A Novel Approach to Define Performance Metrics for Students’ and Teachers’ Evaluation

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Abstract: Evaluation is an unavoidable feature in any teaching or learning scenario. The evaluation strategy of students differs widely throughout the world. Further, most of the institutes do not use any objective technique to assess the teaching performance of a teacher. The present paper defines performance metrics both for student and teacher evaluation and also discusses the methodology for calculating relevant metrics. In a decision-making scenario, these metrics may help in providing enough insight into the assimilation capability of students and teaching capability of teachers. Once measured properly for an adequate length of time, these metrics can also be customised to provide other useful information like utility of a course modification, institutional performance etc. The system has been tested for analysing four courses in a premier engineering institute and the outcome found to be encouraging.

Keywords: education technology, evaluation system data warehouse, performance metric, ontology

1. Introduction

In any educational institution, besides regular teaching and learning activities, evaluation is a matter of utmost importance. It can be defined as “a series of procedures carried out to collect information about learning experiences on the basis of which recommendations can be made to improve the quality of the services provided” (Edwards 1991). It is not only important from the students’ point of view; rather the performance of the whole institute depends on the evaluation techniques. The objectives of an evaluation process can be summarised as follows (Harlen 1978, Deale 1975).

- To gather information about a wide range of student characteristics as feedback for making decisions about the learning environment, especially in the context of matching experiences to individual students.
- To accumulate information which will enable to define progress (or lack of it) and corrective actions to be taken, if required.
- To provide information to a teacher, which will help him/her in judging the effectiveness of his/her teaching with respect to individual students or groups.
- To inform other teachers who may have to make decisions about the students.
- To compare progress of students under different teachers.
- To compare new teaching materials with old and finally to help in developing an efficient and effective teaching policy.
- To allocate students to streams or sets based on their competence in different branches of their course.
- To inform employers or higher education institutions about attainments.

The present research on intelligent and automatic evaluation techniques mainly concentrates on automatic evaluation of computer programs (Benford et al 1993, Foxley et al 1998, Brusilovsky et al 1996) or mathematical problems (Sapir 1999, Xiao 1999). It has also been tried to evaluate free text answers based on different text processing methods like keyword based analysis (Burstein et al 2001), pattern matching techniques (Ming et al 2000) etc. In Alfonseca et al (2001) the BLEU method of machine translation system is used for evaluating free text answer, but the method does not work properly for certain kind of questions (like asking yes/no or advantage/disadvantage like questions). In VanLehn (1997), an evaluation technique is presented which is based on the student model. The evaluation technique in VanLehn is mainly concerned with the extent of assimilation of concepts. The inference mechanism of the system is based on Bayesian Network. The system has been demonstrated for physics only and it deals with 290 physics rules. But the approach does not seem to be scalable for a large number of concepts. The existing systems have the main focus on the assessment techniques of students. Unfortunately, there is hardly any universal mechanism that can
give the best assessment. In Reddy (2004), “Analytical Hierarchical Process” is used for calculating accurate weightage for theory and practical examinations and the approach is claimed to be universal across institutions. But in all cases, two major aspects of evaluation have been ignored (Biswas and Ghosh 2005) namely,

- Assessment of teachers and teaching policy.
- Defining a universal metric to measure the performance of students and teachers irrespective of a particular course, subject or institution.

Both of these factors are extremely important from an institutional point of view. It is a common observation that students prefer some teachers than others based on various reasons. So there should be an objective mechanism to measure the teacher’s teaching performance also, along with the students’ performance. Finally a universal metric of performance is needed very much for a comparative study of students, and teachers throughout a large number of institutions. The present paper discusses about some universal performance metrics for teachers and students and the methodology for measuring them. The metrics are viewed both from theoretical point of view and implementation point of view. From theoretical point of view, the significance of the metrics is given and their definitions are expressed through propositional calculus statements. From implementation point of view, scheme diagrams for an online database and a data warehouse have been described for storing enough information about a curriculum as well as efficient measurement of the performance metrics. The scope of the metrics presented in this paper is not only confined to performance evaluation, rather more sophisticated decisions regarding course modification and institution performance can easily be taken from the metrics. The organisation of the paper is as follows. In the next section the proposed methodology is discussed. Section 3 demonstrates a case study that gives an example of application of the proposed methodology. Finally conclusion is drawn at section 4.

2. The proposed methodology

The present paper discusses about an evaluation system, which can be used to evaluate the performance of both students and teachers in an educational institution. In the next section an operational overview of the proposed methodology will be presented. The evaluation will be done based on online examinations held at different time of a course. The online examination is found to make no change in scoring compared to paper pencil tests (Bodmann et al 2004). However the system can also be used (with dropping some of its features) for a traditional offline examination system. In fact, the case study in section 3 will describe a limited application of the system for a traditional system where the examinations were not online. The system is designed to be used for a long duration of time covering a number of academic sessions. It has been suggested in Aspinwall (2005) that an evaluation system should be built up step by step; perhaps using different methods for data collection until enough is available. So, the emphasis is given on designing a database schema for storing basic information about course curriculums; and later consolidating the information stored in the database into a data warehouse for efficient long-term data analysis. The data warehouse will actually be used to evaluate students and teachers’ performance on a long range and also to take strategic decisions about a course design, improvement measurement etc. In section 2.2, the designs of an online database and data warehouse are presented. The point assignment technique in an online examination is described in section 2.3. We have defined several performance metrics to aid decision-making regarding performance measurement of students, teachers and institutes based on the points scored by students. Definitions of these performance metrics are presented in section 2.4. In section 2.5 and 2.6, practical implications of the metrics and some other important utilities of the proposed evaluation methodology is pointed out respectively.

2.1 Operational overview

The proposed evaluation system will operate in three phases, namely,

- Initialisation Phase
- Running Phase
- Assessment Phase

These system phases conform to the regular course calendar. The initialisation phase will take place before start of a course. The running phase will run with the course. After the end of the course, the students’ and teachers’ performance will be evaluated in the assessment phase. The initialisation phase mainly concerns with database fill up with curriculum details and demographic information. A
course is broken up into a number of subjects. Each subject is further classified into chapters or topics. Further, a topic is broken up into some concepts. For example, a secondary level science course can be divided into subjects like physics, chemistry, biological sciences and mathematics. Now physics can be classified into topics like optics, magnetism, mechanics etc. The topic mechanics includes concepts like free body diagram, inclined plane, momentum etc. The ontology of a course is shown in Fig.1. In order to extend this ontology for several subjects, we can define surmise relationships among different concepts and topics of different subjects and once fully developed, the ontology can also be easily used to define a knowledge space for a student (Dietrich et al 2001). In Reddy (2004) the variance of student performance is shown to be dependent on the standard on question papers and subjects. So, it can be inferred that an evaluation technique should use different weightages for different subjects and questions. To take care of this fact, each topic, concept and question is associated with a difficulty index (refer Fig.1). In Rios et al (1998), Rehak (1997) and Byrnes (1995), we get a list of other metadata associated with a question like type, topics assessed, complexity etc. to generate customised and personalised examinations or quiz sessions. Most of these metadata are inherent in our system due to considering the ontology structure (refer Fig. 1) of a course. In the proposed system, besides difficulty level, we consider only another metadata of a question, i.e. an expected answer-time. This expected answer time can be used to differentiate a blind guess from an intelligent guess by comparing it to the response time of a question in an online examination scenario (more elaborately explained in section 2.3).

In the running phase, the teacher can periodically evaluate the class performance by designing online examinations or quiz sessions. These examinations or quiz can be designed using the existing question-answers within the database or by inserting new questions and answers. Even the course instructor can add new topics or concepts during this running phase. Short-term assessment can also be carried out by manually analysing the points scored by the students during an examination. The point calculation system is explained in the section. After the end of the course, the final assessment will be carried out. The final assessment will not only consider the immediate performance of a student in a single course, but also takes care of historical data available about the students, teachers and subjects. Sufficient data will be maintained to calculate the performance metrics as defined in section 2.3.

2.2 Database design

The database is designed according to the operational phases of the system. The initialisation and running phase will deal with an online normalised database. In the assessment phase, the content of the database will be analysed and consolidated into a data warehouse. This data warehouse will store information that will facilitate to calculate performance metrics at various levels of granularities and for various combinations of the dimensions. The schemas of the database and data warehouse are furnished in the next two sections.

2.2.1 Database tables

The database is designed to automate the whole evaluation process. A database always provides more flexibility in designing an examination or quiz session (Brusilovsky and Miller 2001). The teachers’ and students’ details will be stored in two tables for analysing their performance individually. The Teacher_Allotment table remembers the courses taught by a particular teacher. The course ontology will be stored in Subject, Topic and Concept tables and their relationships will be stored in two separate tables (Concept_Topic_Mapping, Subject_Concept_Mapping). The examination questions and answer-options need to be pre-stored in Question and Answer tables. The Question_Answer_Mapping table stores correct answer(s) of each question. If the methodology is deployed in a subjective examination system (which does not provide answer options), the Answer and Question_Answer_Mapping tables need to be dropped. To use the system in a paper-pencil based examination scenario, the expected response time field of Question table has to be dropped. The rest portion of the database remains same in all cases.
Figure 1. Ontology of the course

Table 1. Database tables

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Table Name</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Teacher</td>
<td>Stores Teachers’ demographic information</td>
</tr>
<tr>
<td>2</td>
<td>Teacher_Allotment</td>
<td>Stores the subjects taken by a teacher</td>
</tr>
<tr>
<td>3</td>
<td>Topic</td>
<td>Stores Topic Details</td>
</tr>
<tr>
<td>4</td>
<td>Concept</td>
<td>Stores Concept Details</td>
</tr>
<tr>
<td>5</td>
<td>Answer</td>
<td>Stores the answer statements</td>
</tr>
<tr>
<td>6</td>
<td>Concept_Topic_Mapping</td>
<td>Maps each Topic to a Concept</td>
</tr>
<tr>
<td>7</td>
<td>Examination</td>
<td>Stores Examination information</td>
</tr>
<tr>
<td>8</td>
<td>Question</td>
<td>Stores question related information</td>
</tr>
<tr>
<td>9</td>
<td>Student</td>
<td>Stores Students’ demographic information</td>
</tr>
<tr>
<td>10</td>
<td>Question_Answer_Mapping</td>
<td>Maps each answer to a question</td>
</tr>
<tr>
<td>11</td>
<td>Student_Session</td>
<td>Stores examination details of individual student</td>
</tr>
<tr>
<td>12</td>
<td>Subject_Concept_Mapping</td>
<td>Maps each Concept to a Subject</td>
</tr>
<tr>
<td>13</td>
<td>Subject</td>
<td>Stores each subject information</td>
</tr>
</tbody>
</table>
2.2.2 Data warehouse tables:

Data warehouse is a subject oriented, time variant, non-volatile, integrated repository of data (Han 2000). It will consolidate the content of the operational database for ease of decision-making. The main differences of data warehouse with the database will be in its utilisation, access pattern and size (Twelve Rules That Define a Data Warehouse 2005). It has been designed by considering aims of an evaluation process presented in section 1. The data warehouse has two fact tables and six dimensions. The fact is the points scored by student in an examination.

Table 2. Data warehouse tables

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Table Name</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Concept</td>
<td>Stores Concept Details</td>
</tr>
<tr>
<td>2</td>
<td>Examination</td>
<td>Stores Examination information</td>
</tr>
<tr>
<td>3</td>
<td>Student</td>
<td>Stores Students’ demographic information</td>
</tr>
<tr>
<td>4</td>
<td>Student_Fact_Table</td>
<td>Table to assess Students’ learning Rate</td>
</tr>
<tr>
<td>5</td>
<td>Subject</td>
<td>Stores each subject information</td>
</tr>
<tr>
<td>6</td>
<td>Teacher</td>
<td>Stores Teachers’ demographic information</td>
</tr>
<tr>
<td>7</td>
<td>Teacher_Fact_Table</td>
<td>To evaluate Teachers’ Performance</td>
</tr>
<tr>
<td>8</td>
<td>Topic</td>
<td>Stores Topic Details</td>
</tr>
</tbody>
</table>
2.3 Point calculation techniques

In a traditional system, students' marks are decided by the extent of correctness of his answer. In the present system, we attempt to calculate marks not only based upon the correctness of an answer, rather considering the hardness of the question and the topic from which the question is developed. The intellect level of a student is tried to be reflected in his obtained marks by considering the response time taken to answer a question. However if the system is deployed in a paper-pencil based examination scenario, the response time cannot be measured for individual questions and need to be dropped. The point calculation will be as follows

\[
\text{Point obtained by answering a question} = \frac{(\text{Topic Difficulty Index} \times \text{Concept Difficulty Index} \times \text{Question Difficulty Index} \times \text{Deviation})}{\text{Response Time}}
\]

The difficulty index signifies the hardness of a question or topic. As for example, the difficulty indices parameters can take values as shown in Table 3.

<table>
<thead>
<tr>
<th>Name of Difficulty Index</th>
<th>Value for Tough</th>
<th>Value for Normal</th>
<th>Value for Easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic Difficulty Index</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Concept Difficulty Index</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Question Difficulty Index</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

The answers given by a student will be used to judge the level of understanding of a student. As for example let us consider the following question and answer options.

Example Question: Why ARP is used?
Possible Answers:

a. To know IP address by giving the hardware address
b. Data structure used for efficient searching
c. To know hardware address by specifying IP address
d. To know router’s IP address

Among the answer options ‘c’ is correct, option ‘a’ can be considered as a silly mistake answer while option ‘b’ is totally unrelated to ARP. So analysing the given answer the level of knowledge and understanding can be easily measured. To parameterise this level of understanding a deviation parameter will be used. To measure the deviation parameter, each answer will be classified in one of six classes and value will be assigned according to the class of the answer. The different values of deviation parameter are shown in Table 4. The response time for an answer will be used to catch blind guesses. It is the time a student takes to give the answer. It will be compared with the expected answer time of a question. For some questions (say, problem-oriented question) if the response time is very much less than the expected time then it is considered as a blind guess answer and points will be assigned according to that. The weightages given to different classes of response time are shown in Table 5. The values shown in Table 3, 4 and 5 are not derived mathematically rather they only serve to differentiate among the classes of difficulty indices, deviations and response times. A practical implementation of the present system is free to choose any value that is capable to consider their physical significance.

Table 4. Value of deviation parameter

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Value for Exact Match</th>
<th>Value for Near Match</th>
<th>Value for Average Answer</th>
<th>Value for Below Average</th>
<th>Value for No Idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deviation</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 5. Weightage of different response times

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Value for Blind Guess</th>
<th>Value for Normal Answer/ Educated Guess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response Time</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

The point obtained by a student at each evaluation session is stored at concept level, topic level and subject level in the online database and later consolidated into the data warehouse.

2.4 Definitions

In this section some parameters will be defined which will be used as performance metric. These metrics will accumulate points scored by the students in various ways to measure the performances. The following proposition will be used to define the performance metrics

\[ \text{Student\_Score}(s, i, o) : \text{Points scored by student } s \text{ on } i\text{-th examination in an ontology element (subject, topic or concept) } o. \text{ From the Data warehouse scheme, it can be clearly understood that this fact is nothing but the data warehouse fact in the Student Fact Table.} \]

\[ \text{Teacher\_Score}(t, i, o) : \text{Points scored by students on } i\text{-th examination in an ontology element (subject, topic or concept) } o \text{ taught by teacher } t. \text{ From the Data warehouse scheme, it can be observed that this fact is the data warehouse fact in the Teacher Fact Table.} \]

The two performance metrics, namely, Student Learning Rate and Teacher’s Performance are defined as follows.

