appropriate training module by providing hyperlinks to lessons that explain a selected question;
- To create an effective user interface (hiding the complexity of the underlying system);
- To provide questions in various formats including text, graphics and diagrams;
- To group questions according to their links to appropriate didactic modules;
- To create a large database of questions so that the tests produce randomly generated questions. This would allow the user to take
the test more than once and use it as a formative assessment; and

- To store and monitor a detailed record of completed tests.

In order to provide a reliable assessment of knowledge, a process of random selection of questions were applied in the SAT. Such a solution minimises the risk of multiple generations of the same tests. Complex multiple choice questions constituted the basic form of the tests. However the database structure does not preclude formulation of “true or false” tasks, and additional questions may be added into the question database. Preparing a test should commence with determining a set of questions and answers. Particular questions may include text, graphics and a link to a website that will explain given questions. Subsequently a teacher/trainer matches the questions with all the possible answers – correct and wrong ones. Answers may also be selected from the list if they have already been input into a system. The prepared questions are then grouped into modules that relate to sets of similar tasks. It is assumed that each module is a set of questions on a common thematic scope. Creation of the actual test involves determining which modules will provide randomly selected questions and the number of questions to be selected.

The functions in the Microsoft Access software that are concerned with preparing and managing the tests were implemented using a client/server architecture. Such a solution significantly shortened the time that was necessary to construct a prototype of a system. In the future this element of the system will be recreated using alternative Internet technologies, such as XML technologies, and the LAMP architecture (Linux, Apache, MySQL, PHP) (Putterill, 2004). To initiate the SAT system and take a test, the procedure starts with logging onto the TRIMAR SAT system. Then a user may choose to complete a new test or examine and use one of the already completed tests.

### 5.2 Training modules (TM)

The basic function of the TM module is to provide SMEs with theoretical and practical knowledge that refers to the introduction and utilisation of Internet marketing in business. Two levels of training are developed: basic and advanced levels. At the basic level, training materials are accessed from a list of Internet marketing topics that correspond to the needs identified by SMEs in the TRIMAR surveys. The advanced level comprises case studies that allow for implementation of the case-based learning method and constitute practical examples of performing Internet marketing activities by enterprises. The aim of the case studies is to enhance training effectiveness, develop decision-making skills and to solve problems by reviewing appropriate cases. Case studies were developed in cooperation with SMEs that have already acquired experience in implementing and maintaining Internet marketing activities. Such cooperation includes those undertakings that were successful as well as those that failed. Each case study describes problems of SMEs in reference to three levels of management: strategic, tactical and operational. The problems are formulated into five groups:

- Establishing the nature of a venture;
- Detailed company analysis;
- Strategic development planning;
- Business plan implementation;
- Monitoring and controlling of performance.

In each group, specific problems to be solved by the SME were identified. Each case study is summarised in a form of a Case Study Report and a Case Study Analysis. In the Case Study Report a company presents the character of its activity (Introduction), Challenge, Campaign, Problem, and Solution. The Case Study Analysis provides a summary referring to Strategy, Challenge, Problem, Expectations of the Market, and Solutions at specific levels of management that indicate the breakdown of the activities along with a final conclusion. Each case study is summarised in a form of a “Case Study Report” and a “Case Study Analysis”.

### 5.3 Case retrieval system (CRS)

CRS serves as a learning tool as well as a decision support subsystem. It contains 70 cases and incorporates case searching and matching activities underpinned by case based reasoning methods. A CRS was adopted as this allowed ready analysis, comparison and contrasting of participant companies and at the same time provided the material for an engaging online tool. By and large companies were familiar with the use of individual cases in their dealings with government agencies and the like. Though for all involved, it was a novel experience to assess cases comparatively using an online tool. The main task of the CRS subsystem is to develop decision-making skills and provide support for solving problems. It implements a case based reasoning approach that includes:

- Reasoning through recollection (Leake, 1996);
- Solving new problems by adapting solutions that were implemented in case of old problems (Riesbeck and Schank 1989); and
- Approach to solving and ‘learning’ problems (Aamot and Plaza, 1994).
Choosing the indexing vocabulary (features used for describing cases) is essential for efficient case retrieval. Good indexes should be predictive enough to describe the factors responsible for solving the case and its outcome, be able to address the purposes the case will be used for and be abstract enough to allow for widening the future application of the case (Watson, 1997). The majority of problem domains cases can be successfully indexed by hand, using the following guidelines suggested by Kolodner (1993):

- Determine what the case could be useful for by designating its points with respect to the set of tasks the reasoner is being asked to carry out.
- Determine under what circumstances its points would be useful for each of these tasks.
- Translate the circumstances into the vocabulary of the reasoner.
- Re-interpret the circumstances to make them as recognisable and generally applicable as possible.

The selection of the indexes in TRIMAR involved the collection of a small number of Internet marketing cases from SMEs within the EU. This was achieved by providing these companies with a pro-forma (Barletta and Mark, 1988) with which to record past cases of a particular problem, the resolved solution to that problem and other aspects relating to the company’s strategic, tactical and operational procedures. Initially, 10 cases were selected in order to search for and define appropriate case index fields. The analysis forwarded 7 initial fields, which seem to provide the most appropriate description of the problems and their associated solutions. On the basis of the first findings, the pro-forma was modified in accordance with the selected index fields and distributed to a larger number of SMEs. There were 60 new cases returned for analysis, and from these, another 2 index fields, “Management Structure” and “Corporate Identity” were added to the initial 7 because many SMEs cited interesting challenges and crisis with these two areas in relation to exploiting new technologies for marketing. This made 9 index fields in total. The index fields were also validated with discussions among project partners before formally being accepted for the CRS system development. The selected indexing fields are shown in Table 2.

The small business case is summarised into the 9 fields listed under Indexing Fields label. The field named Content explains the options presented to the small business and explains examples of the type of information expected in that field, and for some fields the small business can include additional information.

### Table 2. Case indexing fields

<table>
<thead>
<tr>
<th>Indexing Fields</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Category</td>
<td>The business function of the company. These were identified as different category groups. A company’s business function would fall into one of these groups.</td>
</tr>
<tr>
<td>Problem Category</td>
<td>The problems the various companies seem to be experiencing. These were identified as different category groups. A company’s problem would fall into one of these groups.</td>
</tr>
<tr>
<td>Business Strategy</td>
<td>The level of business strategy, as in the use of business models and planning, that a company was using for general business activities</td>
</tr>
<tr>
<td>Company Size</td>
<td>The size of the company as the number of employees employed</td>
</tr>
<tr>
<td>Website Strategy</td>
<td>The level of website strategy, as in website planning, that a company was using for the development and presentation of their website</td>
</tr>
<tr>
<td>IT Knowledge</td>
<td>The level of IT knowledge a company has at its disposal</td>
</tr>
<tr>
<td>Market Reach</td>
<td>The market in which the company was active</td>
</tr>
<tr>
<td>Management Structure</td>
<td>The type of management structure that exists within a company</td>
</tr>
<tr>
<td>Corporate Identity</td>
<td>The level of company visibility within its trading sector</td>
</tr>
</tbody>
</table>

The linkage between the three modules, TM, SAT and CRS; is a core aspect of the e-learning training system. Their linkage encourages interactivity and participation between the learner (SME) and the system. The linkage between the modules in the system also engages the SMEs because the content in the form of the training materials and the case studies are context sensitive and related to SMEs current situations, and it provides feedback and support necessary to ensure repeated visits. Finally, all training systems have a duration, and it important that those deemed to be useful should be updated and maintained in light of new research and developments in the field of e-learning.

### 6. Conclusion

The paper discusses the importance of engaging SMEs in effective Internet marketing activities and analyse their training and decision support needs in the context of a TRIMAR project. It then presents a case based approach for enhancing the training and decision making for SMEs in adopting Internet marketing technologies. The web-based intelligent training system provides
training for decision makers in making decisions related to introducing and performing Internet marketing activities. The self assessment tool aims to test the users’ prior knowledge on Internet marketing and directs them to the appropriate level of training. The training module provides two levels of training: basic and advanced. The advanced level of training is supported with a case base, which contains about seventy case studies on small business Internet marketing implementation. The case retrieval subsystem adopts a case based reasoning approach to help managers to learn and to find solutions from similar cases in previous contexts. The intelligence of the system is based on case-based learning methods and case-based reasoning techniques.

The TRIMAR system attempted to combine traditional ways of delivering text-based learning materials with a case base to enhance web based training and knowledge acquisition. The TRIMAR system was tested and evaluated by various users via an online evaluation questionnaire. The online feedback form was unstructured allowing the respondents complete freedom to express their views of the system. The feedback was positive and encouraging. For example, some users said:

“The system offers the possibility for an integrated theoretical and practical learning for companies."

“The examples shown in the case studies allow the user to find solutions for potential business problems without having to experience them. Problems concerning cultural and social differentiation are evident through the case studies and solutions for the problems that are supplied.”

However, its small case base limits the system’s power, especially its capability to enhance training with case base. Some users noted this, e.g.

“The idea of the system is very good – especially the case base. But at the moment the volume of the case base is too small to find matching problems. I hope that many SMEs will put in their cases so the case base will grow.”

It is hoped that with the “add new cases” function provided in TRIMAR the case base can be extended to provide better training and services to SMEs. The online feedback survey was optional, and return rates were low. However, without exception feedback received from companies was favourable with no problems with the system identified. The case studies obtained particularly positive responses although respondents felt the system needed to be populated with more cases studies.

The TRIMAR system has been in place for six years and recent feedback and research findings suggests that there is a need to update and enhance the system. However, there are a number of challenges and issues, which need to be addressed for the further enhancement. It is clear that to maintain authenticity the training system must be redesigned to keep up-to-date with the changing needs of SMEs. The case based approach needs to be revised and redesigned to maintain the authenticity, personalisation and interactivity currently delivered by the system. Other challenges include how to keep the training content up-to-date and inform users with the new development, how to measure the effectiveness of the skill improvement and knowledge transfer of TRIMAR users, how to incorporate more human intervention in TRIMAR system, such as expert tutoring sessions, online community, and discussion forum.

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Piloting a Process Maturity Model as an e-Learning Benchmarking Method

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Abstract: As part of a national e-learning benchmarking initiative of the UK Higher Education Academy, the University of Manchester is carrying out a pilot study of a method to benchmark e-learning in an institution. The pilot was designed to evaluate the operational viability of a method based on the e-Learning Maturity Model developed at the University of Wellington, New Zealand, which, in turn was derived from Carnegie Mellon’s widely accepted Capability Maturity Model. The method is based on gathering evidence about the many and interdependent processes in the e-learning and student lifecycles and takes a holistic view of maturity, addressing multiple aspects. This paper deals with the rationale for the selected method and explains the adoption of a process based approach. It describes the iterative refinement of the questionnaire used to elicit evidence for measures of five aspects of maturity in a range of e-learning processes, in five process areas. The pilot study will produce a map of evidence of e-learning practice across the processes matrix and a measure of the degree of embedding in a sample of faculties within the institution expressed as capability and maturity. To provide a useful measure of where an organisation is with respect to a particular aspect of e-learning, it needs to be able to act on that measure, finding any new activities required or modifying current activities to improve its processes. The pilot study aims to evaluate the potential for improvement inherent in the capability maturity model and to examine the resource implications of obtaining useful evidence. A successful benchmarking effort should be able to inform an institution’s planning and resourcing processes and the outcomes of this pilot should lead to an informed decision about a method for benchmarking the embedding of e-learning, both for the particular institution and for the sector, which in turn can lead to operational suggestions for improvement.

Keywords: embedding, e-learning, process, maturity, benchmarking

1. Introduction

A recurring issue in e-learning is the barriers to its successful embedding within an institution. What is more problematic is the persistence of this issue in spite of better project management and greater knowledge of the aspects of e-learning. Suwardy, Ratnatunga, Sohal, and Speight (2003) report similar findings more generally for embedding IT, suggesting that the experience is not unique to the educational sector. Remeyni, Sherwood-Smith, and White (1997) argue that to realise business benefits, technology must be carefully integrated with the business strategy of the enterprise and its corporate culture, a process known as Active Benefit Realisation. They describe how this involves continuous participative evaluation to manage inevitable changes in the business, and a shifting of the focus of information systems to be the shared responsibility of a group of the main information systems stakeholders. However, Alshawi, Irani and Baldwin (2003) record that managers across different sectors continue to struggle to come to terms with the socio-technical (human and organisational) aspects of IT deployment. They note that the benefits from expenditure on IT systems continue to be considerably less than expected, and that managers continue to find it difficult to determine how to evaluate investments and realise maximum benefits in IT.