**Student Learning Rate:** It is defined as the average increase in score in two consecutive examination sessions. It is expressed as follows

\[ \text{Student\_Learning\_Rate}(s, o) = \frac{\sum ((\text{Student\_Score}(s, i+1, o) - \text{Student\_Score}(s, i, o)))}{(|\text{Student\_Score}(s, i+1, o) - \text{Student\_Score}(s, i, o)|)/N-1, \text{ for all } i} \]

where, \( N = \text{Total number of examinations taken by teacher } t \text{ which include ontology element } o. \)
The metric will not be deviated by an instantaneous good or bad performance, since it measures the rate of change of a student’s performance over a large number of examinations.

**Teacher’s Performance** \((o, t)\) : Deviation of the average points scored by the students for a particular ontology element \(o\) taught by teacher \(t\).

\[
\text{Teacher's Performance } (o, t) = \text{Avg}(\text{Teacher_Score}(t, i, o)), \text{ for all } i - \text{Avg}(\text{Teacher_Score}(t, i, o)), \text{ for all } i, t
\]

Since a particular ontology element is taught by a number of teachers in different contexts, a single teacher cannot control the overall average. Hence effect of a particular academic session cannot affect the metric considerably. Besides these performance metrics the difficulty level of various ontology elements can also be defined (redefined) using the propositions

\[
\text{Difficulty Level}(o) = \text{Difficulty level of ontology element } o.
\]

\[
\text{Difficulty Level}(o) = \text{Avg}(\text{Student_Learning_Rate}(s, o)), \text{ for all } s
\]

### 2.5 Implications of the metrics

A traditional examination system evaluates a students’ expertise at a particular point of time. It is a well-known fact that “to a teacher or anyone else trying to help an individual, a single assessment would be of little help because one may not be equally good or bad in all aspects of learning, but a lot more information is needed which merge different kind of data.” (Harlen 1994). The metric, Student Learning Rate, presented in the previous section, aims to quantify a students’ progress throughout a time interval. Faculties also do the same thing when they compare students’ marks in mid-semester, half-yearly or annual examinations. This metric is an attempt to automate this comparison process and to find students difficulties in different topics, concepts or subjects. In a big institute, there exist several departments and many a time same subject or topics are covered in curriculums of different departments. The metric Teachers Performance is an attempt to quantify a teachers’ expertise in different subjects or topics. The metric should never be used alone to measure a teachers’ performance but can be used as a part of a rating process. The difficulty level will signify the overall hardness of a subject, topic or concept. Since each of the metrics is defined at the lowest granular level, they can be rolled up to get important information about the learning process. Some examples of the uses of these metrics are given in next section.

### 2.6 Other utilities

Besides the performance evaluation, the metrics can be used for many other useful purposes. Some examples are given below.

- Generating different types of test statistics to understand and evaluate a teaching and learning system. The system can provide enough information to fulfil the aims of an evaluation system presented at section 1.
- Finding out the assimilation capacity for a particular topic, concept or subject for individual as well as a special type of students. Students can be rolled up by average marks, grades, age, departments, institution, province or country. The knowledge can in turn be used to develop a student model and to personalise an e-learning system.
- The necessity or usefulness of a course modification can be found out by comparing the difficulty levels of an ontology element (like subject, topic or concept) taught at different years.
- Total improvements or rate of improvement in the performance of students, teachers and a whole institution, both in absolute term and relative to other institutes, can be measured by comparing Students’ Learning rate at various rolled up levels of granularities.

### 3. A case study

In order to measure the performance of the proposed metrics, a data warehouse is to be built with sufficient volume of data. However the data warehouse cannot be developed unless all examinations have to be conducted through the proposed system for sufficient long time. A case study for validating
the proposed system has been carried out using available examination details for two courses from an academic section of the authors’ academic institution. The case study only demonstrates the calculation of students’ learning rates in a traditional paper-pencil based subjective examination scenario and two of the possible usages of student learning rate via analysing a single course and comparing two courses. Unfortunately, the students’ performance measure according to a topic or concept cannot be done since data was not available at that level of granularity. However our analysis in such a limited scope also reveals some important insights into a course. Currently four courses have been analysed, which will be termed as follows

- Course1 Batch2
- Course2 Batch1
- Course3 Batch1
- Course3 Batch2

Among these Course3 was taught for two batches in two consecutive years. The same teacher also taught Course2. Another teacher of the same department taught Course1. The analysis process is carried out in two phases. First each course is analysed separately and the outcomes are shown to the concerned course instructor. After reviewing the results, the instructor wanted some additional details that led to the second phase of analysis and a comparative study among the four courses.

3.1 Phase 1-course analysis

The basis of the proposed evaluation process is calculation of Students’ Learning Rate. In the case study, Students’ learning rates are calculated for each course based on marks scored by students in different assignments, class tests, mid-semester and end-semester examinations at different stages of the course. For confidentiality purpose we have not shown scoring details of an individual student, rather we clustered student in different groups and carry out our experiments on the average score obtained by each cluster (the analysis done on each cluster can also be done on individual students). The testing procedure consists of following steps.

- Preparation of tabulation sheets of students considering their marks at different assignments, class tests, mid-semester and end-semester examinations.
- Clustering students according to their marks. Each cluster corresponds to a group of similar types of students.
- Calculating students learning rate for each cluster.
- Plotting the learning rate of each cluster with respect to different evaluation stages.
- Analysis of the graph.

For Course 1 Batch 2 the learning rate calculation technique has been elaborated in a little more details. For rest of the courses, the student clusters, normalised scores, learning rates and learning curves are shown. Based on the learning curves we pointed out our findings for each of the courses.

3.1.1 Test result for course 1 batch 2

The first course (Course 1) for batch 2 was taken by 52 students. The evaluation process consists of three assignments, two class tests, mid-semester examination and end-semester examination. The student clusters are shown in Table 6.

Table 6. Student clusters

<table>
<thead>
<tr>
<th>Cluster id</th>
<th>Class Test1 (40)</th>
<th>Assg1 (100)</th>
<th>Assg2 (100)</th>
<th>Mid Sem (60)</th>
<th>Assg3 (100)</th>
<th>Class Test2 (50)</th>
<th>End Sem (100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17.50</td>
<td>28.67</td>
<td>0.00</td>
<td>28.39</td>
<td>8.33</td>
<td>31.67</td>
<td>44.85</td>
</tr>
<tr>
<td>2</td>
<td>24.79</td>
<td>33.43</td>
<td>76.43</td>
<td>38.11</td>
<td>29.07</td>
<td>34.00</td>
<td>64.93</td>
</tr>
<tr>
<td>3</td>
<td>24.36</td>
<td>66.94</td>
<td>85.00</td>
<td>40.50</td>
<td>39.43</td>
<td>36.71</td>
<td>69.14</td>
</tr>
<tr>
<td>4</td>
<td>24.05</td>
<td>80.18</td>
<td>70.00</td>
<td>37.00</td>
<td>43.55</td>
<td>35.32</td>
<td>68.32</td>
</tr>
</tbody>
</table>

Based on Table 6 above students’ learning rates are being calculated for these four clusters as shown in Table 7. Marks at each examination or assignment are normalised to a scale of 100. Now the learning rates are plotted with respect to assignments, class tests, mid-semester and end-semester examinations i.e. different evaluation stages arranged chronologically. The plot is shown in Fig. 4. The
first observation about the curves is their zigzag nature i.e. students learning rate varies for each consecutive evaluation stages. As the evaluation stages are analysed it can be found assignments and examinations came alternatively. So students did better in assignments, did not do well in examinations and vice-versa. Hence the suggestion, based on this analysis, to the course instructor was to increase conformance between the assignments and examinations. Besides this observation, the trend line (the thick black line) shows that students learning rate decreases as the course was going on up to third assignment and then increases again. This finding is in conformance with the education structure of our institute where the course load is gradually increased up to mid-semester and then gradually decreases.

Table 7. Calculation of students’ learning rate for course 1 batch 2

<table>
<thead>
<tr>
<th>Clusterid</th>
<th>Normalised Score</th>
<th>Normalised Score</th>
<th>Normalised Score</th>
<th>Normalised Score</th>
<th>Normalised Score</th>
<th>Normalised Score</th>
<th>Normalised Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of Course</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Assignment 1</td>
<td>28.67</td>
<td>33.43</td>
<td>4480.96</td>
<td>6428.83</td>
<td>3212.33</td>
<td>617.56</td>
<td>480.96</td>
</tr>
<tr>
<td>Class Test 1</td>
<td>43.75</td>
<td>62</td>
<td>816.24</td>
<td>-36.48</td>
<td>-402</td>
<td>151.29</td>
<td>80.18</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>0</td>
<td>76.43</td>
<td>85</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>MidSem</td>
<td>47.32</td>
<td>63.52</td>
<td>67.5</td>
<td>61.67</td>
<td>61.67</td>
<td>61.67</td>
<td>61.67</td>
</tr>
<tr>
<td>Assignment 3</td>
<td>8.33</td>
<td>29.07</td>
<td>39.43</td>
<td>43.55</td>
<td>43.55</td>
<td>43.55</td>
<td>43.55</td>
</tr>
<tr>
<td>Class Test 2</td>
<td>63.34</td>
<td>68</td>
<td>73.42</td>
<td>70.64</td>
<td>70.64</td>
<td>70.64</td>
<td>70.64</td>
</tr>
<tr>
<td>EndSem</td>
<td>44.85</td>
<td>64.93</td>
<td>69.14</td>
<td>68.32</td>
<td>68.32</td>
<td>68.32</td>
<td>68.32</td>
</tr>
<tr>
<td>Total</td>
<td>2538.5</td>
<td>2294.67</td>
<td>5068.12</td>
<td>6455.02</td>
<td>4089.08</td>
<td>6455.02</td>
<td>4089.08</td>
</tr>
<tr>
<td>Student_Learning_Rate</td>
<td>362.64</td>
<td>327.81</td>
<td>724.02</td>
<td>922.15</td>
<td>584.15</td>
<td>922.15</td>
<td>584.15</td>
</tr>
</tbody>
</table>

Figure 4. Student leaning rate at different time of course 1 batch 2

For the rest of the courses the student clusters, normalised scores, learning rates and learning curves are shown. Learning curves are also drawn based on the learning rates of students at different time of a course.
3.1.2 Test result for course 2 batch 1

The second course (Course 2) for batch 1 was taken by 30 students. The evaluation process consists of one assignment, two class tests, mid-semester and end-semester examinations. The student clusters are shown in Table 8. Normalised scores for each cluster are shown in Table 9. The learning rate, calculated from the normalised scores, is shown in Table 10. The variation of learning rate at different time of the course is furnished in Fig. 5.

Table 8. Student clusters

<table>
<thead>
<tr>
<th>clusterid</th>
<th>CT-1 (5)</th>
<th>CT-2 (5)</th>
<th>Asg (5)</th>
<th>Mid Sem (30)</th>
<th>End Sem (50)</th>
<th>Attd (5)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
<td>2.67</td>
<td>4.33</td>
<td>19.33</td>
<td>24.00</td>
<td>0</td>
<td>50.33</td>
</tr>
<tr>
<td>2</td>
<td>2.43</td>
<td>2.86</td>
<td>0.00</td>
<td>19.43</td>
<td>21.43</td>
<td>0</td>
<td>46.14</td>
</tr>
<tr>
<td>3</td>
<td>4.35</td>
<td>4.12</td>
<td>5.00</td>
<td>25.00</td>
<td>35.53</td>
<td>4.53</td>
<td>74.00</td>
</tr>
<tr>
<td>4</td>
<td>2.00</td>
<td>3.00</td>
<td>5.00</td>
<td>17.00</td>
<td>22.50</td>
<td>0.5</td>
<td>49.50</td>
</tr>
<tr>
<td>5</td>
<td>2.78</td>
<td>4.22</td>
<td>5.00</td>
<td>22.44</td>
<td>31.22</td>
<td>3.78</td>
<td>65.67</td>
</tr>
</tbody>
</table>

Table 9. Normalised scores

<table>
<thead>
<tr>
<th>clusterid</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT-1</td>
<td>0.00</td>
<td>48.58</td>
<td>87.06</td>
<td>40.00</td>
<td>55.56</td>
<td>46.24</td>
</tr>
<tr>
<td>Mid Sem</td>
<td>64.44</td>
<td>64.76</td>
<td>83.33</td>
<td>56.67</td>
<td>74.81</td>
<td>68.80</td>
</tr>
<tr>
<td>CT-2</td>
<td>53.34</td>
<td>57.14</td>
<td>82.36</td>
<td>60.00</td>
<td>84.44</td>
<td>67.46</td>
</tr>
<tr>
<td>Asg</td>
<td>86.66</td>
<td>0.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>77.33</td>
</tr>
<tr>
<td>End Sem</td>
<td>48.00</td>
<td>42.86</td>
<td>71.06</td>
<td>45.00</td>
<td>62.44</td>
<td>53.87</td>
</tr>
</tbody>
</table>

Table 10. Learning rate

<table>
<thead>
<tr>
<th>Eval Stage</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT1</td>
<td>0</td>
<td>2360.02</td>
<td>7579.44</td>
<td>1600</td>
<td>3086.91</td>
<td>2138.14</td>
</tr>
<tr>
<td>Mid</td>
<td>4152.51</td>
<td>261.79</td>
<td>-13.91</td>
<td>277.89</td>
<td>370.56</td>
<td>508.95</td>
</tr>
<tr>
<td>CT2</td>
<td>-123.21</td>
<td>-58.06</td>
<td>-0.94</td>
<td>11.09</td>
<td>92.74</td>
<td>-1.8</td>
</tr>
<tr>
<td>Assg</td>
<td>1110.22</td>
<td>-3264.98</td>
<td>214.33</td>
<td>1600</td>
<td>242.11</td>
<td>97.42</td>
</tr>
<tr>
<td>End</td>
<td>-1494.6</td>
<td>1836.98</td>
<td>-837.52</td>
<td>3025</td>
<td>-1410.75</td>
<td>550.37</td>
</tr>
</tbody>
</table>

50.33| 46.14| 74| 49.5| 65.67| 57.13|

Figure 5. Student learning rate at different time of course 2 batch 1

Inference

- Except for clusters 1 and 2, the learning rate remains more or less flat for all the students (refer fig. 5).
- The trend line shows (refer Fig. 5) a decrease in students' learning rate; however the average score of the student is 57.13, which is not bad. So it may indicate the course content failed to present much new aspect to the students and so they earned marks but learned little.
3.1.3 Test result for course 3 batch 1

The third course (Course 3) for batch 1 was taken by 26 students. The evaluation process consists of two assignments, one term paper, mid-semester and end-semester examinations. The student clusters are shown in Table 11. Normalised scores for each cluster are shown in Table 12. The learning rate calculated from the normalised scores is shown in Table 13. The variation of learning rate at different time of the course is furnished in Fig. 6.