The same problem exists in the UK Higher Education sector. Here most e-learning initiatives exist as projects with a finite life. This means that single projects or developments can operate only as enablers, each of which offers an individual focus that can be harnessed to create greater organisational change. Success in an organisation is however integrally linked to the structure and organisation of its environment. It cannot be entirely the objective of a limited duration project. To be successful a project must have impact on the organisation, on the people within it and on the way they work. This requires detailed knowledge of the organisation and engagement with key stakeholders as well as an understanding of how project outcomes can be brought in to an existing structure. It also requires an organisation that is capable of being sufficiently responsive and able to accommodate successfully designed developments into its structure within normal resource constraints. For change to be engineered successfully from projects therefore requires an organisation-wide approach that encompasses all aspects of e-learning. Methods for describing and investigating e-learning processes within an organisation are not well...
developed. There is little development of systems and processes that are managed across product or service lifecycles. In UK HE, teaching and learning design, development and delivery are generally the product of piecemeal, unconnected processes with multiple operators and stakeholders, and no consistent quality assurance mechanisms. There is need therefore for developing the means of describing and analysing processes in the e-learning domain that meet the requirement of what we might call next generation e-learning. That is, e-learning that has moved away from cottage industry types of operation to those that are scalable, quality assured and responsive to market demand. One solution is benchmarking processes (Hirumi, 2005) and in particular those that provide a guide to change and improvement.

2. Application of a capability maturity model to e-learning processes

The e-Learning Maturity Model (eMM) model was developed in New Zealand based on two complementary models, the Capability Maturity Model (CMM) from the Software Engineering Institute (SEI 2002) and SPICE (Software Process Improvement and Capability Determination) (El Emam, Drouin, and Melo, 1998). The Capability Maturity Model for Software characterises a mature, capable software process and the progression from an immature, ad hoc software process to a mature, well-managed software process. This model is currently applied to a number of industry sectors (Griffiths 2005). SPICE, which is a joint effort by the International Standards Organisation (ISO) and International Electrotechnical Commission (IEC) to create an international standard for software process assessment adds the approach for organising the e-learning provision practices and processes into process areas. The CMM has five levels of maturity, ranging from ‘initial’ to ‘optimised’. Each level of maturity in the CMM has a corresponding set of key practices. The practice descriptions are an elaboration of what is meant by maturity at each level of the CMM. From the first phase of his work in New Zealand, Marshall has come to a more holistic view of process maturity in which there are five dimensions of maturity. There is not necessarily a linear progression of capability from one to the next. That is, it is not necessary to reach full capability in one dimension before progressing to the next. It is possible for organisations to develop different patterns of capability across the five dimensions that are to some extent independent (Marshall 2006b). The combination of CMM with SPICE as a basis for eMM provides a means for an institution to appraise their ability to perform their key business processes, such as those required for e-learning provision. It also provides the mechanism for giving guidance to improve process capability. The eMM also offers the means to create the underlying reference model for measuring process maturity from multiple aspects and assessing capability within each aspect. Implementing the CMM determines the state of an organisation's current software process, the high-priority software process-related issues facing an organisation, and obtains the organisational support for software process improvement. Implementing the eMM should similarly create a picture of the current e-learning provision processes across the institution and highlight issues facing the HEI.

In order to succeed with the implementation of eMM it is important first to reach an understanding of the terms ‘process’ and ‘practice’. A process is usually taken to mean the ‘who’, ‘what’, ‘how’ and ‘when’ of doing something in a context (Kruchten, 2004). A process in eMM is a description of the goal of a set of activities, each of which will be the responsibility of some role(s) and carry constraints concerning the timing and manner of their execution. The activities carried out to achieve the five maturity dimensions of that process goal are captured in descriptions of practices. Figure 1 shows how a process has a goal, comprises activities, has maturity dimensions that are supported by a set of practices and belongs to a process area. It may be seen that the practices are organised according to which dimension of a process they support. eMM seeks to identify the dimension and capability of processes from evidence about practices. These measures, for a set of processes, form the basis for assessing institutional (or other level) capability and maturity. The processes of interest are those concerned with the management of the lifecycles of e-learning products, the student experience, and the management of the teaching and learning context.

Figure 1 is a conceptual model of the elements of eMM and their connection to the e-learning lifecycle which allows a whole system view of e-learning provision. We need to understand how the eMM processes and practices fit together with the e-learning lifecycle and with a process driven knowledgebase to support people in their roles (Dexter and Petch 2006). Also in this whole system view is a monitoring and evaluation framework that is required for useful-time response to measurements of process and product quality which in turn is required to enable HEIs to act on the measurement results and make the eMM an ongoing process improvement mechanism. Future work will be on creating a model of the mapping of capability assessment into a monitoring and evaluation reference model.
for the institution’s key processes in teaching and learning and their support.

Figure 1 Conceptual Model of the eMM and its links to the e-Learning Lifecycle

3. Characteristics of the eMM method

The eMM method is a process of assigning values to the capability and maturity attributes of the process array based on documented and oral evidence. eMM considers the whole life cycle of e-learning from planning to delivery and evaluation. In each of the five process areas that make up the life cycle between six and twelve processes are identified as key indicators of the process area. This process set is, of course, not universally fixed. Its selection is a matter of judgement and experience and it is subject to revision. For each process, a set of practices is identified at each level of maturity. Much of the work on applying eMM has been on refining and adding to this list of practices both from the literature and from local instances of practices. In applying eMM, evidence on the practices undertaken in each process area is collected from the variety of sources that exist within an institution. These include quality assurance procedures, quality assurance reports, course logs, policy and strategy documents, course documentation, and a host of other documents as well as evidence gained from interviewing staff and students. Marshall (2006) indicates the breadth and variety of sources that are gathered in a typical university. These evidence sources are then analysed to determine the practices that they provide evidence for so that a matrix of evidence against practices can be constructed. From this, judgements are made of the practices carried out in each of the process areas and the levels of maturity of the indicator processes. The resultant assessments of maturity are then presented in the same form as figures 2 and 5. The relations between these elements of the method are shown in Figure 3.

Figure 2 Snapshot of eMM scoring across multiple institutions (from Marshall 2005b)

The relations between the various elements of the method are illustrated in Figure 3 in which it may be seen that the set of processes and their dimensions form a stable core or standard, and the associated practices which are initially drawn from the literature may vary according to local issues. The evidence collection and mapping for
process capability in a particular dimension is informed by the practices.

Figure 3 Core eMM components and their relationship to local issues that can modify the practices

The method is intrinsically general. General aspects are evident based on first principles and on fact that practice matrices come from established body of knowledge from the field of e-learning. The initial development of eMM by Marshall and Mitchell (2004) was based on a survey of the literature relating to e-learning, quality assurance and benchmarking. Each aspect of the metrics, processes and criteria is based on an extensive and critical appraisal of the literature and as such the method represents the best available and widely agreed criteria for benchmarking. In choosing eMM, it was recognised that the details of the processes, practices and evidence needed to be determined for each major new instance of use, so that they are appropriate to the circumstances of the application. In first developing eMM Marshall and Mitchell (2004) culled an extensive set of practices from the literature. Subsequently, these were refined and extended as the method was applied to successive cases. A major part of developing the application at Manchester was a detailed analysis of practices and questions in the first version of eMM to produce a version that was valid for the university.

The University of Manchester provides an instance of a large research intensive university, one of the Russell Group. It has four faculties, twenty three schools, over 100 discipline areas and 3500 academic and related staff. It has recently undergone major reorganisation with a merger in 2004. It has high ambitions to be world leading site not only in research but also in education, based especially on e-learning. It is clear that this requires a radical approach to managing quality. A stated objective of the institution is to establish quality assurance processes that are embedded in all aspects of education and are not ‘event driven’ as at present.

Quality is seen as a continuous part of operations both to apply and to monitor. Additionally Quality Assurance and Enhancement is envisaged as an integral part of a planning-review-evaluation cycle that is the basis for resource allocation and for both operational and strategic planning. This requires a method and a toolset that gives not only detailed operational intelligence on aspects of operations and performance but also provides a means of achieving planned and managed improvements in aspects of performance. It has in other words to be the means to change practice. eMM is not a method intended for a one-off snapshot of the state of things, but to drive change to find where improvements may be made and to track change and improvement over time. It is a method to allow a visualisation of the state of the organisation and compare parts of the organisation, or to view state change over time. This is an essential aspect for engaging operational managers and strategic managers as well as academics. Additionally, the value of the method as developed by Marshall et al. is in its ability to handle and display large amounts of data in single graphics (Tufte, 1990). The development of rich visual design by Marshall et al. is a valuable development of eMM that makes it an effective management and communication tool. Figure 2 shows how within one display, and this only a partial one, around 150 data items are received synoptically. The density of data prompts a focus on patterns which are the appropriate level for institutional analysis and comparison. The eMM rationale focuses on the progressive changes to achieve optimal performance. At the core of the method as it is applied is the set of practices that ensure such progression and improvement. These are context specific and have to be designed and developed for each application but there are generic elements relating both to HEIs and to e-learning. In particular the method cannot be seen simply as applying only to e-learning but in reality to all teaching and learning. Metrics within the method are designed to identify whether or not particular practices that may be associated with any level of development of processes are followed or not and the extent to which they are followed. The practices observed in the method are those identified for a particular institution, or type of institution, that are ‘indicator’ practices. Those, in other words, that give the most sensitive indication of differences and change. The process of developing the metrics of the method is one of fine tuning the indicator metrics so as best to reflect the real processes involved in design, development and delivery of e-learning. This fine tuning is based on understanding of processes, on the availability of evidence and on the likelihood that evidence is reliable. Additionally, the metrics and the criteria
used with them are designed to be progressive, that is to be sensitive to and indicate changes that are real in the ways indicated by the rational of the approach, viz. in terms of increasing maturity and capability.

4. Method development: The Manchester case

eMM in its early versions has been developed and tested in a limited context outside the UK only on project-type operations, and within a limited time-frame. In adopting the method at Manchester, there was a need to extend eMM to the whole institutional level with coverage for the whole e-learning lifecycle and to tailor the method to a UK HEI. In assessing how eMM can be practically applied within a UK HEI, the key components to be considered were:

- The process list
- The database of related practices
- The definition of dimensions created through assigning practices to the dimensions
- The evidence map that defines where information on what is being carried out in relation to practices can be found

Marshall’s approach presumes a particular set of evidence that should be sought for each organisation, and uses questionnaires as a tool to locate that evidence. Once a preliminary assessment of the available evidence is made, interviews can be used to clarify actual circumstances against what might be suggested from documentation collected up to that point. In UK HEIs, the form of evidence and where it may be located is less clear. Other local and specific factors also contribute to the need for a revised approach to guide evidence collection for the pilot to be successful in the Manchester case:

- A need to assess the scalability potential for the eMM methodology,
- The ‘newness’ of the organisation under pilot and its related structures
- The combined impact of old and new structures working together in the early stages of the organisation
- Staff familiarity and day-to-day knowledge in a period of extensive change
- A requirement to minimise the workload in making the methodology repeatable as a precursor to long-term viability.

In collecting evidence, prior contact with organisational staff is needed to build an evidence matrix to help locate where particular material and/or documentation may lie and in what forms it may be found. For this purpose, the pilot has identified a series of process-based questions capable of guiding interview-based discussion. In contrast to Marshall’s approach, interviews are a first-contact point for locating evidence, rather than a follow up to evidence already identified. Questions are used to guide discussion around evidence for the processes in eMM. The interview process also allows a communication channel to be developed with key staff. However, for this approach to work, the question set must elicit the full set of possible information against all the processes listed in the five process areas. Otherwise gaps will exist due to the data gathering process itself. To achieve such a question list requires a multi-dimensional matrix mapping of the proposed questions back to the eMM process list. It may be that some processes and their dimensions may be over-represented, in which case the question set can be adjusted. Some process dimensions may not be represented, which will require questions covering these areas to be added. Alternatively, it may be found that gaps in questions are in fact covered by the evidence. Where questions exist that represent a process not already listed in eMM, that process may be added for future eMM iterations. This set of activities is non-trivial. An equivalent exercise is also necessary for deriving evidence-based practices appropriate to the pilot situation and from which assessments of a process can be made.

The pilot approach developed at Manchester should yield a self-contained, comprehensive set of questions for producing a structured evidence matrix for a UK HEI. What is described here is the basis of a transferable technique for adapting eMM to take account of differences in local structuring and availability of evidence when a whole institution is considered. This can be done without compromising the integrity or comparability of any results generated by this method. Initially eMM may not appear to cover some issues of immediate concern to UK HE. However, there are a number of ways that specific educational issues can be investigated within the framework:

- A process can be identified for inclusion in the master process list.
- The place of specific issues in individual processes can be assessed through the practices assigned to each process dimension.
- The question list can be modified to include specific questions related to the issue.