Table 11. Student clusters

<table>
<thead>
<tr>
<th>clusterid</th>
<th>Asg1 (5)</th>
<th>Asg2 (3)</th>
<th>Term Pap(7)</th>
<th>Mid Sem (30)</th>
<th>End Sem (50)</th>
<th>Attn (5)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.00</td>
<td>2.00</td>
<td>6.00</td>
<td>14.67</td>
<td>27.00</td>
<td>3.33</td>
<td>58.00</td>
</tr>
<tr>
<td>2</td>
<td>4.00</td>
<td>0.00</td>
<td>6.00</td>
<td>12.43</td>
<td>24.71</td>
<td>1.71</td>
<td>48.86</td>
</tr>
<tr>
<td>3</td>
<td>4.00</td>
<td>2.00</td>
<td>5.00</td>
<td>24.00</td>
<td>25.00</td>
<td>2.00</td>
<td>62.00</td>
</tr>
<tr>
<td>4</td>
<td>5.00</td>
<td>3.00</td>
<td>6.00</td>
<td>19.60</td>
<td>32.53</td>
<td>3.87</td>
<td>70.00</td>
</tr>
<tr>
<td>5</td>
<td>5.00</td>
<td>2.00</td>
<td>5.00</td>
<td>16.00</td>
<td>29.00</td>
<td>3.00</td>
<td>60.00</td>
</tr>
<tr>
<td>6</td>
<td>5.00</td>
<td>3.00</td>
<td>7.00</td>
<td>20.67</td>
<td>40.33</td>
<td>4.67</td>
<td>80.67</td>
</tr>
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</table>

Table 12. Normalised scores

<table>
<thead>
<tr>
<th>clusterid</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asg1</td>
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<td>80.00</td>
<td>80.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>93.33</td>
</tr>
<tr>
<td>Mid Sem</td>
<td>48.89</td>
<td>41.43</td>
<td>80.00</td>
<td>65.33</td>
<td>53.33</td>
<td>88.89</td>
<td>59.65</td>
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<tr>
<td>Asg2</td>
<td>66.67</td>
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<td>100.00</td>
<td>66.67</td>
<td>100.00</td>
<td>66.67</td>
</tr>
<tr>
<td>Term Paper</td>
<td>85.71</td>
<td>85.71</td>
<td>71.43</td>
<td>85.71</td>
<td>71.43</td>
<td>100.00</td>
<td>83.33</td>
</tr>
<tr>
<td>End Sem</td>
<td>54.00</td>
<td>49.43</td>
<td>50.00</td>
<td>65.07</td>
<td>58.00</td>
<td>80.67</td>
<td>59.53</td>
</tr>
</tbody>
</table>

Table 13. Learning rate

<table>
<thead>
<tr>
<th>Eval Stage</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
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<td>10000</td>
<td>8400</td>
<td>6400</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>8710.49</td>
</tr>
<tr>
<td>Mid</td>
<td>-2612.23</td>
<td>-1487.64</td>
<td>0</td>
<td>-1202.01</td>
<td>-2178.09</td>
<td>-967.83</td>
<td>-1134.34</td>
</tr>
<tr>
<td>Assg2</td>
<td>-316.13</td>
<td>-1716.44</td>
<td>-177.69</td>
<td>1202.01</td>
<td>177.96</td>
<td>967.83</td>
<td>49.28</td>
</tr>
<tr>
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<td>362.52</td>
<td>7346.2</td>
<td>22.66</td>
<td>-204.2</td>
<td>22.66</td>
<td>0</td>
<td>277.56</td>
</tr>
<tr>
<td>End</td>
<td>-1005.52</td>
<td>-1316.24</td>
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<td>426.01</td>
<td>-180.36</td>
<td>-373.65</td>
<td>-566.44</td>
</tr>
<tr>
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<td>1845.18</td>
<td>1157.15</td>
<td>1873.96</td>
<td>1568.43</td>
<td>1925.27</td>
<td>1467.31</td>
</tr>
<tr>
<td>Total Marks</td>
<td>58</td>
<td>63.68</td>
<td>62</td>
<td>70</td>
<td>60</td>
<td>70</td>
<td>63.26</td>
</tr>
</tbody>
</table>

Figure 6. Student learning rate at different time of course3 batch 1

Inference
- The steep fall after first assignment (refer Fig. 6) of all the curves show that the first assignment was too easy in comparison to other assignments and examinations.
- The learning rate of the student cluster, who got lowest marks (cluster 2), has a wavy nature (refer Fig. 6). The nature of the curve indicates that weaker students cannot cope well with the course.
- The course is found to be most effective in terms of learning rate for the cream students (cluster 6)
The trend line (refer Fig. 6) indicates the general nature of the course which is same as the previous example. The load of the course has increased up to the mid-session and then decreased again that results the U-shaped curve.

### 3.1.4 Test result for course 3 batch 2

The third course (Course 3) for batch 2 was taken by 35 students. The evaluation process consists of one assignment, two class tests, one term paper, mid-semester and end-semester examinations. The student clusters are shown in Table 14. Normalised scores for each cluster are shown in Table 15. The learning rate calculated from the normalised scores is shown in Table 16. The variation of learning rate at different time of the course is furnished in Fig. 7.

#### Table 14. Student clusters

<table>
<thead>
<tr>
<th>Cluster</th>
<th>CT1 (5)</th>
<th>CT2 (5)</th>
<th>Assg (5)</th>
<th>Paper (30)</th>
<th>Mid (50)</th>
<th>End (50)</th>
<th>Attn (5)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>1</td>
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<td>0.00</td>
<td>1.83</td>
<td>23.00</td>
<td>37.03</td>
<td>42.71</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.50</td>
<td>3.17</td>
<td>3.75</td>
<td>33.3</td>
<td>21.83</td>
<td>32.33</td>
<td>66.92</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3.09</td>
<td>2.45</td>
<td>3.93</td>
<td>2.29</td>
<td>19.54</td>
<td>34.25</td>
<td>65.54</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2.75</td>
<td>2.67</td>
<td>0.00</td>
<td>1.00</td>
<td>12.08</td>
<td>21.42</td>
<td>39.92</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1.44</td>
<td>2.29</td>
<td>4.07</td>
<td>2.72</td>
<td>16.89</td>
<td>33.14</td>
<td>62.36</td>
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</table>

#### Table 15. Normalised scores

<table>
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<th>Cluster</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT1</td>
<td>45.84</td>
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<td>55.00</td>
<td>28.88</td>
<td>48.30</td>
</tr>
<tr>
<td>Mid</td>
<td>51.94</td>
<td>72.78</td>
<td>65.12</td>
<td>40.28</td>
<td>62.31</td>
<td>58.49</td>
</tr>
<tr>
<td>CT2</td>
<td>0.00</td>
<td>63.34</td>
<td>48.92</td>
<td>53.34</td>
<td>45.84</td>
<td>42.29</td>
</tr>
<tr>
<td>Assg</td>
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<td>78.58</td>
<td>0.00</td>
<td>81.38</td>
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</tr>
<tr>
<td>Term paper</td>
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<td>66.67</td>
<td>45.71</td>
<td>20.00</td>
<td>54.44</td>
<td>44.70</td>
</tr>
<tr>
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<td>64.67</td>
<td>68.50</td>
<td>42.83</td>
<td>66.28</td>
<td>57.66</td>
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</table>

#### Table 16. Learning rate

<table>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
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<td>3816.77</td>
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<td>834.05</td>
<td>2332.89</td>
</tr>
<tr>
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<td>37.21</td>
<td>518.93</td>
<td>11.16</td>
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<td>1117.56</td>
<td>103.84</td>
</tr>
<tr>
<td>CT2</td>
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<td>-89.11</td>
<td>-262.44</td>
<td>170.56</td>
<td>-271.26</td>
<td>-262.44</td>
</tr>
<tr>
<td>Assg</td>
<td>0</td>
<td>135.96</td>
<td>879.72</td>
<td>-2845.16</td>
<td>1263.09</td>
<td>22.09</td>
</tr>
<tr>
<td>TP</td>
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<td>-69.39</td>
<td>-1080.44</td>
<td>400</td>
<td>-725.76</td>
<td>-5.24</td>
</tr>
<tr>
<td>End</td>
<td>87.05</td>
<td>4</td>
<td>519.38</td>
<td>521.21</td>
<td>140.19</td>
<td>167.96</td>
</tr>
<tr>
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<td>145.42</td>
<td>498.73</td>
<td>547.36</td>
<td>175.82</td>
<td>392.98</td>
<td>393.18</td>
</tr>
<tr>
<td>Total Marks</td>
<td>42.71</td>
<td>66.92</td>
<td>65.53</td>
<td>39.92</td>
<td>62.36</td>
<td>55.49</td>
</tr>
</tbody>
</table>

![Figure 7. Student leaning rate at different time of course3 batch 2](image)

Inference
As like batch 1, in case of batch 2 also we find wavy nature (refer Fig. 7) of learning rates for lagging students (cluster 1 and 4). The same result for both batches also proves the correctness of our method.

The trend line (refer Fig. 7) shows the general nature of the course remains same as other courses.

The average learning rate shows that batch 1 was better than batch 2 in terms of learning. The average score scored by students of batch 1 (63.26) and batch 2 (55.49) also confirms the result.

3.2 Phase 2 - course comparison

As per the request of the instructor of course 2 and course 3 we go for a comparative analysis of batch 1 and batch 2 for course 3 and also for a comparison of all the courses (i.e. course 2 and course 3 for two batches) taught by the teacher. The learning curves are shown in Fig. 8 and Fig. 9 respectively.

![Comparison between batch 1 and batch 2 for course 3](image1)

**Figure 8.** Comparison between batch 1 and batch 2 for course 3

As shown in Fig. 8 the learning rate of batch 1 has decreased initially and then increased again. On the other hand for batch 2 the trend line remains near zero line throughout the course. It can be concluded that the subject matter for batch 1 presents something new to them. So their learning curve first decreases but after getting accustomed with the course it is increased again. However batch 2 does not get anything new to be added to their knowledge base from the course. Since the average marks of batch 2 (55.49) is less than that of batch 1(63.26) so it is obvious that the course material was not known to batch 2 before. So they cannot learn as like batch 1 due to either their lack of effort or due to the teaching technique. Now, when we compare all the three courses taught by the teacher we get some more insights into the teaching-learning situation. As shown in Fig. 9, the trend line for course 3 batch 1 is of U-shape, but the trend lines of course 2 and course 3 batch 2 both run near zero line. Since the trend line for two different batches and courses are almost same so according to our system, it is the teaching technique that should be changed for increasing the learning rate.

![Comparison between different courses for a teacher](image2)

**Figure 9.** Comparison between different courses for a teacher

As shown in Fig. 8 the learning rate of batch 1 has decreased initially and then increased again. On the other hand for batch 2 the trend line remains near zero line throughout the course. It can be concluded that the subject matter for batch 1 presents something new to them. So their learning curve first decreases but after getting accustomed with the course it is increased again. However batch 2 does not get anything new to be added to their knowledge base from the course. Since the average marks of batch 2 (55.49) is less than that of batch 1(63.26) so it is obvious that the course material was not known to batch 2 before. So they cannot learn as like batch 1 due to either their lack of effort or due to the teaching technique. Now, when we compare all the three courses taught by the teacher we get some more insights into the teaching-learning situation. As shown in Fig. 9, the trend line for course 3 batch 1 is of U-shape, but the trend lines of course 2 and course 3 batch 2 both run near zero line. Since the trend line for two different batches and courses are almost same so according to our system, it is the teaching technique that should be changed for increasing the learning rate.

4. Conclusions

The present paper defines some performance metrics for student and teacher evaluation and also discusses the methodology for calculating those metrics. The information stored in the system will be expressive enough to efficiently measure the performance. The metrics are intended to provide a fully objective assessment strategy; not aimed to criticise individuals. Once measured properly for adequate length of time, the metrics and the stored information can also be used to find utility of a course modification, to compare performances of different institutions and for research on education techniques. The paper demonstrate a
case study for analysing four courses at a premier engineering institute, which, in spite of lack of data, has yielded encouraging results about the learning and teaching of the courses.

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Initial Evaluation and Analysis of Post Graduate Trainees’ Use of a Virtual Learning Environment in Initial Teacher Training

Alison Hramiak
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Abstract: This paper describes the initial findings of a longitudinal case study that investigates the use of a virtual learning environment to enhance the placement experience for full time postgraduate certificate in education (PGCE) students. Geographically separated trainees can feel very isolated on placement. The purpose of the VLE was to try to alleviate this by offering a way for trainees to maintain contact and offer mutual support while on placement. A preliminary analysis of the results is used to offer some insight into how this type of support might be improved for future students, by the construction of minimum pedagogical framework for initial teacher training.

Keywords: Teacher training, Virtual learning environment, pedagogical framework

1. Introduction

This paper describes the initial findings and analysis of a longitudinal case study investigating the use of e-learning technology, specifically a virtual learning environment, (VLE) to enhance the training experience of trainees on the professional year post graduate certificate in education (PGCE). The purpose of the research is to try to determine if the trainee placement experience can be enhanced by using the communication and collaboration opportunities provided by the VLE to negate the geographical isolation of students. This paper reports the initial findings of the first year of the study, and recommends a minimum pedagogical framework for the implementation of VLEs in this type of teaching and learning.

2. Context and background for the research

The research is grounded in theories of networked collaborative learning, (de Laat and Lally, 2003; Jones, 2000) linked with socio constructivism (Dillenbourg, 1999; Kyriakicou, 1999; Vygotsky, 1978) and communities of practice (Wenger, 1998). It also builds on previous work done at Sheffield Hallam University which reported that whilst there was great potential in using the VLE as a mode of delivery, it also required a great deal of time and input from academic and technical staff (Angier, 2004). Previous research recommends that trainees have equal access to the shared electronic resources, and that a sense of community is created between the learners in the group, giving them opportunity to structure the online experience for themselves. Research that has explored the ‘connectedness’ of the trainees who engaged with the VLE for the purposes of study, reports that there is a heightened sense of feeling connected as part of a wider learning community (Thurston, 2005). The forming of the sense of community is deemed to be a necessary initial step in online collaborative learning (Wegerif, 1998). Other research has identified key issues of access to the technology and support for teachers, amongst others, as being important to the success of the use of communications technology for teaching and learning (Abbott et al., 2005). In other studies, research confirms that electronic conferencing can be used as a tool by which to enhance the learning and teaching of trainee teachers, but that its success depends on the nature interaction and level of collaboration among the participants (Kyriakicou, 1999).

Research done in Northern Ireland has some parallels with the work done here. This research reports that online discussion not only reduced the sense of loneliness often felt by trainee teachers when they are dispersed on teaching practice, but also helped to build a community of practice among them (Clarke, 2002). Evidence from Open University (OU) PGCE trainees suggests that extensive use of electronic networking systems can encourage collaboration and support and enhance practice (Selinger, 1997). Galanouli and Collins found that trainees used computer conferencing successfully without moderation by tutors (Galanouli and Collins, 2000). In the study described here, the tutor only participated in the discussion boards when required, for example, when asked to do so by other participants, or in order to encourage greater use of the system. In the Galanouli and Collins study, no
tutor had access to the system at all. The main aim of this study is to determine and implement, as an iterative process, a pedagogical framework for the use of information and communications technology, specifically, a VLE, on initial teacher training. The purpose of the study was to establish, over the course of a number of years, and through practitioner led research, a pedagogical framework that utilised e-learning technology, and which would enhance the placement experience for trainees.

3. Methodology and methods

The approach taken for the study is that of an evaluative, longitudinal case study, (Bassey, 1999; Yin, 1984) looking at how the VLE might be used iteratively, over a period of two to five years, to enhance the placement experience for trainee teachers. The methodology is that of practitioner led action research, with the tutor as participant and researcher. It engages with both context rich qualitative and quantitative data collection and analysis, searching for themes within and across a distinct number of data sets. This provides methodological triangulation to the study and thus adds rigour to any conclusions drawn (Cohen and Manion, 1994). Trainees start the one year Applied ICT PGCE in September of each academic year. During that time, the trainee spends approximately one third of their time at university, and two thirds of their time on two separate school placements. All the trainees in this study have a degree in information technology, (IT) and some also have either higher degrees and or work experience in this area also. All had access to a computer with internet facilities for the duration of the course. The VLE used for this research was Blackboard© (BB) and a site was set up specifically for use by the Applied ICT PGCE trainees early on in the course (October). In addition to this, the trainees had received familiarisation sessions on the use of the VLE, and had also been given much group work in class, in order to get them working together as a learning community (Kyriakicou, 1999; Rovaii, 2001). The Blackboard© site was set up to provide trainees with the means of staying in touch with their peers while on placement in school. The wide area covered by the course meant that trainees were geographically isolated from each other while on placement. The site was set up to provide a place, (or space) albeit virtual, where they could swap ideas, raise questions, discuss issues and experiences, and so on, despite their physical separation from each other.

Consent was obtained from all participants prior to the start of the study. Over the course of the academic year, a total of six discussion boards were set up for use by the students. Some were set up for use as soon as the BB site was ready and accessible by the students, others were set up later in the course to reflect the needs of the trainees as they progressed on the course. While the trainees were on placement, a number of synchronous chat sessions were also set up. A record of the use of, and access to, the BB site was also obtained for the purposes of the study. An online survey, (accessible only from the BB site) was also completed by the students towards the end of their second placement (and academic year). The survey covered both their access to and usage of the BB site, and also their preferred learning styles. The survey included both open and closed questions, allowing for factual and narrative style responses. A group interview was also conducted with the trainees at the end of the course. This data was used to augment the data from the survey and the discussion boards. The interview was conducted for triangulation purposes, to clarify issues emerging from the other data sets. All the data sets were collated and analysed for themes within, and across them, and this is described in the following section.

4. Results and findings

This section describes the results for each of the different data sets obtained from the study, and also gives a comparative analysis of the data from all the data sets.

4.1 Discussion board data analysis

The following table, (Table 1) gives the usage and access results from the discussion board data from the BB site from October to June, with brief comments on the relation between the statistics and the activities on the course.
Table 1: Discussion board statistics for Applied ICT PGCE trainees 2004-2005

<table>
<thead>
<tr>
<th>Totals for Discussion Boards</th>
<th>Urgent</th>
<th>TP1</th>
<th>TP2</th>
<th>Assignments</th>
<th>Interviews</th>
<th>Ebay</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Threads</td>
<td>14</td>
<td>20</td>
<td>12</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>No. participants (minus tutor)</td>
<td>4</td>
<td>9</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total No. messages</td>
<td>24</td>
<td>46</td>
<td>38</td>
<td>19</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>N° tutor messages</td>
<td>13</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>N° tutor messages as %</td>
<td>54</td>
<td>22</td>
<td>24</td>
<td>32</td>
<td>43</td>
<td>100</td>
</tr>
<tr>
<td>Access Up to 12pm</td>
<td>10</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Access 12-6pm</td>
<td>7</td>
<td>14</td>
<td>15</td>
<td>7</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Access 6pm to 12am</td>
<td>7</td>
<td>25</td>
<td>16</td>
<td>7</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>First trainee posting</td>
<td>19/10/2004</td>
<td>15/10/2004</td>
<td>03/02/2005</td>
<td>18/10/2004</td>
<td>10/03/2005</td>
<td>10/03/2005</td>
</tr>
<tr>
<td>Last trainee posting</td>
<td>16/11/2004</td>
<td>16/12/2004</td>
<td>08/03/2005</td>
<td>16/03/2005</td>
<td>24/03/2005</td>
<td></td>
</tr>
<tr>
<td>End date db</td>
<td>25/11/2004</td>
<td>07/01/2005</td>
<td>10/03/2005</td>
<td>22/03/2005</td>
<td>31/05/2005</td>
<td>08/03/2005</td>
</tr>
<tr>
<td>N° days</td>
<td>29</td>
<td>62</td>
<td>33</td>
<td>149</td>
<td>14</td>
<td>n/a</td>
</tr>
<tr>
<td>Notes and comparison with course activities</td>
<td>Not very useful. Superseded by email by tutor and students.</td>
<td>End of messages coincides with end of term on TP1. Used from transition time in school to end of 10h timetable on TP1</td>
<td>Used from end of transition time in school to beginning of 3rd week of full time in school (on 15h timetable by this time) in TP2</td>
<td>Used from the 3rd week of transition time in school in TP1 to 4th week of full timetable (15h) in TP2. Used in blocks in Oct/Jan/(2)mid March, which coincides with hand in dates for assignments, work on them in university, and hand in dates in April, respectively. Assignments were due in</td>
<td>Very short usage – coincides with a flurry of activity in terms of job hunting and interviews and includes the Easter holidays. By end March, most had either got jobs or were getting interviews regularly.</td>
<td>Not used</td>
</tr>
</tbody>
</table>

As can be seen from the data in Table 1, there was low usage of the discussion boards throughout the duration of the course. The most used board was that for the first teaching placement (TP1). This had the most threads and messages but with a very small number of participants who were actually posting them. The data also shows that the tutor engaged significantly with most of the boards, (placing at least 20% of the messages on all boards) in order to respond to any questions set and to encourage further usage of them. The longest lasting board was that for the assignments, however, as the table shows, the trainee messaging finished six days before the end date of the board – this board was mainly used around assignment deadlines. Access times for placement boards show an increase in message posting throughout the day, other boards, however, show no real significant pattern between posting and time of day. The actual usage of the boards is so low that it is not reasonable to draw any firm conclusions from the data given in Table 1, other than to conclude that participation on the site was low, and that usage was restricted to a small number of participants. In Table 2, the access statistics over time, for the second block placement, for each of the discussion boards, (detailing the number of hits per board per month) is given. All figures include the tutor’s hits, as the tutor was deemed to be part of the on line group. Figures are rounded up to the nearest number with percentages in parenthesis.
Table 2: Access statistics for applied ICT PGCE BB site march to June 2005

<table>
<thead>
<tr>
<th></th>
<th>No Students</th>
<th>Total Hits</th>
<th>DBoard</th>
<th>Announce</th>
<th>Content</th>
<th>Email</th>
<th>Staff Info</th>
<th>Comms</th>
<th>Collab</th>
</tr>
</thead>
<tbody>
<tr>
<td>March (to 10.3.05)</td>
<td>13</td>
<td>1274</td>
<td>870 (68)</td>
<td>203 (16)</td>
<td>150 (12)</td>
<td>22 (2)</td>
<td>8 (1)</td>
<td>17 (1)</td>
<td>4 (0.3)</td>
</tr>
<tr>
<td>April</td>
<td>12</td>
<td>403</td>
<td>268 (67)</td>
<td>83 (21)</td>
<td>45 (11)</td>
<td>3 (1)</td>
<td>3 (1)</td>
<td>1 (0.2)</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>11</td>
<td>487</td>
<td>224 (46)</td>
<td>128 (26)</td>
<td>76 (16)</td>
<td>15 (3)</td>
<td>10 (2)</td>
<td>8 (2)</td>
<td>6 (1)</td>
</tr>
<tr>
<td>June</td>
<td>11</td>
<td>79</td>
<td>24 (30)</td>
<td>27 (34)</td>
<td>14 (18)</td>
<td>6 (8)</td>
<td>3 (4)</td>
<td>3 (4)</td>
<td>2 (3)</td>
</tr>
</tbody>
</table>

As can be seen from the data in Table 2, the total number of hits tails off as trainees enter the final phase of the course and move to full timetables in placement two around the end of March, beginning of April. The visits and hits for the month of June coincide with the days when trainees attended university. The number of trainees on the course remains fairly constant, only dropping by two from March to June, BB site usage drops off significantly over those months, particularly at the very end of the course when trainees have completed their second placement at the end of May.

4.2 Synchronous chat sessions

The synchronous chat sessions were conducted in November and December as previously stated. The 16th November session (approximately half way through the first placement) was set up for 6pm and ran for an hour. A total of four trainees participated, three male and one female. The second chat session was set up for 16th December at 6.30 pm, to 7.30 pm (a later time than for the previous session at the request of the students. This session was terminated early because of technical difficulties wit the BB site that prevented access to the ‘chat room’ for some participants. The archive from the November session is summarised below:

Table 3: Summary of the synchronous chat session 16th November 2004

<table>
<thead>
<tr>
<th>1. Overall feel of the session</th>
<th>2. Discussion topics covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very informal. Language was friendly, often humorous, and questions were open, how, what, tell us more, can I check...? and so on. Trainees always asked about each other's well being when they joined. Closed questions were used only when clarification of a point was required. The discussion remained very friendly and informal throughout the session independent of who joined later in the session.</td>
<td>Placement visits and arrangements. Teaching observations and teaching practice. Assignments, and help with them. Use of BB. Contact with other students. Lessons and lesson plans. The use of Plan B in lessons. ICT and other problems in lessons. The levels of work and pupils being taught on teaching practice. GCSE and Key Skills questions preparation. The difference in ability between pupils in the various schools. How to engage pupils, ideas for the practicalities of this, using PowerPoint, electronic whiteboards, and online options. Length of teaching sessions. Some personal questions. Different ideas of how to get pupils to present work, the problems, solutions, ideas, shared experiences, starter activities, different ideas for lessons, and the activities in them, use of internet resources, group work.</td>
</tr>
</tbody>
</table>

There were problems with the messaging due to the time delay between answers to any given question. This made the messaging appear disjointed and unsynchronised, particularly when an answer to one question would appear after other questions had been asked. The time delay affected the flow of text to such an extent at times that it was difficult to facilitate the discussion between the trainees and between the trainees and the tutor. When asked if they had found the session useful, there were a number of positive responses from the students:
“[…] better than nothing but I do prefer face to face”
“but at least it is a form of real time communication”
“yeah some good ideas”
“yes [tutor’s name] definitely useful”

4.3 Group interview

A group interview was conducted with the trainees at the end of the course. The whole PGCE cohort, (a total of 11 trainees) participated, 10 male and one female. A summary of what was said is given in Table 4.

Table 4: Summary of responses from the group interview

<table>
<thead>
<tr>
<th>1. Was the BB site useful?</th>
<th>2. Priorities</th>
<th>3. Most/Least Useful Things on the BB Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful at the start of teaching practice – a ‘comfort blanket’ when you don’t know anyone – this was agreed by all. It needs to be the main point of contact if you want people to use it. Email was preferable. Technical problems at the start put you off. Handy for information – as a resource.</td>
<td>When asked about use of BB in terms of their priorities, the whole group confirmed that BB came after: Teaching practice and lesson planning. Assignments. Job hunting.</td>
<td>All agreed with a comment made that they would not miss it if it wasn’t there – it was an enhancement only. Only two in the group said they made it a habit to check it regularly as part of a work routine.</td>
</tr>
</tbody>
</table>

Some trainees found the documents on the site useful, and some found the discussions useful, but, ‘only if they got going’. Trainees also mentioned problems with technical issues and familiarisation as being issues for non participation.

5. Preliminary comparative analysis of data

It is beyond the scope of this paper to fully document the data from the online survey (questionnaire) used in this study. A summary of this data, however, is given in Table 5 for comparison with the other data sets.

Table 5: Summary of all data set findings

<table>
<thead>
<tr>
<th>Data Set</th>
<th>Summary of findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion boards</td>
<td>TP1 discussion board was the most used, followed by TP2, Assignments, Urgent and Interviews. TP1 had the most participants the other discussion boards had similar lower numbers of participants.</td>
</tr>
<tr>
<td>Synchronous chat session</td>
<td>Low participation rate. Very friendly and informal. Lots of topics covered. Very practical help offered. All participants found it useful.</td>
</tr>
<tr>
<td>Access to BB site statistics</td>
<td>Decrease in overall activity from March to June. Discussion boards were the most used feature on the site. Db and email usage decreased from March to June. Announcements and contents remained mixed (up and down). Access data for site shows no discernable pattern.</td>
</tr>
<tr>
<td>Questionnaire</td>
<td>Low time spent by trainees per week on BB. Mostly accessed for reading. 60% of the group made regular contributions. No real difference in use on/off placement or between TP1 and TP2. 80% of the group happy/satisfied about amount read and contributions of tutor. Trainees were less than happy with the level of their own contributions. 60% of the group said it enhanced their ITT but that the discussion boards were dominated by a few. Ideas for improvement and use of site were given. Trainees said that the use of email as communication far outweighs BB</td>
</tr>
</tbody>
</table>
Learning styles indicated are those of a preference for learning with and from others, interactions with others were given as important (except family). They like to participate, discuss, reflect and learn with and from others.

Group Interview All agreed that BB was a low priority and a comfort blanket at the start of TP1 only. BB needs to be available from the start of the course, and to be the main point of contact to increase usage and thus to make the discussion boards useful.

A comparison of all the data sets, given in Table 5 shows that the low participation rates observed for the BB site and the synchronous chat session, are supported by the responses to the questionnaire and the group interview. Low participation rates are also reflected in the interview comments and questionnaire returns, which show that the discussion boards are dominated by a few participants, and that the trainees preferred to use email rather than the discussion boards to maintain contact with each other. The trainees indicate, in their responses to the learning styles part of the questionnaire, a preference for socio-constructivist type learning. That is, learning through interaction with others. The responses showed a preference for participation, discussion, and reflection with each other. The comments made at the group interview support this data, and also give some indications for improvement of the use of the VLE for future groups. These are discussed in detail in the following section. This preference for interaction with others as a way to learn on the course is something, however, that is not reflected in the use of the BB site. This preference for socio-constructivist type learning may be something that may not be transferable from face to face to online situations, as indicated by the low participation rates.

6. Discussion and Analysis

In this section of the paper it is intended to present ideas on what the findings of the study might mean, and also what they offer in terms of recommendations for future work in this area. Data from the study indicates that the VLE was, at best:

- An enhancement only.
- Useful for information but not really used significantly as an interactive and collaborative tool.
- A comfort blanket at the start of placement only.
- A low priority.

As with other studies, (Galanouli and Collins, 2000) this study found that the frequency of communication falls off during school placement, though not due to network access, more because of the reasons stated above. Earlier research has recognised that tutors also need time to prepare the resources and structure the VLE, and to maintain the site throughout the academic year (Angier, 2004). In this study, there was a lot of work done by the tutor, for not very much in return in terms of benefits to students - according to the data collected from them. A balance is required of time spent by tutor against benefits to students, and it may be more appropriate to look at alternatives to running and interactive VLE for ITT, even if this means going against the tide of pressure to use interactive, collaborative, electronic resources across all education sectors (DfES, 2005). Trainees on such an intensive course as ITT need to make rational workable decisions about what to spend their time on, and how to prioritise tasks. In doing so, they tend to look to where they will get the most benefit for the least effort, because their time is both very precious and very limited. There may have been consequences of these particular groups of trainees having already got an IT degree, for example, one reason for their lack of participation may be that they already have well established means of working with technology for communications and were not prepared to change in the light of other pressures on this course. There is still much to be learnt about the way trainee teachers perceive the benefits of using e-learning tools while on placement. It is also a recognised that we need to focus on how best to use the technology available to us, how to use it sensibly and why, (Williams, 2003). For some the cost of time is a prohibitive factor when so many other pressures challenge their daily routines. Given the intense pressures of the course, trainees may have chosen to use email over BB as their preferred method for communications with their peers, particularly when time constraints were so restricted. Other research has also shown that students do not always use the online learning environment in all the ways that might have been intended, or indeed in the most effective ways, and has also indicated what steps can be taken to ensure that student use is as effective as possible (Beasley and Smith, 2004). Other software, such as HICOM, enables trainees to participate in discussion boards via email, and this may have affected the results found in this research. This
facility, however, is not yet available with BB. As such, it is difficult to tell, at this stage, whether the low participation of the group as a whole, is an effect of the nature of this specific group, or linked to more general phenomena, such as the tendency of small numbers of participants to dominate the discussion boards. Analysis of data from subsequent cohorts will enable this particular theme to be investigated further. From the results of this study a minimum pedagogical framework is proposed as a way forward to improving the use of online learning environments on courses such as this.