Each of these has its own implications for continued long-term comparability and integrity of eMM and to address this there is a need for a continuing dialogue between eMM practitioners. To preserve the integrity of eMM as a method, the master process list should be subject only to minimal changes. In general, practices that reflect
specific issues gradually become absorbed. Additionally, it is common that practices that at one time are regarded as diagnostic of particular dimension or levels of maturity may become absorbed and then regarded as the norm across the sector. They therefore lose their discriminating and diagnostic power. Additionally, it is possible that as a novel practice becomes part of a routine it in fact ceases to indicate any particular level of maturity. Given the fluidity of the practice model, it is a good approach for specific issues to be appropriately aligned and represented within the practice database, and continually reviewed. This also supports the role of benchmarking as a key tool for driving change in practice within an organisation. However it is important that the integrity of the mapping of a question set to processes array is not compromised by random addition and removal of questions, which can result in gaps and incomplete analysis. Therefore it is preferable if changes to the question set are done in a version-controlled manner that is accompanied by a full re-mapping exercise.

Figure 4 summarises the pilot project process. It identifies each activity (ellipse) in the process of piloting the method from initial collection of process information and associated practices through to the final refined method based on evidence from Manchester. The figure shows also the artefacts (rectangles) used at each stage as well as those produced by the pilot project activities.

Figure 4 The eMM pilot method
The principle documented outputs from the pilot are:

- A set of processes organised into five process areas
- A set of process related questions used to elicit evidence
- For each process, a set of practices that are used to describe and distinguish level of capability at each of its dimensions
- For the set of processes, a corresponding matrix of evidence that is available for determining the nature and status of practices across the dimensions.

Figure 5 illustrates the nature of the processes within one of the process areas, that of Learning. Ten processes are used to cover this process area. Figure 5 also shows an anonymised set of results of capability levels for an institution. A quick visual inspection reveals those processes which are relatively strong or weak and those processes where unusual patterns of capability are evident.

<table>
<thead>
<tr>
<th>Learning</th>
<th>Processes that directly impact on pedagogical aspects of e-learning</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1.</td>
<td>Learning objectives are apparent in the design and implementation of courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2.</td>
<td>Students are provided with mechanisms for interaction with teaching staff and other students</td>
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<td></td>
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</tr>
<tr>
<td>L3.</td>
<td>Student skill development for learning is provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L4.</td>
<td>Information provided on the type and timeliness of staff responses to communications students can expect</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L5.</td>
<td>Students receive feedback on their performance within courses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L6.</td>
<td>Research and information literacy skills development by students is explicitly supported</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>L7.</td>
<td>Learning designs and activities result in active engagement by students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L8.</td>
<td>Assessment of students is designed to progressively build their competences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L9.</td>
<td>Student work is subject to specified timetables and deadlines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L10.</td>
<td>Courses are designed to support diverse learning styles and learner capabilities</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Figure 5: Patterns of capability across the processes

An example of the sorts of practices that are used to determine such capability levels is given in Figure 6 which shows practices relating to the Learning process area.

An example of the evidence that is used to reach a judgement about a practice that relates to two processes in the Learning Process Area is shown in Figure 7.

5. Reflections on the plot

The pilot had two related aims. First was to provide a vehicle for change management within the institution so that it can move to a continuous process of improvement in teaching and learning. There are already indications of the opportunities and challenges in doing this. It is clear that institutional buy-in to the change is needed across the institution from executive level to course development and administration level. Not only do practices relate to each level but the whole philosophy of the approach assumes a move to a connected organisation. The cultural, interpersonal, procedural, educational and technical aspects of teaching and learning are all the subject of change and for the method to be effective these aspects of an organisation have to be managed. Adopting eMM is not a soft or quick option. The second aim was to inform the HE sector as part of the sector-wide initiative on benchmarking e-learning. The key point here is to get over the idea that eMM is one method that has
a particular purpose and function. That purpose serves well the ambitions of a large university seeking radical change and seeking to align operational aspects of processes in a systematic manner. It will not answer all needs and applied inappropriately will be an expensive mistake. For those institutions for which it is appropriate the pilot will provide a robust, thorough and rational method.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Practice examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>5: Optimisation</td>
<td>Information on success of courses as measured by the stated learning outcomes is used to inform and support the design and (re)development of courses, programmes and degrees.</td>
</tr>
<tr>
<td></td>
<td>Strategic planning of teaching and learning across the institution is used to determine new or modified outcomes that are promulgated to courses, programmes and degrees.</td>
</tr>
<tr>
<td>4: Management</td>
<td>Information is collected on the extent to which courses are providing learning objectives that address the full range of cognitive outcomes appropriate to the course and students.</td>
</tr>
<tr>
<td></td>
<td>Courses are regularly reviewed to ensure that staff are incorporating learning objectives in course design and delivery consistent with the expectations of the institutional policies, guidelines and standards.</td>
</tr>
<tr>
<td></td>
<td>Performance of students against the expected outcomes measured using a variety of qualitative and quantitative metrics.</td>
</tr>
<tr>
<td></td>
<td>Regular reviews of course learning objectives undertaken to ensure currency and effectiveness.</td>
</tr>
<tr>
<td>3: Definition</td>
<td>Institutional policies require that a formal statement of learning objectives is part of all course documentation provided to students.</td>
</tr>
<tr>
<td></td>
<td>Teaching staff are provided with training, guidelines and examples for developing learning objectives that address the full range of cognitive outcomes appropriate to the discipline, pedagogical approach and students.</td>
</tr>
<tr>
<td></td>
<td>Teaching staff are provided with training, guidelines and examples in assessing student outcomes and the extent to which learning objectives are being met.</td>
</tr>
<tr>
<td></td>
<td>Training, templates, examples, standards and guidelines are provided on how to use learning objectives explicitly in the design and delivery of courses in order to assist student learning.</td>
</tr>
<tr>
<td></td>
<td>Institutionally defined graduate attributes exist and are referenced in policy guiding course, programme and degree design, development and delivery.</td>
</tr>
<tr>
<td>2: Planning</td>
<td>Programme or degree planning and review processes consider the relationship of learning objectives of individual courses to those of the programme or degree as a whole.</td>
</tr>
<tr>
<td></td>
<td>Statements of learning objectives are explicitly requested in institutional templates for course summaries and documents such as course prospectuses or syllabi.</td>
</tr>
<tr>
<td></td>
<td>Course planning and review documentation explicitly refers to the learning objectives when assessing the course and making any decisions about the course structure, learning design and content.</td>
</tr>
<tr>
<td></td>
<td>Course design activities reference the learning objectives and use them to determine the nature and relationship of content, activities and assessment used in the delivery.</td>
</tr>
<tr>
<td>1: Delivery</td>
<td>Learning objectives are provided explicitly in the formal descriptions of the course provided to students, including the summary versions provided prior to enrolment as well as within detailed course prospectuses or syllabi.</td>
</tr>
<tr>
<td></td>
<td>Learning objectives are linked explicitly throughout learning and assessment activities using consistent language.</td>
</tr>
<tr>
<td></td>
<td>Learning objectives for individual courses or modules are explicitly linked to wider programme or degree objectives and institutional graduate attributes.</td>
</tr>
<tr>
<td></td>
<td>Learning objectives are aimed at supporting student outcomes that go beyond recall and acquisition of knowledge.</td>
</tr>
<tr>
<td></td>
<td>Course workload expectations and assessment tasks are consistent with the learning objectives.</td>
</tr>
</tbody>
</table>

Figure 6 Practices in the Learning Process Area (Marshall 2006a)
Table 1

<table>
<thead>
<tr>
<th>Learning Objectives are apparent in the design and implementation of the course</th>
<th>1. Learning Delivery</th>
<th>2. Planning</th>
<th>3. Definition</th>
<th>4. Management</th>
<th>5. Optimised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course outline (C); Courses assessment description (C).</td>
<td>Course outline (C); Courses assessment description (C); Project Protocol (P).</td>
<td>Faculty e-learning strategy (S); teaching and learning strategy (S).</td>
<td>Student questionnaires (E); teaching and learning strategy (S).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course outline (C); Courses assessment description (C); Student questionnaire (E); WebCT discussion groups (C); Student support website (E).</td>
<td>Course outline (C); Student support website (C); Student guide to e-learning (E).</td>
<td>Faculty e-learning strategy (S); teaching and learning strategy (S); Netiquette/Email policy (F); Student Feedback (E).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evidence Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Course content and resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Policies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>Procedures and planning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Reviews and Reports</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Evaluation &amp; Feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Quality Assurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>Staff Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD</td>
<td>Project Documents</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 7  A sample of evidence in the Learning Process Area

One of the merits of the method is the intrinsic life cycle approach. No doubt the method could be developed to address only limited aspects of the lifecycle and especially for the purpose of comparison with other benchmarking methods it could be applied either partially or redeveloped to focus on particular areas with additional metrics and criteria. However, this would in some ways abandon the logic of the method which is firmly rooted within a lifecycle concept. One of the characteristics of e-learning that has emerged has been a realisation that a lifecycle approach is necessary if we are to manage the complex array of issues and processes required for successful delivery (Dexter, Petch and Wilcox, 2004). The eMM method aligns well with this philosophy for educational engineering and in fact is seen as one part of the repertoire of tools that must underpin such an approach. A mapping of eMM on to an e-learning lifecycle model based on the Rational Unified Process model (Dexter et al. 2004) shows that all the main elements of the lifecycle are in fact covered by eMM.

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Interactive Nonlinear Learning Environments

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Abstract: E-learning materials often have a linear design where all learners are forced into a single-mode pedagogy, which is contrary to the interaction that occurs in face-to-face learning. Ideally, e-learning materials should be nonlinear, interactive, contain context-sensitive and active learning elements, and accommodate various learning levels and styles. This paper presents an educator's perspective on approaches to designing such e-learning materials, which are essential to enhancing the education of future generations of students.

Keywords: Interactive, nonlinear, e-learning environments, active learning

1. Introduction

1.1 Effective and intelligent use of information technology in e-learning

Modern tools of information technology provide excellent opportunities for creating engaging e-learning environments. In recent years, online learning via Internet has increased substantially. However, computer-based learning materials tend to have a linear or sequential design where all learners are forced into a single-mode pedagogy. This is in sharp contrast to the pedagogy and interaction that occurs in individualised face-to-face learning. Simulating the teaching and learning process between educator and learner is difficult in an electronic medium such as the Internet, which, in essence, replaces one page of information for another each time a link is selected. Presentation software also promotes a linear “next/previous” page pedagogical style. Ideally, computer-based learning materials should be nonlinear, interactive, contain context-sensitive and active learning elements, and accommodate various learning levels and styles (Lee et al. 2004, Swaak et al. 2004, Phelps 2003, Chen and Macredie 2002). Such e-learning environments, in which the educator's pedagogical approach and expertise are encoded into the design, represent an effective and intelligent use of information technology for learning environments where each student is guided during their independent study. This goal is extraordinarily difficult to achieve, especially since educators are often not adept at computer programming or using other tools required to achieve such a goal. While the technical aspects of e-learning are often performed by technical personnel and instructional designers, such personnel do not have the pedagogical expertise of an experienced educator. Therefore, the perspective of the educator in designing nonlinear interactive learning materials is essential.

During the past 15 years, I have researched and used various approaches to e-learning and explored many promising information technology tools that initially showed great promise and yet proved unsuccessful. Other tools and approaches ultimately proved to be very effective at enhancing learning. Rather than simply a matter of selecting the appropriate information technology tools, effective e-learning materials fundamentally stem from the educator's pedagogical expertise and close personal interaction with the learner. Still, linear learning designs – whether custom-designed or commercial learning systems – dominate e-learning education. In order to significantly enhance the e-learning educational experience for future generations of students, information technology must be effectively and intelligently used for learning materials that are: (1) interactive in the sense of context-sensitive responses to the learners actions, (2) nonlinear so that learners can determine their own learning path, and (3) actively engage learners of different levels of base knowledge.

1.2 e-Learning and the science curriculum

My primary field of expertise is in the science of ecology, which integrates all aspects of the biological and physical components of nature. Principles from disciplines such as chemistry, biochemistry, physics, geology, geography, botany, zoology, and biology are used for the understanding of how organisms respond and adapt to their environment. Students must be able to integrate biological levels that range from the molecular to the individual with ecological processes that include the physical environment (climate, temperature, wind, solar radiation, etc.), interactions among organisms (e.g., competition, herbivory, predation, and parasitism), and the structure and function of whole ecosystems. Thus, the integrative nature of ecology makes this science ideal as a model for nonlinear interactive learning environments.
Understanding of ecological principles relies heavily on the visual elements of nature (photographs and video of plants and animals, sounds of animal communication, animations of processes, etc.). Thus, effective learning designs in ecology should include a blend of multimedia elements, e.g., digital audio, video, scientific and conceptual graphics, and animations. The inclusion of context-based audio clips and cues can significantly increase the rate of learning and retention of understanding (Mayer et al. 2005, Marente and Mayer 2004, Mayer et al. 2003, Mayer and Anderson 1991). The latter appears to be applicable to a variety of subjects in e-learning.