6.1 A minimum pedagogical framework for the implementation of VLEs in teacher training

From the analysis of the initial findings of this study, a pedagogical framework for the implementation of VLEs for ITT is as proposed as follows:

- Ensure that trainees have access to the site and are familiar with it.
- Engender/encourage the trainees to become a face to face learning community prior to the geographical separation of placement, including the use of peer to peer assessment, and also using collaborative exercises to build their confidence in, and respect for each other. Embed the use of the site in the face-to-face sessions to model good practice, for example, using the site to access course information and link to other useful sites.
- Make the site the focus of communications on the course – give them a need for it.
- Provide online peer to peer collaboration exercises that can only be done via the VLE.
- A critical mass of active participants – pivotal to the success of this type of online learning and participation.
There are some aspects of face to face teaching and learning that are difficult to replicate using e-learning technologies (Tanner and Jones, 2000). This is arguably the case for the type of interactions that occur on a PGCE course. In these courses, the modelling of good practice that occurs in university sessions means that trainees are frequently involved in peer to peer interactions, group work and discussions, whole class brainstorming, and ultimately, in collective reflection and analysis. This is not necessarily something that is easily replicated online. It was certainly not replicated in this study, as indicated by the preference of trainees for socio constructivist types of teaching and learning when face to face, that were not deployed online. Continuation of this study over a number of years, with successive PGCE cohorts, using the pedagogical framework described here as part of the iterative ongoing research, will enable further knowledge to be gained concerning possible ways forward for enhancing placements on initial teacher training.

7. Conclusion
The paper has presented the findings of this study as a work in progress. It proposes a minimum pedagogical framework for initial teacher training in order to enhance the placement experience of geographically isolated students. The practical steps taken to improve and enhance the experience of trainees on placement will be reviewed and investigated over the coming months.

8. Biographical Details
Alison Hramiak has worked for nine years teaching and managing e-learning. She has worked in all three education sectors, schools further and higher, and has published in journals and at conferences. She has Doctorate in Education. Alison Hramiak is a senior lecturer at Sheffield Hallam University, and is the Course Leader for the Secondary PGCE in Applied ICT and also teaches on the Masters in E-Learning and Multi Media, and Doctorate in Education. Her research interests are in the field of the application of e-learning to teaching and learning, and the professional development of teachers, particularly through the use of VLEs within secondary education.

References


Online Communities of Practice Enhancing Statistics Instruction: The European Project EarlyStatistics

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Abstract: Acknowledging the fact that teachers are at the heart of any educational reform effort, the European Union funded project EarlyStatistics aims to enrich European children’s learning of statistics by offering their mathematics teachers a high-quality online professional development program. A central conviction underlying the design of the program is that learning as part of a community of practitioners can provide a useful model for teacher professional development. Teachers participating in the program will form a virtual community of practice, which will support best practices and innovation in statistics education by providing access to a wide array of colleagues, discussions, and resources eluding teachers in their workplaces.

Keywords: community of practice, professional development, statistics, distance education

1. Introduction

The Lisbon European Council of 2000 placed the development of a knowledge-based society at the top of the Union’s policy agenda, considering it to be the key to the long-term competitiveness and personal aspirations of its citizens. Statistics education is a key factor in achieving the objective of an educated citizenry. In a world where the ability to analyse, interpret and communicate information from data are skills needed for daily life and effective citizenship, statistical concepts are occupying an increasingly important role in mathematics curricula. Statistics education is becoming the focus of reformers in mathematics education as a vital aspect of the education of citizens in democratic societies (National Council of Teachers of Mathematics [NCTM], 2000). Despite the larger place for statistics in mathematics curricula, the research literature indicates that people continue to have poor statistical reasoning even after having formally studied the subject. Most college-level students and adults have little understanding of data beyond the simple – and often misleading – bar charts and pie charts encountered in the media (Rubin, 2002), and exhibit a strong tendency to attribute deterministic explanations to situations involving chance (e.g. Hirsch and O’Donnell, 2001). While university level statistics instruction can indeed be successful in helping students improve their stochastical reasoning (e.g. Meletiou-Mavrotheris and Lee, 2002), poor intuitions and biases acquired early on can be extremely difficult to change (Fischbein, 1975). It is now widely recognised by leaders in mathematics education that the foundations for statistical reasoning should be built in the earliest years of schooling rather than being reserved for high school or university studies (NCTM, 2000).

Statistics has already been established as a vital part of the school mathematics curriculum in many countries. However, instruction of statistical concepts is, similarly to the college level, still highly influenced by the formalist mathematical tradition. Deep-rooted beliefs about the nature of mathematics as a subject of deterministic and hierarchically-structured knowledge are imported into statistics (Makar and Confrey, 2003), affecting instructional approaches and curricula and acting as a barrier to the kind of instruction that would provide students with the skills necessary to recognise and intelligently deal with uncertainty and variability. Intuition and mindset about data and variation are systematically ignored in the mathematics classroom (Meletiou-Mavrotheris and Stylianou, 2003). One of the most important factors in any educational change is the change in teaching practices. Teachers are in the critical path to the implementation of any innovation (Frykholm, 1999). The direct relationship between improving the quality of teaching and improving students’ learning in mathematics is a common thread emerging from educational research (Stigler and Hiebert 1999). For it is what a teacher knows and can do that influences how she or he organises and conducts lessons, and it is the nature of these lessons that ultimately determines what students learn and how they learn it. Statistics has been introduced into mainstream math curricula without adequate attention paid to teachers’ professional development. As Lajoie and Romberg (1998) point out, statistics may be as new a topic for teachers as for children. The majority of teachers have been trained in very traditional mathematics classrooms with little or no exposure to statistical concepts, and, as a result, have very limited knowledge of statistical content and its pedagogy. Many of the senior teachers have
never formally studied statistics. Younger teachers may have taken an introductory statistics course at
college, such a course however does not typically adequately prepare future teachers to teach
statistics in ways that develop students’ intuition about data and uncertainty (Rossman et al., 2006).
College-level statistics courses are often lecture-based and do not allow pre-service teachers to
experience the model of data-driven, activity-based, and discovery-oriented statistics they will
eventually be expected to adopt in their teaching practices.

There is substantial evidence of poor understanding and insufficient preparation to teach statistical
concepts among both pre-service and practicing teachers (Carnel, 1997; Begg and Edward, 1999).
Most teachers are likely to have a weak understanding of the statistical concepts they are expected to
teach and relatively deterministic epistemological sets, often sharing the same misconceptions
regarding the stochastic as their students (Carnel, 1997). As a result, they tend to focus their
instruction on the procedural aspects of probability and statistics, and not on conceptual
understanding (Nicholson and Darnton, 2003; Watson, 2001). The arid, context-free landscape on
which so many examples used in statistics teaching are built ensures that large numbers of students
never see, let alone engage in, statistical reasoning. In order to make statistical thinking accessible by
all students, there ought to be fundamental changes to the instructional practices, curricular materials,
tools and cognitive technologies employed in the classroom to teach statistical and probabilistic
concepts. If the statistics classroom is to be an authentic model of the statistical culture, it should
provide ample opportunities for experimentation with stochastical ideas in varied contexts. It should
courage statistical inquiry and data modelling rather than teaching methods and procedures in
isolation (Lehrer and Schauble, 2004). It is only through exploration and experimentation that students
will appreciate the wide applicability and practical usefulness of statistical tools. Advances of
technology provide us with new tools and opportunities for the teaching of statistical concepts to
young learners. These new technological tools are, in fact, designed explicitly to facilitate the
visualisation of statistical concepts by providing a medium for the design of activities that integrate
experiential and formal pieces of knowledge, allowing the user to make direct connections between
physical experience and its formal representations (Pratt, 1998; Meletiou-Mavrotheris, 2003;
Paparistodemou and Noss, 2004). Having such a set of tools widely available to students has the
potential to significantly change the curriculum—to give students access to new mathematical topics
and insights by removing computational barriers to inquiry (Rubin, 1999). Students can experiment
with statistical ideas, articulate their informal theories, use them to make conjectures, and then use
the experimental results to test and modify these conjectures. There is evidence that use of such
software in the statistics classroom promotes conceptual change in students and leads to the
development of a more coherent mental model of key statistical and probabilistic concepts (Bakker,

Technology advances, and especially web-based training, also provide new opportunities for teacher
professional development. Internet technologies make it possible to overcome restrictions of shrinking
resources and geographical locations and to offer, in a cost-effective and non-disruptive way, high
quality collaborative learning experiences to geographically dispersed teachers across Europe. The
web offers the potential for teachers in different countries to collaborate and build communities of
practice in social constructivist learning environments. Collaborative and participatory communities of
teachers have been shown to act as vehicles that promote teacher learning and development (Tinker
and Haavind’ Concord Consortium 1997). In this article, we provide an overview of EarlyStatistics, a
project funded by European Union under the Socrates-Comenius action, which was designed in
response to the high level of interest in statistics and the need for further improving the quality of
statistics education offered in European schools. EarlyStatistics aims to provide high quality online
professional development in statistics education to elementary and middle school mathematics
teachers around Europe. The project harnesses the power of the Internet to provide European
teachers with access to a wide array of colleagues, discussions, and resources eluding them in their
workplaces (Zern, 2002). It supports the development of a virtual community of practice that will help
teachers to improve their teaching practices in statistics by exchanging ideas and sharing best
pedagogical strategies (Gray, 2004).

2. Project description

2.1 2.1 aims and objectives

The overall aim of EarlyStatistics, which began in October 2005 and will run for three years, is to
enhance the quality of statistics education offered in European elementary and middle schools by facilitating intercultural professional development of teachers using exemplary web-based educational tools and resources. Acknowledging the fact that teachers are at the heart of any educational reform effort the project consortium, comprised of five partner institutions in four European countries (Cyprus, Greece, Norway, and Spain), utilises distance education to offer high-quality professional development experiences to geographically-dispersed teachers across Europe. More specifically, the project has the following objectives:

- Developing and pilot testing an intercultural online professional development course in statistics education for elementary and middle school teachers. The design of the course is based on current pedagogical methodologies utilising collaboration, statistical investigation, and exploration with online interactive problem-solving activities.
- Conducting a teaching intervention into the classrooms of the teachers attending the pilot professional development course. The materials and resources developed will be evaluated and revised through real-classroom implementation.
- Developing a multilingual information base to support and promote the program’s activities and objectives by offering open access to the professional development course content and pedagogical approach, and to various other links and resources.
- Initialising networking among teachers across Europe by building an online community for the exchange of ideas, content, tools, and instructional practices relating to statistics education. The long-term objective is to sustain and, if possible, expand this community into a pan-European network of communication.
- Developing a pedagogical framework that provides recommendations on how to take advantage of available web-based technologies for the effective delivery of high-quality online teacher professional development in statistics education through the establishment of a virtual community of practice.

2.2 Pedagogical and didactical approach

The process of improving student learning through technology integration is never solely a technical matter, concerned only with properties of educational hardware and software (Shamatha et al., 2004). Research on cognition and learning has recently been synthesised to focus on four components that are fundamental for the successful establishment of any learning environment: learner, knowledge, community, and assessment (National Research Council [NRC], 2000). These four interlinked components are essential for the successful establishment of any learning environment, whether for student or teacher learning. Thus, they form a theoretical framework on which to base an understanding of the necessary characteristics of an effective learning environment (Shamatha et al., 2004). This Effective Learning Environment Framework was employed in the study to guide the design of the EarlyStatistics professional development program. The program learning environment is carefully designed to be learner-centred, community-centred, knowledge-centred, and assessment centred.

2.2.1 Learner-centred environment

Distance education is a useful framework for in-service teacher training, but it can represent a large variety of pedagogical perspectives. The most common approach is to follow a highly structured format, setting objectives and sub-objectives in detail and designing tasks to fit these objectives. EarlyStatistics adopts a very different approach to teacher online professional development. Recognising the fact that professional development is most effective when deeply contextualised in the teacher’s professional activity (Smylie, 1995) and that teachers will bring a diverse variety of strategies into the program as a result of their own professional experiences, the project uses an approach that respects and utilises teachers’ professional knowledge. The distance education environment is being designed as a framework for flexible learning (Collis and Moonen, 2001), regarding teachers as the main agents of their professional development, supported by an environment rich in challenges and interactions. Rather than using text-based, static content, that tends to be the norm in distance education of mathematics/science courses, teachers will be provided with ample opportunities for interactive learning through use of contemporary multimedia and Internet technologies. We foster a supportive and engaging learning environment, in which the teachers will be actively involved in constructing their own knowledge, through their own experiences and participation. We will engage participating teachers in the process of learning and help them develop
their pedagogical and content knowledge of statistics through authentic educational activities such as projects, experiments, and computer explorations with real and simulated data, group work, and discussions. This active, learner-centred environment, will serve as a model to the participating teachers as to kind of learning situations, technologies and curricula they should employ in their own classrooms.

2.2.2 Knowledge-centred environment

In addition to being learner-centred, EarlyStatistics also has a clear focus on learning objectives. It aims to improve teachers’ content and pedagogical knowledge of statistics. To help teachers to go beyond procedural and rote memorisation and to acquire a well-organised body of knowledge (NRC, 2000), the professional development program under construction emphasises and revisits a set of central statistical ideas (GAISE, 2005), rather than presenting statistical content as a sequenced list of curricular topics. The conceptual “Framework for Teaching Statistics within the K-12 Mathematics Curriculum”, developed by a group of leading statistics and mathematics educators (GAISE, 2005), is being used to structure the presentation of content. This framework uses a spiral approach so that instructional programs from pre-kindergarten through high school encourage students to gradually develop understanding of statistics as an investigative process that involves four components: (i) clarifying the problem at hand and formulating questions that can be answered with data; (ii) designing and employing a plan to collect appropriate data; (iii) selecting appropriate graphical or numerical methods to analyse the data, and (iv) interpreting the results. This spiral organisation of content will help teachers understand statistics as a comprehensive approach to data analysis. Using real data, active learning and technology, participating teachers will learn where the “big ideas” of statistics apply and how, and will develop a variety of methodologies and resources for their effective instruction at different levels of schooling.

2.2.3 Community-centred environment

Central to the design of EarlyStatistics is the belief that learning as part of a community of practice can provide a useful model for teacher professional development (Barab and Duffy, 2000). Community of practice (Wenger, 1998) is a theoretical construct grounded in an anthropological perspective that examines how adults learn through social practices (Gray, 2004). A community of practice consists of a group of individuals with a shared domain of expertise, who engage in a process of collective learning about practices that matter to them (Wenger, 1998). Teachers participating in EarlyStatistics will interact and learn about statistics by engaging in joint activities and discussions, helping each other, and sharing best pedagogical strategies. Through these interactions, they will build relationships and form a community that will support best practices and innovation in statistics instruction. This online community of practice, which will promote the sharing of multiple, multinational perspectives, will shape not only the teachers’ identity as practitioners, but also the identity of the practice itself (Gray, 2004).

2.2.4 Assessment-centred environment

Assessment is an integral component of EarlyStatistics. It is aligned with learning goals, focusing on understanding of key ideas and not just on skills, procedures, and computed answers (GAISE, 2005). The learning environment is being designed so as to enable the research team to continuously monitor teachers’ progress and to provide timely feedback. We will use a multitude of assessment instruments to evaluate, while at the same time also help to improve, teachers’ evolving ideas about statistical concepts and their instruction. Moreover, teachers will be provided with multiple opportunities for self-assessment. Most of the hands-on and technology-supported instructional activities developed through the program require teachers to first make conjectures about the expected results, then to test these conjectures through computer simulations or other data explorations, and finally to reflect on and to evaluate on their results and to compare and contrast them to those of other people. There will also be several low-stakes assessments included for participants to monitor their own progress, as well as some infrequent (Gould and Peck, 2004).