Computer-based presentation software, Internet editors for creating online learning sites, and many commercial courseware systems tend to emphasise a linear and sequential pedagogical approach. This is particularly the case if default templates are used to create the learning materials. Although the linear or sequential designs are certainly the most straightforward and easiest to develop, I have found these of limited value in simulating the teaching-learning process between educator and learner. Because I believe the future of computer-based learning will require a very different and sophisticated pedagogy, my research on enhancing the science curriculum with information technology has focused on authoring systems that allow educators to encode their pedagogical approaches and expertise into learning materials. Using such authoring systems, I have developed a comprehensive suite of interactive nonlinear learning modules in the science of ecology for a learning audience that ranges from the non-scientist to undergraduate to graduate level learners in ecology. Learners via course sites on Internet access these learning materials. Although I have not conducted a formal evaluation study on the use of electronic learning materials in my courses, these learning materials have been used and evaluated by hundreds of students over the past decade. The interface for my learning materials has been developed and refined with the input of students. Student performance on examinations for on-campus students and online students is comparable. Also, students and instructor are able to have a more flexible learning schedule with this type of e-learning.

Although my scholarly work has focused on the use of information technology for enhancing the science curriculum, my work can serve as a model for a variety of disciplines with relevance in several areas: (1) significant potential for scaling to large enrolments without additional human resources or time commitments, (2) the ability to accommodate a variety of learning levels, styles, and paces from the same learning module, and (3) a student-centred learning model that is considerably more flexible than the fixed class and semester schedule.

2. Learning models

2.1 Linear learning models

The dominant learning design in e-learning, whether in the form of lecture presentations or course sites on Internet, employ a two-dimensional linear or sequential pedagogy (Figure 1).

![Figure 1: Two-dimensional linear learning model.](image)

All learners are forced into this single-mode pedagogy, which has a specific starting and ending page. The instructor predetermines the flow of information between the starting and ending pages. Such designs follow a very logical flow of information from elementary to more complex topics, very much in the mode of the traditional printed textbook – chapter 1, 2, 3, etc. In contrast to the traditional printed textbook, however, the e-learning material can only be used in the predetermined linear manner. A learner can open a printed book to any page and turn to any other page, but there is no connection or logic between randomly opened pages in the book. Since all learners have to follow the single-mode design, the linear design does not accommodate various different learning levels and styles. Novice, intermediate, and advanced learners all begin at the same point, and proceed through the learning material in the same path. Only the pace of learning may differ because the more advanced learner may proceed through the learning
materials at a faster pace than less advanced learners. This, however, is only the case if the pedagogical design allows learners to actually proceed at their own pace. If the instructor designs the e-learning course so that the entire class must advance together, the advanced learner can only proceed at the average pace of the class.

The three-dimensional linear learning design is a variation that includes ancillary information elements on each page (Figure 2). Each page may contain an ancillary set of information elements such as definitions, comments, and images. Although this design may appear somewhat nonlinear, all learners, regardless of their initial knowledge base and learning style, still follow the same main learning path from start to end pages as predetermined by the instructor. As in the two-dimensional learning model in Figure 1, the simple “next/back” pedagogical approach does not allow the learner to skip among pages at will – only back and forth between two adjacent pages.

These additional elements may be comments, side notes, definitions, or images. Within each page, the learner thus has access to an increased set of information that is related to the main page of information. However, the learning path is fundamentally still linear as described above for Figure 1.

![Figure 2: Three-dimensional linear learning model.](image)

For learners who require a high level of guidance in their learning, the linear designs shown in Figures 1 and 2 can be highly effective. Information is presented in a logical manner from the elementary level to increasingly more complex levels. In some cases, it may be advantageous for the entire class to advance at a particular pace. Also, in many cases, this type of pedagogy occurs in large-enrolment classes where the instructor leads all learners through the material in the same way and pace. Learners at all levels of education are accustomed to this format and thus linear e-learning designs are a familiar extension. However, e-learning via the Internet provides great potential to accommodate learners of various abilities and levels.

### 2.2 Nonlinear learning models

As an educator, I believe that a fundamental goal in education is to provide each learner a personalised learning experience that accommodates learners of different abilities, initial knowledge base, and learning styles. With traditional teaching styles in the traditional classroom, such personalised teaching is often not possible. This is especially the case in large-enrolment courses. Ideally, education should have a pedagogical approach that approximates the personalised relationship between tutor and learner. If used intelligently, the emergent tools of information technology have the potential to realise this ideal education experience.

In contrast to the linear learning models where all learners follow a rigid path (see Figures 1 and 2), nonlinear or nonsequential learning designs shift the responsibility for mastering a particular subject to the learner. The instructor may provide guidance to the learner and determines the level of mastery. However, the learner is responsible for mastering the subject through a self-determined path and rate. Such a learner-centred pedagogy will ultimately be more effective than the instructor-centred pedagogy (Felder 2005).

The design of nonlinear learning environments is inherently difficult and complex. In such designs, learners should be able to select any entry point in the subject (similar to opening a book to any page), and directly move to any other point in the subject at will (Figure 3). Ideally, learning is individualised because each learner designs their own learning path and pace by the choices the learner makes. Information is divided into packets instead of sequential pages. Although this learning model may contain some “next/back” navigation, the learner can navigate in any direction among information packets. The information packets are connected in a coherent
manner so that ancillary information that is necessary for learning (definition, images, audio, video, etc.) can be accessed directly. This design can accommodate linear and nonlinear learning styles, novice to advanced learners, and a path and pace set by the learner – not as predetermined by the instructor.

This is similar to randomly selecting any page in a printed textbook and then moving directly to any other page in the book. However, with interactive computer-based learning materials, the information on nonsequential “pages” is connected in a rational manner so that the learner has a coherent learning experience. That is, each information packet has extensive connections to other information packets. This is also known as hypertext or hyperlinks. However, rather than simply resulting in the navigation to a subsequent page (i.e., the “next/back” navigation model), a selection of a hyperlink may initiate a variety of actions: (1) display a definition or other related information on a layered or “pop-up” subwindow, (2) play context-relevant audio or video, (3) display an image, or (4) display additional context-relevant information in text form. In this three-dimensional design, the learner’s attention remains focused on the main subject while having direct access to ancillary information through subwindows.

Figure 3: Three-dimensional nonlinear learning model.

2.3 Authoring systems for developing three-dimensional learning environments

Authoring systems such as Toolbook Instructor 2004 by SumTotal Systems and Macromedia Director are sophisticated computer software programs that allow educators to design three-dimensional learning models. Although linear learning designs can easily be developed with these authoring systems, these programs are highly suited for designing nonlinear learning materials with sophisticated feedback to the learner. While the learning curve for authoring systems is relatively high as compared to presentation software or Internet page editors, the most time and effort will be devoted to the planning phase. Imagine an interactive nonlinear learning environment that truly accommodates a variety of learning styles and levels, and where learners determine their own path and pace toward mastery. Such a learning environment requires a relatively large investment of time in the planning phase.

3. Integration of multimedia elements for enhanced learning

3.1 Static elements

In addition to the interactive nonlinear design of the learning environment, the use of visual elements is very important for understanding complex information and concepts (Mayer and Jackson 2005, Mayer et al. 2005). However, the key to the effective use of visual elements is the
integration of these elements in a context-sensitive manner. For example, scientific and conceptual graphs that occur in isolation (e.g., on a separate page or “pop-up” window of an Internet browser) are not as effective as when such visual elements are fully integrated with text and/or other multimedia elements (see below). This is particularly the case for the sciences. Many processes and relationships in ecology, e.g., rely heavily on the graphical display of data. In print media, the context of the visual elements is primarily based on the position of elements on a page of text. Computer-based learning materials provide more precise positioning so that visual elements can be displayed in context to the learner’s actions. Furthermore, the visual elements that are displayed in response to the learner’s actions can be individualized for that learner so that novice learners may be shown visual elements in more elementary form, while more advanced learners may be shown more complex visual elements. As is the case for any e-learning design, the expertise of the educator for the design and use of visual elements is a significant factor in their effectiveness (Mayer et al. 2005).

3.2 Animations and visualisation

The ability to animate visual elements, whether two- or three-dimensional animations, adds a significant learning dimension that is not possible in print media. Scientific and conceptual illustrations that move can be highly effective for understanding dynamic processes. In biology and ecology, e.g., blood flow, molecular actions, nutrient cycling, energy flow in the environment, and the structure and function of ecosystems are some examples where animations can be particularly effective. However, simple animations with “start/pause/stop” controls are not as effective as interactive animations with audio that respond to the learner’s actions. Such interactive animations are similar to computer games, which are essentially continuous animations that respond to the game player’s actions. In this manner, interactive animations can be highly effective because there are immediate consequences and feedback to the learner’s actions. For example, in an interactive animation on the ecology of a rainforest, a consequence of the learner’s actions may include extinction of a species or other changes in the rainforest. Such context-sensitive feedback provides opportunities for learning that do not exist in static print media or static visual elements in e-learning.

The emerging field of visualisation represents an advanced form of animation. The goal of visualisation is to simulate a process in a three-dimensional, photorealistic, quantitative, and interactive manner. Visualisation is also known as virtual reality, in which the learning is positioned within the simulated process or scene. Visualisation models are commonly used to model various processes in physics, aerospace, medicine, and the military to understand complex interactions and systems. While visualisation is an extraordinarily powerful tool, the technology is still relatively difficult for educators to use routinely. The required high-powered computer systems are expensive and the software is relatively complex. However, this emergent field has great potential for e-learning in the future.

3.3 Audio and video

The principal communication component of face-to-face learning that is largely absent from e-learning is audio. When audio is fully integrated and interlaced with text-based and visual information, it can add an important dynamic dimension to e-learning environments. Thus, audio can significantly enhance static and animated visual elements. An extensive body of literature in educational psychology indicates that the predominantly text-based learning environment of online courses is in direct opposition to the way humans learn most effectively: audio narratives reinforced with visual elements (e.g., Mayer et al. 2005, Mayer et al. 2003, Reynolds et al. 2002, Moreno and Mayer 2000, Mayer and Anderson 1991). This research demonstrates significantly increased learning rates and knowledge retention occurs when audio is added to visual elements. However, high quality audio cues and narratives are largely absent from online education. This is largely due to three fundamental obstacles: production time, cost, and poor voice training of instructors. As consequence, the principal components of even the most comprehensive course Internet sites remain largely text-based with some multimedia elements. Courses with “chat” or discussion groups are entirely text-based and require intensive reading of text on a computer screen.

Using current technology and methods to produce high quality audio lecture (e.g., similar to professional radio broadcasts with no errors, extensive pauses, “uhhs”, or “ums”) for online learning may involve many hours of production time for each one hour of completed audio lecture. With few exceptions, the audio is recorded impromptu with no editing or refinement. This is primarily due to the extraordinarily high production costs and limited expertise among faculty members for creating high quality voice recordings up to the standard of broadcast radio. Thus, an entire semester-long course online can amount to a considerable investment of time for the instructor. Revisions of audio lecture involve
the same amount of time and effort in order to maintain recording quality and consistency. Even highly edited audio recordings will reflect the deficiencies of the instructor (poor voice quality, diction, and tonal quality); instructors with speech impediments or non-native English speakers are at a particular disadvantage for producing high quality audio narratives for online learning materials. A new technology with extraordinary potential to resolve these fundamental obstacles is enhanced synthetic speech, which is remarkably human-like in voice quality and expressiveness. Although many businesses (e.g., telephone companies, airlines, and corporations dealing with international clientele) are rapidly adopting synthetic speech technology, such technology is lacking in e-learning for the general learner and especially for learners that are reading and vision disabled (Harrysson et al. 2004).

A key advantage of synthetic speech is the substantial reduction in production time for the original recording and for any subsequent revisions. Producing audio with this technology for online learning materials is a straightforward procedure of digitally recording the audio that is produced as the synthetic voice software reads and speaks written text. A variety of voices are commercially available: variations of male and female voices, various English accents, and various international languages. The voices are highly expressive and human-like; pronunciation can be fine-tuned for special terms within a discipline. This completely eliminates the inherently poor quality of instructors' voices in audio recordings. The appropriate selection of a synthetic voice — or a combination of several different voices — can result in a high-quality audio lecture for any instructor. In fact, one instructor could create multiple dialogs and discussions among virtual instructors or students, even with a mixture of female and male voices. Students could even select a particular voice for their learning environment. This approach to integrating synthetic speech is also highly relevant to emergent technologies such as “pod casting,” where audio narratives are transmitted to personal audio players. Thus, integration of synthetic speech into online learning materials presents extraordinary possibilities for enhancement of teaching and learning.