2.3 Project outputs

The following outputs are expected as a result of the EarlyStatistics project activities:
2.3.1 Curricular and instructional materials for statistics teaching and learning

The consortium has/will spend the first two years of the project in designing and developing, using contemporary web-based tools and resources, a line of research-based curricular and instructional materials on statistics for elementary and middle school teachers and students to be used during the professional development course. Central to the development of the material is the functional integration of technology with existing core curricular ideas, and specifically, the integration of new types of tools (e.g. the dynamic statistics software Fathom© (Finzer, 1999), and Tinkerplots© (Konold, 2005)), which will provide teachers, and subsequently their students, with the opportunity to model and investigate real world problems of statistics. The course material is being produced in the partners’ national languages, as well as in English. This material, which will be evaluated and revised through real-classroom implementation, will be added to the project information base (see 2.3.4 below).

Figure 1: Structure and content of earlystatistics professional development course

2.3.2 A professional development course in statistics education for elementary and middle school teachers

The main outcome of the project will be the professional development course in statistics education for elementary and middle school teachers. The course is currently under development, and will be pilot tested during the final year of the project with a group of 30-40 teachers from the four partner countries. As seen in Figure 1, the course will aim at enriching the participating teachers’ (i) knowledge of and about statistics; (ii) knowledge about teaching and learning, and (iii) practical knowledge. This will be achieved through a four-stage course that will last for 13 weeks. During the first stage (weeks 1-4), the emphasis will be on enriching the participants’ content knowledge of statistics. Through hands-on and computer-based practice and experimentation, intensive use of simulations and visualisations, feedback from each other and reflection, teachers will come to gain better understanding of some of the bedrock concepts in probability and statistics that should be integrated into the elementary and middle school mathematics curriculum. Teachers will then spend the next four weeks (weeks 5-8), focusing on children’s learning and what is required to involve them in learning about statistics. They will explore a broad range of topics of interest to the statistics teacher, including computer-supported teaching (use of educational software, Internet resources etc.), curriculum issues (e.g. role of statistics in the national and European mathematics curricula), and statistics education research (development of statistical reasoning in children, common student misconceptions, etc.). At a next stage (weeks 9-11), teachers will undertake a teaching experiment.
They will customise and expand upon materials provided to them, and apply them in their own classrooms with the support of the design team. Teachers will write up their experiences, including a critical analysis of their work and that resulting from their pupils. This will help them to reflect on their practice and apply self-criticism constructively. Finally, once the teaching experiment is completed, teachers will report on their experiences to the other teachers in their group, and will also provide samples of their students’ work for group reflection and evaluation (weeks 12-13). They will exchange ideas and insights as to how to further improve their teaching practice and to increase their students’ achievement.

Since the course will contain both theoretical and practical content, and will be used for the education of adult learners, we assume that the best approach is to present content in a way that is relevant for the teachers. Teachers will participate in a number of collaborative and participatory activities that will help them improve their content and pedagogical knowledge of statistics, and, being actual practitioners, will then apply what they learn in the course to a real classroom setting. The course will be delivered, for the most part, online through text, illustrations, animations, audio/video, technology-rich interactive problem-solving activities, and multilingual interfaces. The instructional content and services on the project dedicated information base will be utilised for teaching, support and coordination purposes. The course material will also be available in CD/DVD format to overcome potential bandwidth limitations. To offer teachers flexibility and to accommodate different time zones, the largest portion of the course will be delivered asynchronously. Asynchronous means of communication will include discussion groups and mail groups. There will also be some synchronous communication through use of technologies such as digital blackboards, audio/video streaming, and videoconferencing. One-way informational postings such as articles and videos will also serve as objects for supporting interaction (Barab et al., 2001a). Additionally, there will be a small number of face-to-face meetings with local teachers.

While there will not be specific ‘classroom hours,’ teachers will work in teams according to a loose schedule. Each week will typically involve a range of activities, readings and contributions to discussion, as well as completion of group assignments. Some weeks will also require teachers to create something, e.g. a PowerPoint presentation, which will be posted on the information base. The course will give special consideration to sociability issues that are important in establishing a functional online community of teaching practitioners. It will employ pedagogical and technology structures that will support the community’s shared purpose. The project information base will offer a variety of tools for professional dialogue and support (e.g. discussion forums, chat rooms, application sharing etc.). A number of strategies will be employed to encourage online dialogue and collaboration among community members, including the following:

- Participants will be assigned to small groups, and each group will be facilitated by an instructor
- Participating groups will receive periodic milestone group assignments
- Group, as well as whole class, discussion questions will be assigned.
- Monitored chat rooms and/or discussion forums will allow teachers to discuss and share content, ideas, and instructional strategies.

The course will be facilitated by members of the research team with expertise in statistics education. Their role will be to guide discussions, to encourage full, thoughtful involvement of all participants, and to provide feedback. Facilitators will help to deepen the learning experience for course participants by encouraging productive interaction and critical reflection on workplace practices (Gray, 2004). This will assist in developing and sustaining the online community of participating teachers over a period that will extend beyond the project lifetime.

2.3.3 A pedagogical framework for the effective delivery of high-quality online professional development in statistics education

At the initial stage of the EarlyStatistics project, the pedagogical and technical experts in the consortium worked jointly to develop a draft pedagogical framework to guide the design and delivery of the professional development course and, consequently, of the infrastructure and services for the dedicated information base that will support the project activities and outputs. This framework provides expert and practitioner recommendations for the effective delivery of online professional development to teachers of statistics through the establishment of a virtual community of practice. It incorporates both pedagogical and technical considerations (e.g. limitations in terms of equipment, software, protocols, and network bandwidth) regarding delivery of online professional development. It
takes into account technological, but also sociability issues that are important in establishing functional online communities (Barab et al., 2001b). The pedagogical framework will be revised based on knowledge gained through the pilot delivery of the professional development course and will be made available to the public. Online professional development designers and instructors in the field of statistics education will be able to benefit from access to this framework. The framework could also serve as a model for professional development programs in other content areas of mathematics and science.

2.3.4 Project information base

At the end of the project, final revisions and enhancements to the information base content and services will be made, and it will then be opened to all interested teachers and teacher educators. The information base will include:

- A hypertextbook with the material, resources, and activities of the professional development course to be used as a self-paced course, in a facilitated online mode, or as part or all of the material used in a face-to-face course or workshop;
- Technologically enhanced curricular and instructional materials for the teaching and learning of statistics in elementary and middle school;
- A Video Case Library containing segments of real teaching episodes, obtained in the classrooms of the teachers participating in the project, representing the landscape of practice in statistics instruction in Europe, for use by pre-service and in-service teachers and by teacher educators;
- A database containing Student Work Samples developed through contributions of participating teachers, providing examples of good practice in European schools that could also be used in teacher preparation and professional development programs;
- Reports and articles developed through the project;
- Links to statistics education resources available on the Internet;
- Collaboration tools for professional dialogue and support (e.g. email, chat rooms, discussion forums).

The information base will target long-term sustainability and maximum dissemination of innovative statistics curricula and teaching practices in different cultural contexts through supporting multilingual interfaces, transnational collaboration of teachers, and accumulation of collective knowledge from end-users. The system will provide a virtual space where European teachers of statistics with a broad range of experiences and expertise will come together to reflect upon pedagogical theory and practice, to exchange ideas and resources, and to build collaborations. It is expected that a network of education practitioners will be formed which will attract knowledge from teachers, but also from trainers and experts in the area of statistics education. The objective is that, after the end of the project, the information base will continue to be enriched by users that find added value in visiting the website for information and in publishing their experiences for other users to take advantage of new developments.

3. DISCUSSION

Over the past decade, a number of teacher educators have grown dissatisfied with traditional, individualistic, approaches to teacher professional development (Barab et al., 2002). They have come to recognise that for teacher professional development to become more effective in producing real changes in classroom practices, it ought to adopt new pedagogical models that foster a culture of sharing and sustained support for teachers (Guskey and Huberman, 1995; Barab et al., 2001b). Currently, most teachers suffer from professional isolation and have very limited opportunities for collegial interactions and exchanges (Zern, 2002). In order for them to become more successful in implementing reform, they should be afforded opportunities to engage in collaborative learning communities in which they can exchange ideas with other teachers and garner support as they try new strategies in their classrooms (Cochran-Smith and Lytle, 1999; Barab et al., 2002). EarlyStatistics aims to enrich European children’s learning of statistics by offering their teachers a high-quality professional development program that seamlessly combines best pedagogical practices in statistics education, adult education, and distance learning. Contemporary visions of web-based instruction and computer-mediated communication which support more participatory and collaborative models of education (Barab and Duffy, 2000; Barab et al. 2001b) guide the program design. The strategies employed include open-ended investigations, use of real-data, simulations, visualisations, collaboration and reflection on one’s own and on others’ ideas and experiences. Particular care is
being taken to build on teachers’ knowledge and experiences and to promote interactive learning and cross-cultural exchange of experiences and ideas. The ideas of collaboration and reflection, and of inquiry and exploration as processes of knowledge construction (Ponte, 2001), underpin the program’s design.

A central conviction underlying the design of EarlyStatistics is that learning is a social act best supported through collaborative activities (Vygotsky, 1978). While the project employs innovative technological tools and resources to support educationally useful human-computer interactions, its focus is on exploiting technology to support human-human interactions (Barab et al., 2001a). It is envisaged that teachers participating in the program will form a self-sustaining online community of practice within which they will improve their content and pedagogical knowledge of statistics through connecting and learning from each other in ways that would not have been possible in a more traditional, face-to-face professional development program. This virtual network of practitioners will be the main source for the publication of additional information on experiences and good practices in statistics instruction. The project outputs and services will be useful not only to teachers, but also to academic experts in statistics education, to national and European Education boards, to teacher training institutions, and to designers of online professional development programs. Academic experts and material developers will get more sensitised to the needs of statistics teachers in different countries, supporting the development of new professional development methodologies and materials grounded in a community-building model. Teacher training institutions will gain clearer understanding of the issues facing statistics teaching and learning and will be able to utilise the project outputs for further improvement of their teacher preparation programs. Online professional development designers will benefit from access to a pedagogical framework for effective professional development in statistics education via the emergence of an online space designed to support teachers in sharing and evolving their teaching practices. The ultimate beneficiaries will be students, who will eventually benefit from improved curricula and teaching practices.

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References


Agent-based Collaborative Affective e-Learning Framework

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Abstract: Based on facial expression (FE), this paper explores the possible use of the affective communication in virtual environments (VEs). The attention of affective communication is examined and some research ideas for developing affective communication in virtual environments are proposed. We place an emphasis on communication between virtual entities, which make use of other data apart from the information being communicated. In particular, we explore the capacity of VEs to communicate affective states, i.e. those aspects of communication concerned with emotional response, and discover how agents within VEs can model and use affective states to enhance the realism of the VEs. Moreover, we discuss the social intelligence that renders affective behaviours of software agents and its application to a collaborative learning system. We argue that socially appropriate affective behaviours would provide a new dimension for collaborative e-learning systems.

Keywords: affective communication, virtual environments, virtual entities, affective states, e-learning systems

1. Problem formulation

The field of affective computing was proposed and pioneered by Rosalind Picard (Picard 1997) from the MIT Media Laboratory. Her definition of affective computing is: “computing that relates to, arises from, or deliberately influences emotions.” Her argument for putting emotions or the ability to recognise emotions into machines is that neurological studies have indicated that emotions play an important role in our decision making process. Our “gut feelings” influence our decisions. Fear helps us to survive and to avoid dangerous situations. When we succeed, a feeling of pride might encourage us to keep on going and push ourselves even harder to reach even greater goals. Putting emotions into machines makes them more human and should improve human-computer communication. Also exploiting emotions could lead to a more human decision-making process. Consequently, in this paper, collaborative affective e-learning framework aim at reintroducing emotional and social context to distance learning while offering a stimulating and integrated framework for affective conversation and collaboration. Learners can become actively engaged in interaction with the virtual world. Further, the use of avatars with emotionally expressive faces is potentially highly beneficial to communication in collaborative virtual environments (CVEs), especially when they are used in a distance E-learning context. However, little is known about how or indeed whether, emotions can effectively be transmitted through the medium of CVEs. Given this, an avatar head model with human-like expressive abilities was built, designed to enrich CVEs affective communication. This is the objective of introducing the Emotional Embodied Conversational Agent (EECA) (Ben Ammar, Neji and Gouardères, 2006). We are arguing, then, that the use of peer-to-peer network in combination with collaborative learning is the best solution to the e-learning environments. Peer-to-peer (p2p) technology is often suggested as a better solution because the architecture of peer-to-peer networks and collaborative learning are similar. (Biström 2005). This paper explores CVEs as an alternative communication technology potentially allowing interlocutors to express themselves emotionally in an efficient and effective way. Potential applications for such CVEs systems are all areas where people cannot come together physically, but wish to discuss or collaborate on certain matters, for example in e-learning, based on the affective communication.

There are several novel elements to this research. Firstly, although CVEs as a technology have been available for more than a decade, user representations are still rudimentary and their potential is not well explored, particularly the avatar as a device for social interaction. Secondly, the use of emotions to complement and indeed facilitate communication in CVEs is equally under-explored. This is partly because early CVEs research was mainly technology driven, leaving aside the social and psychological aspects, and partly because the required computing, display and networking resources became available only recently. Thirdly, design guidelines for an efficient, effective, emotionally expressive avatar for real-time conversation did not exist prior to this research. The multi-agent methodology can certainly bring several advantages to the development of e-learning systems since it
deals well with applications where such crucial issues (distance, cooperation among different entities and integration of different components of software) are found. As a result, multi-agent systems, combined with technologies of networking and telecommunications, bring powerful resources to develop e-learning systems. In this research work, we propose emotional framework for an intelligent emotional system. This system is called EMASPEL (Emotional Multi-Agents System for Peer to peer E-Learning), based on a multi-agents architecture. (Ben Ammar, Neji and Gouarderes 2006).

2. Related works

Several projects implement learning systems based on multi-agents architectures. Some of them work on a generic platform of agents. (Silveira, Bica and Viccari 2000) For example, JTS is a web-based environment for learning Java language (Rivera and Greer 2001) based on a CORBA platform and using Microsoft agents. In this environment, learners have access to their learner models and are able to change it, in the case they do not agree with the information represented. Another example is I-Help, a web-based application that allows learners to locate human peers and artificial resources available in the environment to get help during learning activities. I-Help is an example of a large-scale multi-agent learning environment. (Vassileva, Deters, Greer 2001) Moreover, interesting results have been achieved by pedagogical agents (Johnson et al 2000) regarding the learner motivation and companion agents acting sometimes as mediators (Conati, Klawe and Socially 2000) of the learning process. Finally, tutor agents are usually related to learner modelling and didactic decision taking. A virtual learning environment (VLE) provides an environment based on network, and the resources in the network are free to share. Therefore, the study process can enhance the collaboration among learners. The VLE can help learners do cooperative study, and make necessary interactions between each other. For example, ExploreNet is a general-purpose object oriented, distributed two-dimensional graphic based computational environment with features to support role-playing games for educational purposes, and cooperative learning of many kinds. Among the research works, Prada (Prada, Otero, Vala, and Paiva 2004) in his Belief system implements an explicit collaborative mode of utilisation. The collaborative mode will challenge learners to share a virtual greenhouse. Each group will be able to alter some environmental conditions parameters to maximise their crop. Liu focuses on Web-based collaborative virtual learning environment (Liu 2005). He provides a cognitive learning architecture based on constructivism. The prototype learning system is effective based on the evaluation. Interaction can promote learners’ active learning. During the studying experience, interaction can offer the learner various controls, such as interacting with the virtual environment and manipulating characters or objects in the virtual environment. VLE technologies can address a wide range of interaction capabilities. Picard and her affective computing groups (Ahn and Picard 2005), describe affective wearable computers that are with users over long periods, like clothing, and that are therefore potentially able to build up long-term models of users’ expressions and preferences. The affective wearables offer new ways to augment human abilities such as assisting the speaking-impaired and helping remember important information that is perceived.