Short video clips and streaming video lectures can also be very effective in e-learning. However, high-quality video clips also have relatively high production time and costs; revisions over time can lead to inconsistencies in the presentation. High-quality streaming video requires relatively high Internet transmission speeds. In contrast to video, audio can be more precisely integrated into learning materials for context-sensitive feedback that can range from short cues, pronunciation, and definitions, to extensive explanations to the learner while the learner reads, studies, and interacts with the text and visual course content.

4. Accommodation of different learning levels and styles

4.1 Context-sensitive responses

An important aspect of engaging and interactive learning environments is context-sensitive feedback to the learner’s actions. Authoring systems (see above) provide built-in features that allow educators to easily design question elements with context-sensitive feedback and immediate evaluation (e.g., scoring of a question or an examination). Moreover, authoring systems allow the educator to design learning materials that emphasise active learning. For example, the inclusion of simple true/false and multiple-choice questions — whether inserted as context-sensitive elements within course content or provided as part of an examination — result in a passive learning style. The learner simply responds to the question by clicking the appropriate answer. In active learning, question elements can be designed so that the learner must move question elements in a particular manner in order to achieve the correct answer. For example, the learner may be asked to construct the molecular structure of a chemical from a set of chemical components. Or, in the field of ecology, the learner may be asked to construct the appropriate sequence of events (environmental factors, plant and animal species, etc.) that occur in the development of a forest from bare ground. In these examples, the learner is actively engaged in developing the solution to the question. At any point during the solution process, the learning environment can be programmed to automatically provide feedback to the learner in a manner that is relevant to the actions of the learner. Evaluation of learner's achievement and performance is also automatic, i.e., a customised evaluation for each learner is provided without additional input by the instructor. Because the feedback and evaluation are context-sensitive and automatic, the learning environment is independent of the number of learners. That is, scaling from small to large numbers of learners is possible without increased instructor time and effort.

There are a variety of ways to design and use context-sensitive elements in a learning environment. My approach has been to create discrete packets that combine a question that the learner answers and a response that evaluates
the learner’s answer (Figure 4). This packet combines a question to the learner, the learner’s answer, and the response to the learner from the professor into a discrete unit. These packets can be inserted anywhere in a lesson to evaluate the learner’s comprehension of the subject matter. Also, control codes can be used to easily branch various learners among novice, intermediate, and advanced learning levels.

A control element is added to the packet to control the type of branching that occurs through the lesson. Rather than the conventional pedagogical method of placing study questions at a particular point in the lesson (typically at the end of a section), context-sensitive control packets can be placed anywhere in the lesson. These packets can be actively presented to the learner based on what the learner is doing, or passively, where the learner has the option to initiate the question or not. This approach allows fine control over the flow of the lesson and evaluation of each learner’s progress toward mastery of the subject matter.

![Figure 4. An example of a context-sensitive branching control packet.](image)

Furthermore, the control aspects of the context-sensitive control packets can be used for complex branching patterns to dynamically shift learners among various learning levels, e.g., novice, intermediate, and advanced (see Section 4.2 below). Each learner’s performance in a particular part of a lesson would determine the material that is subsequently presented to the learner. In this way, a learner who consistently exhibits a high level of mastery is continually presented with learning materials at the highest level and difficulty. In contrast, learners at the novice and intermediate levels would be presented learning materials at a level suitable for their learning style and pace. The various paths these learners take would continually progress toward the advanced level and on to mastery. The appropriate placement and number of control packets would influence the level of correspondence between the learner’s interaction with the context-sensitive control packets and progress toward mastery. All learners could eventually master the subject matter.

### 4.2 Branching patterns in e-learning designs

The personalised instruction that occurs between instructor and learner is lost as the number of learners per instructor increases from one to many. In the case of the typical classroom or online course, all learners are essentially instructed in the same manner, regardless of differences in base knowledge, learning ability, and learning styles. Interactive nonlinear learning models have the potential to resolve this issue of scale by context-sensitive branching patterns (Figure 5). Such designs can automatically detect a learner’s base level of knowledge and subsequently branch each learner to the appropriate level of subject content, testing, and evaluation. Also, because the learning design is
nonlinear, each learner can determine his or her own learning style and pace. Such designs thereby simulate the individualised learning that would occur between an instructor and learner.

The learning design automatically detects the base level of knowledge of each learner and branches him or her to the appropriate level of subject matter. For example, novice learners may require the presentation of content at a more elementary level than for intermediate or advanced learners. All learners eventually reach the advanced level of content, which leads to mastery of the subject matter.

The primary goal of this branching model is for all learners to achieve the level of mastery of the subject matter set by the instructor. Regardless of their starting base of knowledge, all learners will eventually – at their own pace – achieve sufficient understanding to learn at the advanced level of subject content. Although Figure 5 illustrates only one learning cycle toward mastery, such a learning cycle can exist for each and every level of learning. By continuously alternating between content, examination, evaluation, and review, all learners will achieve mastery of the subject matter.

5. The third dimension in learning environments

Printed learning environments, e.g., textbooks and articles, typically present materials in a segmented manner in an order determined by the author (e.g., table of contents, chapter one, two, three, etc., and index). Computer-based non-linear learning environments (see Section 2 above) allow significantly greater flexibility for accommodating a variety of learning levels and paces. Typically, the designs are composed of a series of bifurcated pathways through which the learner navigates (e.g., Figure 3 above). By extending this to a three-dimensional design, I envision a learning environment as a sphere containing an entire set of information on a topic – including all appropriate multimedia elements (photographs, graphs, text, audio, video, and numerical data, etc.). A key difference from bifurcated pathways is that learners are free to select the starting point of their learning session anywhere on the sphere, rather than at a point determined by the instructor. In addition to selecting the starting topic on the sphere for a learning session, the information can be designed to be increasingly more detailed and complex as the learner probes deeper into the sphere. Thus, one learning sphere can accommodate the spectrum of novice to advanced learners.

Figure 6. The concept of a three-dimensional learning sphere that represents a complete set of information on a topic.

The topic could be narrowly focused (e.g., analogous to a book chapter) or very broad (e.g., analogous to a complete book). All appropriate multimedia elements are included. The learner can select any entry point into the learning sphere and navigate directly to any other subtopic.

With more comprehensive learning environments that address a variety of topics, many learning spheres can be integrated into a lattice framework (Figure 7). A variety of learning spheres are positioned onto the lattice by the instructor. Each learning sphere represents a complete topic that includes all information and appropriate multimedia. Even though the possible pathways in the lattice are predetermined by the instructor, learners can develop their own unique pathway among the learning spheres for an individualised learning experience. Fundamentally, the learning lattice represents the universe of knowledge...
determined by the instructor; the connections in the lattice are rigid and represent the possible navigation pathways. The instructor positions any number of learning spheres on the lattice, thereby increasing the knowledge base integrated into the lattice. Even though the lattice has rigid navigation pathways, learners can develop their own unique pathway among the learning spheres for an individualised learning experience. The instructor can continually add more learning spheres as well as increase the size of the lattice to increase the universe of knowledge available to the learner.

Figure 7. A rigid lattice that represents the universe of knowledge on a particular broad topic.

6. The total interactive learning environment: Guided independent learning

The nonlinear learning model combined with multimedia elements, context-sensitive feedback, and branching, has culminated in a comprehensive e-learning environment that I call guided independent learning. This pedagogical approach is learner-centred (Felder 2005), where the learner is primarily responsible for their learning toward mastery. Also, because my pedagogical approach and expertise are encoded into learning materials, learners are guided during their independent study. The learning materials that I have developed combined all the attributes described in the above sections and are available for review at: EcologyOnline.net. The learning materials I have developed are primarily for the science of ecology. However, these learning materials can serve as a model for e-learning in other subjects.

Learning materials that incorporate the interactive nonlinear designs I have discussed above provide a powerful pedagogical approach that simulates a highly individualised instruction for mass education. That is, individualised instruction is not a function of scale in regard to numbers of learners. The key pedagogical elements of guided independent learning are that: (1) the learning materials are learner-centred so that the learner is primarily responsible for mastering the subject material, (2) the instructor’s pedagogical approach and expertise are encoded into the e-learning materials, and (3) the learning design is interactive, nonlinear, integrates multimedia elements, and contains context-sensitive feedback.

7. Conclusions

Although modern tools of information technology provide excellent opportunities for creating engaging e-learning environments, the dominant pedagogical approach for e-learning involves a linear or sequential design where the instructor determines a single-mode pedagogy for all learners. The emergent tools of information technology provide great potential for designing computer-based learning materials that are nonlinear, interactive, contain context-sensitive and active learning elements, and accommodate various learning levels and styles. When the educator’s pedagogical approach and expertise are encoded into such learning designs, each learner can be individually guided in their
independent study toward mastery. Even though the technical aspects of designing e-learning materials can be difficult for educators, it is essential to master the various tools of information technology in order to appropriately provide the educator’s perspective in effective e-learning materials.

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References
Designing Online Instruction for Success: Future Oriented Motivation and Self-Regulation

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Abstract: Given the high rate of student drop-out and withdrawal from courses and programs using an online learning format, it is important to consider innovative ways to foster and encourage student success in online environments. One such way is to incorporate aspects of student future orientation into the design of online instruction. This paper presents an overview of a program of research examining whether perceptions of student motivation, self-regulation, and future time perspective can be positively influenced through future oriented instruction in a blended learning (semi-virtual) environment at a German university. Individual differences in student future time orientation can provide insight into this interesting connection between the influence of attitude toward time on motivational and self-regulatory processes in learning. In conclusion, the practical implications of this topic for the design of online learning environments must be considered: Increased effort needs to be taken for developing methods for online instruction to tap into and encourage the future orientation of students, and for providing meaningful connections to the content and possible future outcomes. This paper intends to provide insight into and examples of how an online course or semi-virtual programs can benefit from a future oriented design.

Keywords: e-learning; future time perspective; self-regulated learning; blended learning

1. Introduction

Mintzberg (2004) asserts the need for management education that delivers flexible, experiential and hands-on opportunities for personal development – not just in areas identified by industry executives and managers, but in areas that are vital for optimal functioning in a knowledge society throughout the lifespan. This means the capacity and competency for learning. The challenges for educators to encourage and foster the internal self-regulated, motivated and managed processes enabling life long learning are immense, yet not impossible. Online instruction using web-based technology deals with the aspect of flexibility, but what about experiential and authentic learning? The use of future oriented instruction in blended learning environments offers an innovative method for achieving this goal. The following sections provide an overview of key concepts relating to the theory of time perspective, future time perspective, and provide an example of research applying these concepts to online instruction using a blended learning format. In conclusion, recommendations are presented for how operation of these concepts can be achieved within a framework of a program-wide initiative offered at the University of Applied Management (UAM) in Germany (UAM Milestones Educational Model).

2. Time perspective

The study of time perspective deals with how the flow of human experience is parcelled into temporal categories, or time frames, usually of past, present and future (Zimbardo and Boyd 1999). Although there is a growing body of literature focusing on time perspective, lack of unity on definitions of concepts and terminology is an inhibiting factor in development of the theory – one literature review has identified 211 different conceptualisations of time perspective (McGrath and Kelly 1986). For this current study, time perspective is defined as a cognitive operation involving both an emotional reaction and a preference for locating action in a specific time frame (Lennings 1998). Further insight into this cognitive operation can be gained by examining other research relating to the field (Husman and Lens 1999), explaining the emotional component through the aspect of attitude (an individual’s positive or negative outlook concerning time), and preferential time frame through the concept of orientation (preferential temporal direction in thought and action) to either past, present, or future.

Zimbardo and Boyd’s theory of time perspective (1999) sub-divides the time frames of past, present and future into 5 different possible perspectives (see Figure 1). This theory operates on two primary assumptions: first, that both individuals and environments operate with identifiable time perspectives; and second, that individuals will function optimally when they are able to act congruently with the time frame of a given environment. A good example is an educational environment, which by definition is heavily focused on the future (Husman and Lens 1999) – a central issue for the research presented in this paper. In order to achieve successful performance in school related tasks, a student...
must be able to function effectively within a future time perspective. Furthermore, new educational environments, such as online and web-based learning increase this future requirement in the necessity for intense self-directed functioning. This will be discussed later in greater detail, but it is important to emphasise the flexible and adaptable characteristic of time perspective: it is neither fixed nor permanent; it is learned, and allows for a flexibility of behaviour contingent upon individual values and beliefs, and the demands of a specific situation or context (Boniwell and Zimbardo 2004).