Synthetic characters with its significant feature of interactive and intelligent behaviour can provide a potential tool for learning in VLE. A number of worthy systems and architectures for synthetic character behaviour control have been proposed (Bruce, Marc and Yuri 2002). For example, Blumberg and his synthetic character groups focus on developing a practical approach for real-time learning using synthetic characters. Their implementations are grounded in the techniques of reinforcement learning and informed by insights from animal training. (Burke, Isla, Downie, Ivanov, and Blumberg 2001). Similarly, USC/ISI developed a pedagogical agent called Steve that supports the learning process. Agent Steve can demonstrate skills to students, answer student questions, watch the students as they perform tasks, and give advices if students run into difficulties. Multiple Steve agents can inhabit a virtual environment, along with multiple students. Therefore, it helps to make it possible to train students on team tasks. At the same time, giving synthetic characters with emotions and personality has a powerful ability to capture and hold students’ attention. Psychologists and pedagogues have pointed out the way that emotions affect learning. According to Piaget (Piaget 1989), it is incontestable that the affection has an accelerating or perturbing role in learning. A good part of the learners who are weak in mathematics, fails due to an affective blockage. Coles (Coles 2004) suggests that negative emotions can impair learning; and positive emotions can contribute to learning achievement. Some educational systems have given attention to generation of emotion in pedagogical environments (emotion expression and emotion synthesis) (Lester 1999) and to the learner's emotion recognition (Conati and Zhou 2002), pointing out the richness presented in affective
interaction between learner and tutor. We argue that socially appropriate affective behaviours provide a new dimension for collaborative learning systems. The system provides an environment in which learning takes place through interactions with a coaching computer agent and a co-learner, an autonomous agent that makes affective responses. There are two kinds of benefits for learning in the collaborative learning environment. One is what is often called ‘learning by teaching,’ in which one can learn given knowledge by explaining it to another learner. The other benefit is often called ‘learning by observation,’ in which one can learn given knowledge by observing another learner working on problem solving, teaching other learners, and so on. While in these approaches of collaborative learning, are primarily concerned with is knowledge-based, goal-oriented, and rational, and thus social intelligence might only be utilised as a side effect.

Affection in our framework is considered from various angles and on different levels.
- The emotional state of the learner will be modelled by an event appraisal system.
- The emotional state of the tutor is modelled as well, including values for emotions and parameters such as satisfaction, disappointment and surprise.
- The dialogue acts come in different forms with variation in affective values.
- Various affective parameters are used in determining which tutoring strategy to use and which instructional act to perform (sympathising or non-sympathising feedback, motivation, explanation, steering, etcetera).

3. Emotional concept ontology

A verbal dictionary can be described as a tool that aims to provide a partial solution for the problem where two persons neither understand the language the other is speaking but still want to communicate. One can just look up the meaning of the words of another language. A nonverbal dictionary has the same concept of a verbal dictionary, but it differs in the type of information that is stored. Instead of words, a nonverbal dictionary contains information about all the ways people communicate with each other nonverbally such as facial expressions in our case to construct the emotional ontology. It is well accepted that a common ontology holds the key to fluent communication between agents; most researchers believe that the common ontology is domain ontology. This assignment can be considered as the extension of a previous work, named FED (an online Facial Expression Dictionary) (Jongh 2002) concerning a nonverbal dictionary. Before we define our research question and objectives, we summarise the idea of a specific part of FED. We only focus on that part of FED, which allows the user to send a picture. This image input will be labelled by emotional word (happiness, sad, etc.). FED requires the user to manually locate the face and facial characteristic points (FCPs). The FCPs are predefined conform the Kobayashi and Hara face model. After manually selecting and submitting the points an emotional word will be output. Thus, FED lacks the ability of automatic extraction of facial characteristic points that are needed for the facial expression recognition process. In the current situation user interaction is needed to complete the whole procedure. In our system the emotional ontology(Cowie, Douglas 2005), cover the major role that helps the emotional agents’ to distinguish emotions. These knots represent features of a current emotion: for example labels or distances etc. that is the case of APML (Affective Presentation Markup Language)(VHML 2001).

4. Update of emotional markup language (EML)

What exactly do we mean by "emotion"? There is much disagreement on this, but one of the most useful definitions, by psychologist Magda Arnold, draws a careful distinction between states and behaviours. In Arnold’s theory emotional experience proceeds in three steps: (1) Perception and appraisal (external stimulus is perceived and judged good, bad, useful, harmful, etc., mostly based on learned associations); (2) Emotion (internal state of arousal or "feeling" arises, involving physiological effects); then (3) Action (specific behaviour such as approach, avoidance, attack, or feeding, depending on emotional intensity, learned behavioural patterns, and other motivations simultaneously present). In this view emotion is an internal state, not a behaviour or a perception of external reality. (Robert and Freitas 1984) The Emotion Markup Language (EML) (Marriott 2002) defines the emotion elements that affect the VH (virtual human) regarding voice, face, and body. The speech and facial animation languages therefore inherit these elements. We have realised some modifications to the APML (Affective Presentation Markup Language) (DeCarolis, Carofiglio, Bilvi, and Pelachaud) language in order to allow the EECA to communicate a wider variety of facial expressions of emotion as well as to allow for a more flexible definition of facial expressions and their corresponding
parameters. These modifications refer mainly to facial expressions timings as well as to their intensity; intensity corresponds to the amplitude of facial muscles movements. For each APML tag we have introduced some new attributes like frequency. The facial expression of an emotion has a limited duration (1/2 to 4 seconds), and the facial muscles cannot hold the corresponding expression for hours or even minutes without cramping.

4.1 Attributes of EML

EML is an XML (W3C 2002) (Extensible Markup Language) compliant text marks up language. This implies that it conforms to a standard for the World Wide Web and hence it can be used with (sufficiently powerful) web browsers.

- **Frequency:** the number of times an emotion is felt
- **Duration:** Specify the time taken in seconds or milliseconds of the emotion existence in the human being.
- **Intensity:** Specify the intensity of this particular emotion, either by a descriptive value or by a numeric value.
- **Wait:** Represent a pause in seconds or milliseconds before continuing with other elements of EML

4.2 Update of EML elements

In our framework we propose the EmotionStyle language, designed to define style in terms of multimodal behaviour, and make an EECA display, and recognise emotion accordingly. A new feature was added to the EML language. This was to add a distances and frequency attributes to EML in order to make to describe more carefully the facial expression. For each we have introduced some distances like D1 to D6.

- **Neutral**
  
  The neutral face represents the reference emotion. The concept of the neutral face is fundamental because all the distances describe displacements with respect to the neutral face.

  - **Description:** Facial expression. \{D1-D6\}=initialised
  - **Attributes:** Default EML attributes.
  - **Properties:** All face muscles are relaxed, the eyelids are tangent to iris, lips are in contact, the mouth is closed and the line of the lips is horizontal.

- **Angry**
  
  Description: Facial expression. \{D2 decreases\}, \{D1 increases\}, \{D4 either decreases D4 increases\}

  - **Attributes:** Default EML attributes.
  - **Properties:** The internal corners of the eyelids decrease together, the eyes are opened largely; the lips join each other or they are opened to make the mouth appear.

- **Disgusted**
  
  Description: Facial expression. \{D3 increases AND D4 increases\}, \{the other distances remain constants\}

  - **Attributes:** Default EML attributes.
  - **Properties:** The superior lip gets up and is stretched in asymmetrical manner, the eyelids are deconstructed.

- **Surprised**
  
  Description: Facial expression. \{D2 increases\}, \{D1 increases\}, \{D4 increases\}, \{the other distances remain constants\}

  - **Attributes:** Default EML attributes.
  - **Properties:** The eyelids gets up, the mouth is opened.

- **Happy**
  
  Description: Facial expression. \{D4 increases\}, \{D3 decreases and D6 decreases\}, \{the other distances remain constants\}

  - **Attributes:** Default EML attributes.
  - **Properties:** (the mouth is open), the commission are stretched back to the ears, the eyelids are stretched. The eyelids gets up, the mouth is opened.

- **Sadness**
  
  Description: Facial expression. \{D2 increases and D5 decreases\}, \{D1 decreases\}, \{the other distances remain constants\}

  - **Attributes:** Default EML attributes.
Properties: The internal corners of the eyelids to the height; the eyes are closed slightly; the mouth is stretched.

< Fear>

Description: Facial expression. \{D2 increases and D5 increases but more that D2\}

Attributes: Default EML attributes.

Properties: the eyelids get up together and their internal parts go to the height. The eyes are contracted and in alert.

4.3 Temporal facial expression features

The facial expression can be defined in relation with the time of changes in the facial movement and can be described according to these three temporal parameters:

- **Duration of Onset**: how much time is necessary for the emotion to appear?
- **Duration of Apex**: how much time the expression remains in this position?
- **Duration of Offset**: how much time so that the expression will disappear?

5. EMASPEL framework

5.1 Architecture

The figure 1 illustrates the architecture of a peer in our P2P e-learning system. In order to promote a more dynamic and flexible communication between the learner and the system, we integrate five kind of agent:

5.1.1 Interface agent

- Transmit the facial information coming from the learner to the other agents of the Multi-Agents System (MAS).
- Assign the achieved actions and information communicated by the learner, to agents Curriculum, EECA and the other agents of the MAS.

5.1.2 Emotional embodied conversational agent

5.1.2.1 Motivation

Agents cannot be content to be intelligent, but must be endowed also by emotions and personality. In the same way the communication in natural language is not enough, it must be doubled by nonverbal communication. Agents are able to give natural responses and therefore come across as believable and even interesting conversational partners. (Prendinger, Ishisuka 2004) Animated pedagogical agents are “lifelike autonomous characters that cohabit in learning environments with learners to create rich, face-to-face learning interactions”. Animated agents carry a personal effect, which is the presence of a lifelike character that can strongly influence learners to perceive their learning experiences positively (Alexander, Sarrafzadeh and Hill). It is widely accepted that animated agents capable of emotion expression are crucial to make the interaction with them more enjoyable and compelling for users (e.g. Lester, Towns, and FitzGerald 1999). Emotional behaviour can be conveyed through various channels, such as facial display (expression). The so-called ‘basic emotions’ approach (Ekman 1999) distills those emotions that have distinctive (facial) expressions.
associated with them and seems to be universal: fear, anger, sadness, happiness, disgust and surprise. More accurately, Ekman prefers to talk about (basic) emotion families. Thus, it consists to have many expressions for the same basic emotion. The characteristics of basic emotions include quick onset (emotions begin quickly) and brief duration, which clearly distinguish them from other affective phenomena such as moods, personality traits or attitudes. Note that only enjoyment and possibly surprise are ‘positive’ emotions. The enjoyment family covers amusement, satisfaction, sensory leisure, pride, thrill of excitement and contentment. Interestingly, the positive emotions do not have a distinct physiological signal. Ekman explains this by referring to the minor relevance of positive emotions in evolution.

5.1.2.2 Description
In the construction of embodied agents capable of expressive and communicative behaviours in the e-learning environment, an important factor is the ability to provide modalities and conversational facial expressions on synthetic faces. For example, an animated interface agent is now being used in a wide range of application areas including personal assistants, e-commerce, entertainment and e-learning environments. Amongst our objectives, is to create a model to generate and visualise emotions on embodied conversational agent. The emotions are particularly important for a conversational agent since they reveal an essential share of the speech through nonverbal signals. William James perceives the emotions like a direct response to the perception of an event contributing to the survival of the individual and insists on the changes induced on the body behaviour of the individual. The body answers initially in a programmed way of this change; constitutes so what one calls the emotions. The feedbacks of the body by the nervous system contribute largely to the experiment of the emotions. Research proved that the emotions succeed the facial expressions. During the learning process and when interacting with the learner, some tutoring agents may want to express affects. Thus, they use EECA, which is able, within a specific activity to translate through a character the emotions of the tutoring agent. It has to be aware of the concerned task and of the desired emotional reaction (by the designer or the concerned tutoring agent). The emotional state of EECA is a short-term memory, which represents the current emotional reaction. To be able to compute emotion, a computational model of emotion is required. Our approach was built on Fridja model. (Frijda 1986)

5.1.2.3 Design of EECAs
This sub-section is about the design of Emotional Embodied Conversational Agents (EECAs). In this field of Human Computer Interaction (HCI) and Artificial Intelligence (AI), the design of EECAs or ‘virtual humans’ and the communication between those agents and human users is the main object of research. A lot of effort was put into making ECAs more natural, believable, and making communication with ECAs more affective, efficient, and fun. One way to improve communication in this way is to make the agent more actively involved in building a relationship with the user. An agent that is able to observe the user, and with its personality, appearance, and behaviour is able to respond to the (implicit) likes and dislikes of the user, in such a way that it can become acquaintances with the user and create an affective interpersonal relationship. Such an agent could have additional benefits over a ‘normal’ Embodied Conversational Agent in areas such as e-learning. EECA is made of three layers (modules) (figure.2): the first one (perception layer) captures and extracts the facial expressions (image acquisition and face tracking) and proceeds to its categorisation (classification).

The second one (cognition layer) analyses and diagnoses the perceived learner’s emotional state. The third one (action layer) takes decision on remedy pedagogical actions to carry out in response to the actual emotional state. Tutoring agents are then informed and may access information in the new affective state to adapt the current tutoring flow accordingly. The cognitive layer includes two main processes named analysis and diagnosis. The analysis of an emotional state recognised by the perception layer makes it possible to translate the meaning of this emotion in the learning context. It is carried out by taking into account several elements including the recognised emotion, the current affective profile, the historic of the actions realised before the emotion expression, the cognitive state of the learner, the emotion evolution and the social context (if it corresponds to social or a collaborative learning).
Agents are virtual human beings. They are designed to imitate or model human Behaviour. Human Behaviour is complex and many-sided. Nevertheless it is possible to argue that human Behaviour can within limits be modelled and can thus be made comprehensible and predictable. Physical, emotional, cognitive, and social factors occur in all forms of human behaviour. Approaches, which regard human beings exclusively as rational decision makers, are of limited value. The modelling of human Behaviour plays an important role in all areas in which action planning, decision-making, social interacting and suchlike play a part. These areas include in particular: Sociology Teaching and education. Consequently, the internal state of the EECA agent is based on the PECS architecture proposed by Schmidt (2000). The PECS architecture is a model of agent that aims to simulating the human behaviour in a group. PECS stands for Physical Conditions, Emotional State, Cognitive Capabilities and Social Status. These are the four main building blocks of a particular PECS agent architecture adding a Sensor-Perception module and a Actor-Actor module. (figure.2) The PECS reference model aims at replacing the so-called BDI (Belief, Desire and Intention) architecture. (Rao 1995) Architectures, such as BDI, which conceive of human beings as rational decision makers, are sensible and useful to a very limited degree only. Restriction to the factors of belief, desire and intention is simply not appropriate for sophisticated models of real systems where human factors play an important role. PECS’s agent model consists of three horizontal layers:

1. **Information Input Layer:** This layer processes the input taken from the agent environment and consists of two components: The Sensor and Perception components. The sensor component takes the external data by means of a set of sensors and the Perception component filters the no relevant data and processes the information. The perceptions are used to update the mental state of the agent or for learning purposes.

2. **Internal Components Layer:** The personality of the agent is modelled at the second layer. Thus, the parameters of this second layer are crucial to find out the response of the agent to the input taken by the information layer. They consist of four components: Physics, Cognitive, Emotional and Social Status. The physical and material properties of the agents are modelled in the Physical component. The emotions that can affect the behaviour of the agent are modelled as part of the Emotional component. The agent’s experience and knowledge are part of the Cognitive component; and finally, the social features of the agent (e.g., whether the agents like to socialise or they prefer to be alone) are described in the Social Status component.