Figure 1: 5 distinct time perspectives according to Zimbardo and Boyd (1999)

Operating from a social cognitive perspective of education (Bandura 1986; 1999) where people are viewed as self-organising, proactive, self-reflecting, and self-regulating, not just reactive organisms, formed and controlled by external events (see Pintrich and Schunk 2002 for a detailed review), this type of optimal social functioning hinges upon achieving a balance of self-regulation and sustained motivation. A key factor providing insight into how to achieve this equilibrium is the examination of attitudes and perceptions of the future – namely future time perspective (FTP).

3. Future time perspective – An overview

Husman and Lens (1999) in their foundational article on the role of the future in student motivation, define FTP as the integration (method and degree) of the chronological future into the present life-space of an individual through motivational goal-setting processes. They have identified four important figures in the development of the literature base. The information in Table 1 summarises their findings. The common feature across all of these theoretical concepts is the importance of goals and planning for the future.

Table 1: Fundamental concepts found in foundational literature on FTP

<table>
<thead>
<tr>
<th>Theorist</th>
<th>Fundamental Concept Relating to FTP</th>
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<tbody>
<tr>
<td>Lewin:</td>
<td>goal setting is closely related to time perspective – individual goals include future expectations</td>
</tr>
<tr>
<td>Fraisse:</td>
<td>importance of individual beliefs in the possible realisation of the future</td>
</tr>
<tr>
<td>Nuttin:</td>
<td>connection of psychological future to motivation (future = time quality of the goal object)</td>
</tr>
<tr>
<td>Gjesme:</td>
<td>FTO = capacity to anticipate the future (including cognitive elaboration of plans and projects), reflecting concern, involvement and engagement in the future</td>
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According to Nuttin and Lens (1985), it is important to think of individual FTP in terms of its extension, density and degree of realism. Extension (also referred to as habitual time space) refers to the amount of time that is considered when making plans, resulting in goals being located either inside or outside of the “habitual time space”. The importance of “inside” goals is much greater than goals that are “outside” in terms of how close and distinct they appear.
Therefore, having an extended habitual space will influence the perception of long-term goals, making them appear to be closer and more important. Density relates to the amount of goals that an individual plans to achieve, and realism refers to whether these goals and plans are realistic or not. The concept of goal-setting is a defining factor in motivational literature, yet exactly how far into the future these goals should reach for optimal performance is unclear and a subject of debate. On one side, goals close to the present (proximal) are encouraged; on the other side, goals that are achieved further in the future (distal) are seen to be the most powerful.

3.1 FTP, Goal-setting and instrumentality

The ability to conceptualise a plan for the future and be affected by long-term future goals is a critical component of motivation (Miller, DeBacker, and Greene 1999; Husman et al. 2000; Simons et al 2004 for reviews), and many popular studies have focused on the topic addressing effective goal-setting. A crucial aspect identified in this literature is goal proximity – how far ahead in the future will the goal be achieved? The literature implies that goals taking less time to achieve will have greater motivation than goals taking longer to achieve. This could be a logical conclusion considering the aspects of challenge, difficulty, and perseverance, but only if FTP is not accounted for (especially the aspect of extension).

Research examining future goals is growing, and many studies examine aspects of value and utility – or instrumentality (Husman et al 2004; Miller and Brickman 2004; Simons et al 2000 for a detailed review). The premise supported by these studies maintains that the degree of task value increases when a present task is viewed as “instrumental” to achieving a relevant goal in the more distant future. Miller, DeBacker and Greene (1999: 250) have identified two key functions of future goals that provide a foundational basis for the current program of research described later in this paper: ‘(1) future goals provide the impetus for the formation of systems of proximal sub-goals; and (2) future goals represent important incentives for present action, but only when current tasks are perceived as instrumental to attainment of those future goals’. Miller and his colleagues expand on Bandura’s (1986) combination of distal aspirations with proximal self-guidance in personal development stating that ‘having a context of personally valued future goals in which proximal sub-goals are imbedded not only makes pursuit of the future goal possible and attainment feasible, it gives meaning to our proximal behaviour; for without future goals to guide the generation of proximal goal systems, human behaviour would be guided only by immediate needs and immediate consequences’ (1999: 251).

3.2 Barriers and limitations to FTP

Potential inhibitors of FTP competency have been identified, including formation of goals that avoid learning or performance (Elliot and Harackiewicz 1994), and negative views, attitudes, beliefs or values about the future (which may be culturally determined, see McInerney 2004). Zimbardo and Boyd (1999) in their theory of time perspective acknowledge that a “temporal bias” may occur, which could severely inhibit the ability to flexibly switch temporal frames among past, future and present depending on situational demands, resource assessments, or personal and social appraisals. Two time perspectives (see Figure 1) are identified in the Zimbardo Time Perspective Inventory (1999) that, when biased, can lead to negative life consequences (such as mental health problems, crime, or addictions) in the predominantly future-orientation of western society: present-hedonistic (reflecting a risk-taking, reckless attitude focusing on present pleasure with little concern for future consequences) and present-fatalistic (reflecting a helpless and hopeless attitude toward the future and life). In academic environments requiring goal-setting and self-directed and regulated learning, rigidity in either of these time perspectives could cripple learning processes – from a disregard for the future (hedonism) or from a complete relinquishment of control, responsibility, or anticipation for all goal directed behaviour (fatalism).

3.3 FTP and academic success

Research by Shell and Husman (2001) examining the relations between FTP and control beliefs, academic achievement and studying of college students (N=198) found that FTP beliefs have a positive effect on motivating achievement and studying. Malka and Covington (2005) in their program of research in three studies confirmed the potential of perceived instrumentality to predict unique variance in achievement independent of other motivational variables. Therefore, they encourage educators to explore the benefits of nurturing perceived instrumentality within instructional interventions. Husman and her colleagues (2004) in their examination of the relationships between instrumentality, task value, and intrinsic orientation in college students (N=207) found that these three unique motivational constructs impact each other in specific ways, and are supportive. In their investigation intrinsic motivation was the most significant predictor of task value, and they encourage further research on the relationship...
between instrumentality and task value. Ultimately, their research is important in solidifying the motivational differences between an activity’s value for the present and value for the future. In another study on the dynamic interaction between college students’ (N=103) volitional strategy use and perception of instrumentality, Husman, McCann and Crowson (2000) confirmed that the relationship between these two constructs grows over time (1 semester). The study encourages further research in a dynamic framework regarding the complex relationships between instrumentality, academic performance, strategy use, and how these might promote and support each other over time.

3.4 Summary
Much of the research presented in this overview has explored the relationship between the motivational constructs of perceived instrumentality, intrinsic motivation and task value. Perceived instrumentality has been confirmed as a valid predictor of key motivational factors: task value (Miller et al 1996); intrinsic motivation (Husman, et al. 2004); achievement (Malka and Covington 2005); volitional and self-regulatory strategy use (Husman, et al. 2000). These studies have stemmed from the intent to identify perceived instrumentality as a unique construct worthy of research in motivational research, and have been successful in achieving this goal. Fostering perceptions of instrumentality within instructional interventions is an aspect that has not been explored in the literature on FTP, and such research is needed. Miller and Brickman (2004) view such future oriented instruction as a critical factor in promoting increased proximal motivation in students.

4. Research examining future oriented instruction
One of the few studies dealing with the effects of future oriented instruction (Schmidt, in press) examines whether perceptions of student motivation, self-regulation, and future time perspective can be positively influenced through future oriented instruction in a blended learning (semi-virtual) environment. Using a convenient sample of first-year undergraduate business students in blended learning (semi-virtual) courses at a German university, Schmidt employs both quantitative (self-report surveys) and qualitative measures (semi-structured interviews) over two semesters. A central element in Schmidt’s program of research is the focus on instrumentality as instructional content. Building on the social cognitive model of future oriented motivation and self-regulation presented by Miller and Brickman (2004), Schmidt emphasises the cyclical nature of complex goal systems and their interaction with instrumentality as a supportive construct increasing the relevance and value of proximal activity for distal goal achievement. As students develop goals for distal future achievement occurring through the accomplishment of proximal subgoal systems, instrumentality plays a key role in solidifying the connection between the here-and-now and the distant future. Conceived as supplementary instruction to any course, future oriented instruction was implemented within a required course (Personality Development and Self-Management – PDSM) dealing with life and career goals, along with time-management strategies.

Future oriented instruction for the treatment group consisted of the following:
- A simple heuristic tool for determining the value and relevance of coursework: stepping stone, hurdle, and hoop
- Explanations on proximal and distal goals presented and discussed in group coaching sessions, including successful implementation strategies
- Worksheets encouraging self-reflection and assessment, as well as individual practice in effective goal-setting (proximal and distal)
- PLUS – regular instruction for PDSM

Instruction for the non-treatment group focussed solely on future goals (for life and career) and time management strategies – no explanations or materials were provided dealing with future orientation, instrumentality, proximal and distal goal systems, and their application in academic environments. The findings presented by Schmidt (in press) that are relevant to the topic of designing successful online instruction are as follows:
- Future oriented instruction increases awareness and understanding of time perspective, instrumentality and distal/proximal goal systems: qualitative interview data analysis revealed that students in the treatment group receiving future oriented instruction were better able to articulate their awareness and understanding of the factors listed above.
- High-FTP increases the likelihood for higher self-reported levels of performance-approach goal orientation, metacognitive self-regulation, strategies for managing time and study environment, and help-seeking strategies: regression analysis of quantitative self-report survey data indicated that having higher levels of FTP positively influenced the learning process factors of goal orientation, self-regulated learning, and effective strategy use.
Low-FTP (high Present-Hedonistic or Present-Fatalistic) increases the likelihood for higher self-reported levels of mastery-avoidance and decreases the likelihood of help-seeking; regression analysis of quantitative self-report survey data indicate the potential negative influence of time perspectives associated with low levels of FTP (see Zimbardo and Boyd 1999).

These findings are valuable to the field of instructional design, especially in the creation of online learning environments. Inclusion of FTP and future orientation, as well as other related concepts such as instrumentality and proximal/distal goal setting can promote positive learning processes necessary for high level performance and achievement. The increased awareness and understanding of factors such as time perspective, instrumentality and distal/proximal goal systems occurring through future oriented instruction provide support for increased research activity in this area. Furthermore, these findings identify FTP concepts as supportive to other positive learning process variables identified from previous research, specifically that learning and achievement improves when students operationalise positive goal orientations (Elliot 2005), and when students take independent initiative in learning activities through metacognitive self-regulation and effective use of learning strategies (Pintrich and Zusho 2001). Even with such positive results, an important question to consider is “who benefits the most from future oriented instruction?” The research conducted by Schmidt (in press) appears to emphasise the generic benefits of FTP and future oriented instruction for all learners. However, another more targeted interpretation can be made attributing such instruction as being most beneficial to learners with low levels of FTP. Functioning without high FTP in a high FTP environment (Husman and Lens 1999; Zimbardo and Boyd 1999) can mean low levels of instrumentality for immediate tasks and activities, and possible negative impact on learning processes.

Compensation for this can occur through future oriented instruction which emphasises and supports the connection between distal and proximal goal systems, increasing the instrumentality for immediate tasks and activities (which has been shown to have positive impact on learning processes). Further research is needed in this area to validate these interpretations and findings. The following section provides an overview of a multi-level model (see Figure 3) for implementing future-oriented instruction within higher education degree programs, of which the program of research by Schmidt represents the course level: other programs of research are in progress assessing implementation of future orientation at the program level (including cross-program measures), as well as pre/post program participation in extra-curricular offerings within blended learning environments.

5. Implications for designing online instructional environments

Online learning presents many advantages, such as easy access, flexibility, and the opportunity to study while remaining engaged in full-time employment. However, even with such advantages, there are still reports of high (from 50 to even 70%) drop-out rates (Schmidt 2004; Wang et al 2003: 2). Some speculations as to why students do not continue with online educational programs include lack of face-to-face contact with instructor and peers, and a deficit in academic self-discipline and motivation required for success in distance learning environments. Stark and Mandl (2003) contend that students are often ill-prepared for the demands of online learning environments, and lack sufficient meta-cognitive abilities to successfully reflect, control or organise their own learning activities (especially concerning time management). Blended learning is a good example of how online instruction can be improved in response to the problems of virtual (online) instruction. It attempts to combine the advantages of both face-to-face (onsite) and online instruction (other terminology can also be found in relevant literature, such as “hybrid”, “mixed” and “semi-virtual” instruction; see Osguthorpe and Graham 2003; Garrison and Kanuka 2004 for detailed reviews). Conceptualising effective instructional measures for the use of blended learning environments involves the application of two main concepts: authenticity and method.

Mintzberg (2004) presents an overview of effective pedagogy using this spectrum to increase the amount of real experience opportunities provided to students (see Figure 2). This figure presents concrete examples of activities for students in a framework that steadily increases the level of authenticity or situational context required (resulting in an active student role). It has been modified by including traditional forms of learning (focus on the teacher, resulting in a passive role for students) at the beginning in order to emphasise the comparison to computer and web-based online instruction.

Given the research relating to the positive effect that high levels of intrinsic motivation, task value and self-regulatory ability (as presented in the preceding sections of this paper) have upon
student achievement, efforts need to be made within instructional environments to foster and encourage growth in these areas. One way to achieve this is to incorporate elements of future oriented instruction into the design of online learning environments.

Figure 2: Pedagogical Scale of Authenticity (based on Mintzberg 2004, p266)

5.1 Future oriented design of online and blended learning environments

Efforts need to be increased for developing methods of online instruction that tap into and encourage the future orientation of students, and for providing meaningful connections to the content and possible future outcomes. Figure 3 provides a detailed overview of the UAM Milestones Educational Model offering a framework for concrete operational examples of how online instruction (teaching techniques, course, and program) benefits from a future oriented design.

Figure 3: UAM Milestones Educational Model
This model outlines the forms of student support (raising awareness; providing feedback and advice) that are possible within typical university degree programs on a spectrum of time. It is presently in operation at the university participating in the program of research presented in section 3 which examined only one course (PDSM) out of an entire program-wide initiative.

- Activities to help students access the job market:
  - Job application training
  - Interview training
  - Assessment Centre training

Post-Study Counselling:
- Consultation and advice on how to continue personal development and growth in meaningful ways that help students identify new goals, move toward professional activity or continued study, connect to a relevant network of experts in the chosen field, and to maintain contact with the institution to share in the exchange of new expertise and knowledge.

5.2 Future oriented teaching techniques

Many of the measures listed and described above in the milestones model rely upon general teaching techniques that encourage and foster student motivation through the development of distal and proximal goal systems that emphasise task and course instrumentality, impacting an overall program. Some helpful elements to consider are listed below with concrete examples of possible activities. They are by no means comprehensive, and can easily be combined or added to other methods by using the full scope of instructional tools and technologies that are available.

5.2.1 Encourage high levels of perceived relevance (course and task)

Course Level
- Present course material embedded within a framework of the overall field. Provide a meaningful introduction that outlines the benefits and uses of such knowledge for future endeavours (consider using various media – video, audio, web-pages, internet, etc.)
- Invite experts from the field to join a discussion forum (e.g. host a chat session on FAQ’s) or to participate in the evaluation of student projects or presentations (e.g. panel of judges).
- Assist the students in recognising peer expertise and relevant experience with the chosen topic (creation of student profiles, reflections on past experiences and/or prior knowledge, etc.).

Task Level
- Whenever possible assign tasks that are constructive in nature, making connections to real concrete examples (e.g. case studies, role plays, observations, simulations, etc.)
solidifying the connection between theory and practice.

- Provide opportunities for students to develop their own autonomy, control and responsibility for learning (task variety, topic choice, format of end product).
- Open-ended projects and/or portfolios (multiple assignments of which only the best are calculated in the final grade)
- Meaningful task sequencing (linking of tasks to create a useful portfolio or resource for continued use or reference).

5.2.2 Encourage effective self-regulation of learning processes

Forethought Phase (planning)

- A wide array of management techniques exist that can assist students in goal-setting, idea generation, task scheduling, etc. Online environments have an advantage of offering instant access to these methods and techniques (make use of links, documents for further self-study, open source material, etc.). Figure 4 is an example of a Gantt Scheduling Chart – one of many planning tools that could be presented to students as a resource (adapted from Dessler 2005: 90).

![Gantt Scheduling Chart]

Figure 4: Gantt Scheduling Chart

Performance Phase (self-observation)

- Include assignments that are non-graded but peer-reviewed – this often encourages students to be aware of the quality, without having the pressure of always satisfying instructor criteria for top marks. Caution is warranted with this activity – practice and guidance is necessary so that students are constructive, positive and working together to create successful learning experiences.
- Use the internet to help locate self-study exercises and programs that could be added to current instructional activities. Students who are interested can improve at their own pace and continue to explore the subject area in a meaningful way.

Reflection Phase (self-evaluation)

- Provide opportunities for reflection – online, onsite; synchronous, asynchronous – many vehicles are available, from journals, logbooks, short “lessons-learned” reflections, discussions, forums, chat-rooms, blogs, etc.
- Guidance in reflection also is helpful – model this activity as a reflective practitioner (e.g. student newsletter, ongoing forum for discussion, informal opportunities outside of the course, etc.)

5.3 Conclusion

As research in educational psychology continues to identify factors that positively influence student motivation to learn, and the subsequent steps that are taken to acquire new knowledge, parallel efforts in research are necessary in designing possible instructional interventions incorporating these factors in concrete operations within a learning environment. Future oriented instruction is one possibility out of many to consider, but it has great potential to support and improve student learning and achievement within online learning environments. Management education cannot stop at the end of formal training or educational programs. It must be integrated into the internal self-learning processes of the individual resulting in personal development over the life span. Therefore, the role of educators using web-based technologies is to continually seek to provide effective means of encouraging and fostering this learning competency within the design of online instructional environments.
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Watch out - the Power Users are Coming

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Abstract: This paper analyses and discusses the future challenges that tertiary educational institutions may expect to face when the traditional organisational forms and norms of the industrial society meet the first generation of natural born ICT using students who have lived their whole life with ICT and the ever changing norms and demands of the unfolding information society. In order to analyse the premise for these challenges the paper applies a long-term perspective on the generations and organisations affected by the transmission. A key to gain insight to the future students and the nature of the encounter is research aimed at the present primary school. Additionally a key to the organisational perspective is identification of organisations’ readiness for change and the potential barriers for adaptation to the information society and the ‘power users’. Based on the analysis, the paper comprises an outline of institutional obstacles inhibiting a successful encounter and argues the necessity of integrating top-down and bottom-up initiatives in future organisations. Thus, the process of change demands awareness and support from both the authorities empowered to make grants and from the management of the educational organisations, and the paper explicitly focuses on collaborating teaching staffs as a tool for improving both individual and organisational adaptability.

Keywords: ICT, Power users, game generation, university pedagogy, collaborative teaching staff, adaptability to change, information society

1. Introduction

In a 4th grade at a Copenhagen suburb primary school, the class gathered data about the weather for a couple of weeks. The data was entered into a database and on the day I visit, the class was going to use the database as a tool for analysis and to produce narratives about the weather. Emilie and Camilla are working together on one computer. They have several windows open in both the database program, Google and Word, the last of which they use to produce their narrative. They have produced a graph displaying hours of sunshine each day and ask me, "what about the days where the sun did not shine?" "You could compare your graph with a graph of days with precipitation", I suggest. Emilie looks at the apparent mess of windows on the screen. "Like this", she says, and shows me a graph displaying both sunshine and precipitation. "We thought that we could only have one thing in each graph". "This is good", I say, "Try to find out what it tells you".

Later when I return to Camilla and Emilie, they have Googled an illustrative photo and they have designed a layout for their narrative about the weather. On the days with neither sun nor precipitation, they have concluded that it must have been cloudy. (unpublished research data from the PIL project at The Danish University of Education, 2006)

The story illustrates ICT’s learning potential as these children (age 9 and 10 years) multitask and handle complex and relatively abstract information as they navigate between applications and multiple windows within these applications. They manage to design a layout for the narrative, discuss the wording and spell correctly. Dependant on the sophistication of their competencies, Sørensen (2005) describes these kids as either ‘competent’ or ‘power users’. The kids represent a process, where the educational system’s traditional, hierarchical ‘food chain’ from teacher to inexperienced pupils and students, seems to disintegrate into horizontal networked relations.

2. The emerging problem

The changing relationship between pupils and teachers is one phenomenological representation of society’s change from industrial society’s educational and organisational top-down practice, to the information society’s more flexible and horizontal network-organisation. In the latter, roles are intertwined and informal learning processes become common (Trilling and Hood 2001). Although children still organise learning hierarchies that resemble formal learning environments (Sørensen 2005), what is new here is that kids learn and use ICT, which is paramount for dealing with and participating in the emerging information society, and that their teachers do not. The generation born before 1970 has acquired all knowledge of computers as adults. Those born after 1970 - ‘The Game Generation’ (Prensky 2001) - are more ICT-competent, but they have acquired their wireless and mobile competencies as adults. Also, The Game Generation (GG’s) is too young to possess influential positions in tertiary educations and most teachers, in schools and in higher education, do not possess the knowledge and competencies that can make the ends meet in a future educational system. Thus, teachers in tertiary educations will soon find them selves caught between on one side: Students who integrate ICT in their everyday lives, possess...
advanced competencies and expect ICT to be n; and on the other side: Research institutions and companies that correspondingly expect candidates to be ICT-competent beyond the level fully integrated in their education of informal learning, that students can acquire on their own.

Figure 1: Model illustrating the field of tension challenging the educational system

Figure 2: Generation gab-model based on simple demographics and duration of job life-circles

The conflicts arising are not just a matter of contrasting societal paradigms. The paradigms are embedded in the generations and as figure 2 illustrates, the process bridges a generation gap that may continue for decades. Thus, organisations' readiness for change becomes highly important.

3. Empirical studies of universities readiness for change

Recent studies of universities and their institutional awareness of and readiness towards change imposed by the societal transformation revealed some obstacles constraining that process, both in terms of ICT, organisational support, and the teachers' attitude. The Rambøll Management Report for the EU (2004, pp. 10) divides European universities into four clusters based on their integration of ICT: Front-runners (16%), Co-operating universities (33%), Self-sufficient universities (36%), and Sceptical universities (15%). The Rambøll Reports' levels of readiness towards changes (table 1) corresponds well to Rogers' (1995) categories of acceptance of innovation in a population: innovators (2.5%) and early adopters (13.5%), early majority (34%), late majority (34%), and laggards (16%), telling us that: 1) necessary changes can only be pushed to a certain point without engendering counterproductive resistance; 2) processes of necessary fundamental changes must be supported and facilitated rather than forced.

Table 1: Rambøll management report, university clusters
Similar to the co-operating universities as regards ICT integration but have a larger group of sceptical teachers. Much less involved in co-operation with other universities or actors and place less emphasis on EU initiatives and new forms of co-operation. The Rambøll study found that these universities are engaged in strategic co-operation only to a very low extent. 28% of the self-sufficient universities are quite large, with more than 20,000 students each.

These universities are lagging behind the rest in almost all respects. They are characterised by limited use of all kinds of digital services. Additionally, only 13% of these universities have developed a formal ICT strategy. The attitudes towards ICT are mixed, with substantial numbers of teachers and management being sceptical.

Three studies of Danish universities published in 2005 support the conclusions in the Rambøll Report. Derup et al. (2005) found that all twelve Danish universities use ICT in the organisational setting, while the implementation of ICT in teaching differs. Learning Management Systems (LMS) are mostly used as tools for course organisation, administration and document sharing. Only few Master Programmes are either online or blended mode. Levinsen (2005a) found that the universities strategy plans for implementing ICT and e-learning were ill-defined, and in-service training for teachers displayed low capacity of participators pr. time unit. These courses prioritise introduction to technology and software such as PowerPoint and LMS-basics, while neglecting pedagogic issues related to online teaching and general use of ICT. Levinsen (2005b) found that in 2003, the number of courses and Master Programmes including e-learning was low (38 courses and 13 Master Programmes). Most were only one or two semesters old and some were offered for the first time in 2003. In late 2004, the numbers rose steeply: 125 courses and 60 educations (inc. Master Programmes). When examining the content using Feltovich et al.’s distinction between well- and ill-structured knowledge domains (1996), it was found that courses using ICT were clustered around training skills and well-structured knowledge domains, while educations and Master Programmes contained more complex and ill-structured knowledge domains.

It was also found that Danish university teachers, who in 1995 had adopted ICT, comprised a small and identifiable group (The Danish Government’s IT Plan of Action, 1995). Although the group of teachers using ICT has grown since then, the above mentioned ‘innovators’ are still dominating the picture. Thus, recently trained ICT-using teachers still belong to the ‘early adopters’, leaving the majority of present Danish university teachers in Rogers’ three groups: ‘early - and late majority’, and ‘laggards’. Additionally, many teachers maintain an ‘industrial society’-attitude towards in-service training, as they insist on learning by attending instructional courses (Sørensen 2005). Thus, findings in the literature point out that neither organisations nor teachers are in general ready for change and adaptation to the future of ICT and ‘power users’.

4. Teachers readiness for collaboration and change

The challenges that both organisations and teachers face can be described as a radical learning process (e.g. in terms of Piaget’s Accommodation, Argyris’ Second Loop Learning, Vygotsky’s Dialectic Learning or Engeström’s Productive Learning). It is generally agreed that this kind of radical transformation is best facilitated within knowledge-sharing environments such as Communities of Practice (Wenger 1998). In a formal context such as tertiary educations this is typically a collaborative teaching staff. Accepting the premise that radical learning transformation needs a collaborative environment, teachers’ readiness to engage in a collaborating teaching staff with their colleagues becomes an area of importance.

A recent unpublished qualitative study (Personal information from M. Pedersen at Copenhagen Business School (CBS) Learning Lab) displays two extremes among teachers when they were asked about collaborating with their colleagues. These teachers had attended an in-service course where experiments with teachers’ collaboration were part of the learning objectives. Few teachers reported that they had continued to collaborate after the course, that they felt their students had profited and they were positive towards the thought of a collaborating teaching staff. Others said outright that: “Why should I participate in a collaborating teaching staff?” – “It works fine for me and my students” (Author’s translation). Some of these latter teachers represent the ‘late majority’ and the ‘laggards’ with acquired ICT-competencies, the ones who (according to Rogers) display not only a resistance towards changes but are also the embodied ‘industrial
society'-approach to learning. Other teachers from this latter group represent the GG’s. The CBS study found that GG-teachers use advanced ICT, collaborative- and group pedagogy, and they act as facilitators and coaches for their students. To some extent GG-teachers fulfil the demands of the information society, just as GG’s are said to “make great workers...and great employees” (Silverthorne 2004), while paradoxically at the same time they reject to collaborate with their colleagues and display an attitude which Silverthorne (2004) describes as highly individualised - “It is all about me”.

In relation to the generation gab illustrated in figure 2, the GG-teachers’ attitude becomes important, as they constitute the next generation of politicians and decision-makers in tertiary education. First of all it is necessary to take a closer look at the organisation of teaching staff in order to identify what it is exactly these teachers think work and why, and what they reject and why.

4.1 Teaching staff organisation – two general patterns

In higher educations the teaching can be organised in various ways both online and on-campus. When looking at the ways teachers collaborate - in degrees of collaboration - we (M. Pedersen and the author) found two distinct extremes which can illuminate the spectre, 1) The collaborating teaching staff and 2) The individualised teaching staff. The collaborating teaching staff can be found at certain Master Programmes in Denmark. The teachers come from different institutions, but know each other from earlier contexts. They work together because they have chosen to do so, and they have designed their Master Programmes within a social constructivist and problem-oriented group pedagogic frame (Dirckinck-Holmfeld 2002). In Rogers’ terms these teachers are ‘innovators’ and ‘early adopters’ and they are the innovators from the 1995 Danish Governments IT Plan of Action. The organisation of their collaborating teaching staff is mirrored in their pedagogy as well as in the collaboration among students and between students and teachers.

The individualised teaching staff can be found at large universities with large institutes (Gleerup 1997), and in an extreme form at large courses attended by 500 or more students at CBS. These large courses have their own top-down organisation where one single person who is responsible for the subject matter has defined the course, content, learning objectives, and evaluation criteria. These courses are subdivided into parallel tracks, each attended by a teacher, who is only responsible for running that particular track. The teachers manage their own track, and there is no formalised collaboration between the tracks. These teachers are often part-time assistant professors, and they generally do not have daily communication, neither to the workplace nor with colleges. The closest they get to genuine collaboration is sharing PowerPoint presentations.

4.2 The course participators and the individualised teaching staff

When asked about where they acquired their teaching skills the GG-teachers replied that they never had any courses in university pedagogy. They relied on their own experience from school and university. Most of them had tried group work and remembered collaborative group work as good learning experiences. They deemed this approach the best solution in their own teaching – but in a self-taught and not theoretically grounded variant. A reflection on the nature of the memory the teachers refer to, may explain why they practice group oriented collaborative pedagogy, and at the same time do not see collaboration as something tied to the teacher’s role. These teachers have experienced collaborative pedagogic approaches as students. From that position, they remember themselves as participators in a group with an inner dynamic and synergy, which drives the project forward to a shared goal beyond the achievement of the single individual. This is what the teachers want to offer their own students on the single track. At the same time they remember an inspiring teacher and supervisor, and this is how they would like to be viewed by their own students. However, the teacher they remember appeared as an isolated individual without a context regardless of the actual context at that time and place.

When the GG-teachers draw on experiences from their own past, they draw on an image of an individualised and isolated teacher. It worked well then, it works well now so they see no contradiction in that practice. From the GG-teachers’ point of view there are few incentives for collaboration with colleges. Additionally, the organisation of the courses as parallel tracks and the part-time status reduce the teachers’ incentive to collaborate. Thus, arguments for participation in a collaborating teaching staff are scarce.

4.3 Looking for answers in the literature

Until recently, literature has focused on the students and their preconditions for attending studies. A recent trend is to focus on teachers’ competencies in relation to exploiting the potential of ICT and thus perform teaching within the frame
of the information society’s demands (Laurillard 2002, Levinsen 2003, Salmon 2003, and Sørensen 2005). When applying ICT and particular in relation to CSCL and CSdCL the teachers’ competencies are challenged, and it is generally agreed that the change from traditional attendance classes to implementing ICT in various forms of networked collaboration, presupposes re-education of teachers. The latest trend is to look at how teachers collaborate and communicate about the development and carrying through of e.g. online courses. Bang and Dalsgaard (2005) demonstrate how genuine collaboration among teachers in four Danish primary schools supports the development of both knowledge-sharing and teaching methods. However, in the paper “Farvel til den ‘privatpraktiserende’ lærer?” (Goodbye to the ‘privately practicing’ teacher?), which refers to the universities, Heilenes and Lerche (2005) asks:

“If we want to facilitate a scenario, where students are seriously and emphatically involved in net-based dialogue and/or mutually binding project collaboration and elaboration of a shared product, it is essential that we as teachers become conscious of the culture we communicate. Can we expect collaboration, interaction, and knowledge-sharing among our students, if we behave individualistically and do not dare to participate in mutually binding collaboration ourselves?” (Author’s translation)

The question of course is rhetorical, and the implicit answer is that we cannot expect collaboration among students if teachers do not collaborate themselves. Heilenes and Lerche see the culture and tradition in the universities as an obstacle preventing teachers from collaborating about their teaching, as well as an obstacle against practised collaborative learning pedagogy. Gleerup (1997) also points at the long tradition of ignoring pedagogy in tertiary education. The consequence is that the majority of teachers today are self-taught. Furthermore, Gleerup points out that the tradition of drawing boundaries around single subjects rather than around cross-disciplinary fields still dominates the educational systems and preserves the pedagogy of the closed door. These traditions, which are rooted in the industrial society’s understanding of learning and education, are identified as obstacles against collaboration among teachers, both regarding knowledge-sharing of teaching experiences and regarding development of teaching the subjects and knowledge domains. Thus, literature offers a background for understanding the current situation, but no arguments for initiating collaborating teaching staffs in the future.

4.4 In search of good reasons - why should a ‘privately practicing’ gg-teacher change practice?

The GG-teachers at the CBS-course confirm Gleerp’s statement that self-taught teachers perceive themselves as responsible for a subject and thus do not see any need to collaborate with their colleges. Heilenes and Lerche’s rhetorical question, and Bang and Dalsgaard’s demonstration of how development of methods depends on collaboration, would not make any sense to the ‘late majority’ and ‘laggards’ or the ‘GG-teachers. Neither would they be motivated to change attitude towards their job as teachers. The basic problem is not to persuade these teachers to accept that a collaborating teaching staff would be beneficial for the teaching practice as such. When the GG-teacher at the CBS-course asks back: “Why should I do that when everything works fine?”, the truth is that at present, there is no satisfactory answer. The personal experience does not correspond with the scholars’ findings and claims. From the GG-teachers’ point of view everything works well, the students collaborate, ICT use is advanced and there is no paradox. The teachers’ individual practice and relationship to an individualised teaching staff is, contrary to the claims in the literature, neither a precondition for nor a barrier against the information society-approach to learning. Thus it becomes relevant to ask whether there are other good reasons why the ‘privately practicing’ teacher should change practice.

5. Educational product development – towards a new paradigm

In the preface of a forthcoming anthology “Kvalitetsudvikling af videregående uddannelser” (Developing Quality in Higher Education), C. Nygaard writes that the aim of the book is to establish a paradigm for continuing development of education. In this paradigm, students’ learning process is the focus and the institutions are responsible for developing the study content and quality. Institutions of tertiary education are not isolated from society and Nygaard argues that the relationship between ICT ‘power user’ students and teachers in the role as coaches becomes highly important, because the students learning process is not only focused around understanding of and reflections on the educational content. In the information society, graduated students are expected to demonstrate adaptability, readiness for change, life long learning, and the ability to practice the educational content innovatively and independently. Therefore students must acquire a comprehensive academic knowledge, which is applicable in their future jobs. It is more important
to know about why and who, while the how becomes less important as it is constantly changing. The how is where the independent and innovative use of academic competencies comes to the test. Where Sørensen (2005, see above) described this from the present perspective of the primary school, Nygaard describes it from the future perspective of tertiary education. In order to offer education that meets these demands, education itself must be subject to constant improvement and innovation. In order to educate the future employees and entrepreneurs as flexibly and knowledge-sharing collaborators, teachers and institutions are bound to act flexible and knowledge-sharing and they are bound to be able to manage ICT at a high level. Thus, Nygaard argues, it is in relation to the improvement and innovation of educations that collaborating teaching staffs are not only advisable but an inevitable necessity.

6. Discussion
Bang and Dalsgaard (2005) explains the relationship between collaborating teaching staffs and innovation using Vygotsky’ and Engeström’s Activity Theory. Table 2 shows the application of their approach on the CBS teachers and their situation:

Table 2: Activity theory applied on the CBS context

<table>
<thead>
<tr>
<th>Activity theory</th>
<th>CBS teachers and their situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A cooperative division of labour</td>
<td>Parallel course tracks at large courses at CBS</td>
</tr>
<tr>
<td>can perform a joint activity</td>
<td>A joint course consisting of individual parallel tracks at CBS</td>
</tr>
<tr>
<td>The participants and other interested parties</td>
<td>Teachers, students and study board at CBS</td>
</tr>
</tbody>
</table>

Even though the participants and interested parties at CBS are satisfied, this particular and similar ways of organising education do not possess the necessary preconditions for adjustment and development. The joint activity functions well as long as the conditions for performing the isolated parallel tracks are unchanged – just as the teachers’ state in the interviews. However, changes do occur and during this process the teachers do not have a comprehensive overview of the whole, and they are therefore cut off from efficient action. Figure 3 shows a model, which demonstrates the blind spots produced by this kind of fragmented organisation.

Figure 3: Model demonstrating blind spots inside a fragmented organisation

The individual teacher’s position implies a first person singular observer perspective, but this first person perspective has some blind spots. It cannot observe how external events may influence the joint activity or the single track, and it cannot observe the parallel tracks. The surrounding organisational observer-position implies a third person plural observer perspective. This third person perspective has a blind spot too. Being outside it cannot gain the necessary insight into how things work in the practice. Changes can be implemented top-down but we cannot be sure that practice develops according to our intentions. In order to grasp how educational systems are interrelated and interact with the external environment, it is necessary to include an internal participating first person perspective and a general shared perspective implying a collaborative we looking at us rather than a hierarchical we looking at them. Integration of
perspectives is a strategy, which compensates the blind spots of the isolated perspectives and offers the ground for an innovative approach to the changes. That is, the constitution of Communities of Practice securing the negotiation of meaning across boundaries, using brokers and boundary objects (Wenger 1998).

The above analysis demonstrates that the encounter between educational systems, the future ICT ‘power users’ and the information society’s demands is a very complex field. It cannot be expected of any individual teacher to rise to this kind of challenge alone, and therefore it is not an isolated question about how to persuade ‘late majority’, ‘laggard’ and GG-teachers to change their practice. This is also a question of how to address and persuade the ‘Self-sufficient’ and ‘Sceptical’ universities to change their overall organisational practice. In organisations still operating according to the industrial society paradigm (remember that ‘Self-sufficient’ and ‘Sceptical universities’ ≈ 50% of all European universities (Rambøll 2004)), the management can be expected to choose the top-down – hierarchical third person – approach when dealing with the problems caused by the unfolding information society. Thus, collaborating teaching staffs are not only a good idea; it is the Holy Grail for product development of educational courses in the information society.

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