3. **Agent Output Layer:** This layer is in charge of modelling the set of possible actions and the selection process, and thus it produces the response of the agent and consists of two components: The Behaviour and Actor components. The Behaviour Component selects the action(s) that are associated with the input information that reaches the agent and the agent's response is based on its internal parameters. The actor component takes the action and executes them. The PECS architecture is not based on any social or psychological theory. The architecture is mainly an integrated model in which several fundamental aspects to human behaviour and decision-making process are taken into account. (Miranda and Aldea 2005). The purpose of the emotional agents consists at extracting the facial expressions (acquisition and facial alignment) and subsequently categorising them using the temporal evolution of distances $D_i$ like it is demonstrated in table 1. The analysis of table 1 shows that it will be possible to differentiate between different emotions while being interested in priority in the $D_i$ distances which undertake significant modifications. Indeed, there is
always at least one different evolution in each scenario. The EECA first carries out an analysis of the emotional state of the learner. The purpose of this analysis is to translate the meaning of the emotion in the training context. It is achieved based on several factors such as: the emotion sent by the emotional agents, the current emotional profile, the history of the actions carried out before the appearance of the emotion, the cognitive state, the evolution of the emotion and the social context (if it is about a social training or collaborative).

The expressions in input are “joy”, “fear”, “dislike”, “sadness”, “anger”, “surprised” and the analysis make it possible to conclude if the learner is in state of “satisfaction”, “confidence”, “surprise”, “confusion” or “frustration”. The interpretation of the analysed emotional state is then established. It will consequently determine the causes having led to this situation (success/failure with an exercise, difficulty of work, misses knowledge, etc), while being based again on the cognitive state of the learner and thus making it possible to the tutor to take, if it is necessary, the suitable teaching actions. The role of the action layer is to define, even if necessary, a whole of tasks that allows to remedy at the observed emotional state; in order to bring the learner in a state more propitious to the knowledge's assimilation. (figure.2). For this reason a collaborative reciprocal strategy in ITS can gain advantage from "mirroring" and then assessing emotions in P2P Learning situations.

5.1.3 The emotional agents

Integrated into a learning environment, aim at capturing and managing the emotions expressed by the learner during a learning session. They currently capture emotions only through facial expression analysis and they are in charge of learner emotion detection. They recognised the learner emotional state by capturing emotions that he or she expressed during learning activities. (Nkambou 2006). For making the affective communication between an EECA and a learner, they need to be able to identify the other’s emotion state through the other’s expression and we call this task emotion identification established by the emotional agents. Extracting and validating emotional cues through analysis of users’ facial expressions is with high importance for improving the level of interaction in man machine communication systems. Extraction of appropriate facial features and consequent recognition of the user’s emotional state is the topic of these emotional agents.

- Analysis of facial expression. The analysis of the facial expressions by the emotional agents is generally done according to the following stages: detection of the face, the automatic extraction of contours of the permanent features of the face: the eyes, the eyebrows, and the lips. Extracted contours being sufficiently realistic, we then use them in a system of recognition of the six universal emotions on the face.

- Recognition and interpretation of facial expression

![Figure 3: Definition of the distances D_i](image)

The Classification is based on the analysis of the distances computed on face's skeletons. The distances considered make it possible to develop an expert system (for classification), which is compatible with the description MPEG-4 of the six universal emotions. Contours of the eyes, the eyebrows and the mouth are extracted automatically by using the algorithms described in (NEJI, Ben Ammar and Alimi 2004, BEN AMMAR, Neji and Alimi 2005). The segmentation leads to obtain what we call skeleton of expression. Six distances were defined: D1: opening of the eye, D2: outdistance between the interior corner of the eye and the eyebrow, D3: opening of the mouth in width, D4: opening of the mouth in height, D5: outdistance between the eye and eyebrow and D6: outdistance between the corner of the mouth and the external corner of the eye (cf Figure 3).

- Joy: {D4 increases}, {D3 decreases and D6 decreases}, {the other distances remain constant}

- Sadness: {D2 increases and D5 decreases}, {D1 decreases}, {the other distances remain constant}
Anger: \{D_2 \text{ decreases}, \ D_1 \text{ increases}, \ D_4 \text{ either decrease D4 increases}\}

Fear: \{D_2 \text{ increases and D5 increases but more that D2}\}

Disgust: \{D_3 \text{ increases AND D4 increases}, \ \text{the other distances remain constant}\}

Surprised: \{D_2 \text{ increases}, \ D_1 \text{ increases}, \ D_4 \text{ increase}, \ \text{the other distances remain constant}\}

The table 1 gives a script evolution of the distance $D_i$ for the six emotions (↑ means increase, ↓ means decrease and " = " translates the absence of evolution). Notice that for the fear, we do not make any hypothesis on the evolution of D1 because we do not know how to translate the condition (eyes are contracted and in state of alert).

**Table 1**: $D_i$ evolution for every emotion

<table>
<thead>
<tr>
<th></th>
<th>$D_1$</th>
<th>$D_2$</th>
<th>$D_3$</th>
<th>$D_4$</th>
<th>$D_5$</th>
<th>$D_6$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joy</td>
<td>=</td>
<td>=</td>
<td>↑</td>
<td>=</td>
<td>↑</td>
<td></td>
</tr>
<tr>
<td>Sadness</td>
<td>↑</td>
<td>↑</td>
<td>=</td>
<td>=</td>
<td>↓</td>
<td>=</td>
</tr>
<tr>
<td>Anger</td>
<td>↑</td>
<td>↓</td>
<td>=</td>
<td>↑</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Fear</td>
<td>↑</td>
<td>↑</td>
<td>=</td>
<td>=</td>
<td>↑</td>
<td>=</td>
</tr>
<tr>
<td>Disgust</td>
<td>=</td>
<td>=</td>
<td>↑</td>
<td>↑</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Surprise</td>
<td>↑</td>
<td>↑</td>
<td>=</td>
<td>↑</td>
<td>=</td>
<td>=</td>
</tr>
</tbody>
</table>

The classification of an emotion is based on the temporal evolution of the information contained in the "skeleton" resulting from this stage of segmentation (temporal evolution of six characteristic distances). For example, joy and disgust differ by the evolution of the distance $D_6$. One notes that emotions (joy and surprise) differ by the evolution of distances $D_1$, $D_2$, $D_3$ and $D_6$. This permits a distinction between these two emotions.

### 5.1.4 Curriculum agent

Saves the history of progression of the learner in the exercise. While analysing the profile of the learner, this agent proposes sessions of activities subsequently to apply.

The agent curriculum keeps the trace of:

- The evolution of the interacting system with learner
- The history of progression of learner in the exercise.
- The agent curriculum carries out the following operations:
  - To manage the model of learner throughout the training.
  - To initialise the session of training by communicating the exercise to the learners according to their courses.
  - To be the person in charge for the individualisation of the training.
  - To carry out the update of the history of the learner model.
  - To record in the base of errors the gaps met (errors made by learner) to help the tutor to be useful itself of this base to direct its interventions.

### 5.1.5 Tutoring agent

The tutor's role is:

- To ensure the follow-up of the training of each learner.
- To support learners in their activities.
- To support the human relations and the contacts between learners.
- To seek to reinforce the intrinsic motivation of learner through its own implication from guide who shares the same objective. These interventions aim at the engagement and the persistence of learner in the realisation from its training.
- To explain the method of training and to help to exceed the encountered difficulties.
- To help the learner how he can evaluate his way, his needs, his difficulties, his rhythm and his preferences.
5.2 Implementation

5.2.1 The Interaction among agents

The interaction among human agents is not restricted to the proposed computational model. On the contrary, the computational interaction among the artificial agents aims at contributing even more for the communication and the exchange among the human agents. The interaction will be one of the main objectives of this model, because the proposal is about a model of collaborative learning. The several interaction forms involved in the model are interaction among artificial agents; interaction among artificial and human agents, and interaction among human agents. In respect to communication among the human agents, the system offers tools (synchronous or asynchronous) when physical presence is not possible (for example, in the case of virtual classes).

5.2.2 The organisational model

Our organisational model is based on the Agent, Group and Role Meta Model (AGR for short) (Ferber and Gutknecht 2003). This Meta Model is one of the frameworks proposed to define the organisational dimension of a multi-agent system, and it is well appropriate to the e-learning context. According to this model, the organisation of the system is defined as a set of related groups, agents, and roles. There are several reasons, which justify the importance of this Meta Model. The main reasons are the following: (i) it is possible to construct secure systems using groups viewed as “black boxes” because what happens in a group cannot be seen from agents that do not belong to that group. (ii) it is possible to construct dynamically components of system when we view system as an organisation where agents are components. Adding a new group or playing a new role may be seen as a plug-in process where a component is integrated into a system. (iii) Semantic interoperability may be guaranteed using roles because a role describes the constraints (obligations, requirements and skills) that an agent will have to satisfy.

5.2.3 Implementation

We programmed agents used in the EMASPEL Framework (figure 4) with the MadKit (Ferber and Gutknecht 1998) Platform. MadKit is a modular and scalable multi-agents platform written in Java and built upon the AGR (Agent/Group/Role) organisational model: agents are situated in groups and play roles. MadKit allows high heterogeneity in agent architectures and communication languages and various customisations. In fact, MadKit does not enforce any consideration about the internal structure of agents, thus allowing to a developer to freely implement his own agent architecture. Communication among agents is implemented by a set of communication primitives, which is a subset of FIPA-ACL (FIPA 2004), extended with specific primitives. We used the JXTA Framework (Gong 2002) to build an open source p2p network.

Figure 4 : EMASPEL Framework

6. Conclusions and further work

Emotion analysis may reveal if the learner feels “satisfaction”, “confidence”, “surprise”, “confusion”, or “frustration”. These states are more precise in an educational context and appropriate pedagogical actions can be taken in order to influence those emotions. Another important process is the diagnosis of the analysed emotional state. This process determines the possible causes which has led to this situation (success/failure in an exercise, difficulty of the tasks, lack of knowledge, incorrect command of the knowledge, etc.). This is done using the learner’s cognitive state and the history of his actions.
Showing emotions, empathy and understanding through facial expressions and body language is central to human interaction. More recently, emotions have also been linked closely with decision-making, problem solving and intelligence in general. We therefore argue that computer-based communication technologies ought to emulate this in some way. We have conducted an experimental study on visualisation and recognition of emotion in the human face and an animated face. The study used six "universal" facial expressions of emotion, as established by Ekman: happiness, surprise, anger, fear, sadness, disgust, together with the neutral expression. Results show that emotions can be visualised with a limited number of facial features, and build a potentially strong basis for communication in collaborative environments. To further establish the possible role emotions can play in collaborative environments, we are currently concentrating on real-time interaction. A group of people enters the virtual space and is assigned a task to complete.

The main objective of the experiment is to investigate how the perception of emotion affects individual and group experience in the virtual world. From the real world, we know that emotions of others influence us in our decisions and in our own emotional state. Emotions can motivate, encourage, can help us achieve things. But they can also change our mood to the negative, make us feel angry or sad when someone else feels that way. Emotions are contagious, and their contagious nature in the real world is potentially transferable and beneficial to the virtual world. The proposed framework mainly includes the peer-to-peer based network platform, for further work we would like to: Integrate the peer-to-peer based network platform into grid system. The newly emerged Peer-to-Peer (P2P) and grid computing will serve as the key driven forces to bring revolutionary impact on the future society.

Standardise the e-learning materials: we will implement the SCORM (ADL 2004) specification to describe the educational resources in EMASPEL, which will provide the interoperability with other system as well as the reusability of learning materials.

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An Effective Profile Based Video Browsing System for e-Learning

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Abstract: E-learning has acquired a prime place in many discussions recently. A number of research efforts around the world are trying to enhance education and training through improving e-learning facilities. This paper briefly explains one such attempt aimed at designing a system to support video clips in e-learning and explains how profiles of the presenters in video clips can be used to improve the usefulness of e-learning systems. The system proposed is capable of storing educational video clips with their semantics and retrieving required video clip segments efficiently on their semantics. The system creates profiles of presenters appearing in the video clips based on their facial features and uses these profiles to partition similar video clips into logical meaningful segments. The paper also discusses one of the main problems identified in profile construction and presents a novel algorithm to solve this problem.

Keywords: eigenfaces, eigenvectors, face recognition, image normalisation, principal component analysis, e-learning.

1. Introduction

E-learning is one of the fastest growing areas today. The main emphasis of e-learning is the management and delivery of quality teaching material electronically without the limitation of the learner access location and time. It includes the use of multimedia involving more than one form of media such as text, graphics, animation, audio, and video. Several approaches have been proposed to increase the acceptance and usage of existing e-learning platforms in education, but most of them are restricted in flexibility with regard to the content and adaptation to the user's skills (Lincoln et al (2001). Video Clips have been used widely in different application domains to deliver information efficiently and effectively. However, the large amount of visual information, carried by video documents requires efficient and effective indexing and searching tools to obtain their maximum benefit in an e-learning environment. The detection and recognition of faces in e-learning video clips where presenters explaining some phenomena, makes automatic indexing feasible to support assertions based on meaningful descriptions of content such as “presenter A and B talking about software engineering”. In recent years many different approaches to video indexing have been developed (Lorente and Torres (1998). Most methods for video indexing use low-level features like texture or colour. The main drawback of low-level feature oriented video indexing is that they fail to recognise people and hence person-based indexing is not possible. People are one of the most important types of object in video sequences. Therefore indexing approaches used in e-learning systems have to be extended to cover the detection and recognition of people in video sequences.

The paper describes an architecture that we have implemented to support the integration of video clip into an e-learning system and efficient use of such video clips in e-learning. In our earlier publications we have described a multimodal multimedia database system that we have developed to support content-based indexing, archiving, retrieval and on-demand delivery of audiovisual content in an e-learning environment (Premaratne et al 2005, 2004). In this system, a feature selection and a feature extraction sub-system have been used to construct presenter profiles. The feature extraction process transforms the video key-frame data into a feature vectors in multidimensional feature space. This process can be considered as an implicit mechanism that both summarises and normalise the key-frame data. The effectiveness of a feature extraction procedure depends on the accuracy of feature selection process, which identifies effective and representative features of the objects involved. In this paper, we propose a novel profile normalisation algorithm to construct presenter profiles effectively. One of the distinct features of the algorithm is that it is capable of generating profiles at different illumination levels. Our method consequently solves the profile overlapping in eigenspace problem by using certain parameters. This work refines our earlier approach for profile construction, which averages all sample key-frame data to construct the presenter profiles. The remainder of this paper is
organised as follows. The system architecture is briefly explained in Section two. Section three reviews a number of techniques related to our work. Section four explains our proposed algorithm for profile creation and profile normalisation. In sections five and six we give our evaluation and conclusion and finally in section seven we comment on future work possible based on this project and the experiences we have gained by using this system.

Figure 1: System architecture

2. System Architecture

The overall architecture of our system is shown in Figure 1. The main components of our architecture are: a Media Server, Meta-Data Database, Ontology and Object Profiles, Keyword Extractor, Keyword Organiser, Feature Extractor, Profile Creator and the Query Processor (Premaratne et al 2005, 2004). The functionality of each of these components are summarised in the following paragraph. The system stores all types of educational material varying from text documents to video clips in the media server. The keyword extractor extracts keywords from the main course materials and passes to the keyword organiser. The keyword organiser organises these keywords in ontology with links pointing to the respective documents to assist subsequent document browsing and retrieval. The feature extractor works on video clips and extracts audio and video features. These features are then used by the profile creator to construct profiles of presenters. Such profiles are subsequently used to create indices on the video clips. The query processor is the main user interface provided for the external users. It enables end users to browse and retrieve educational material stored in the media server easily and quickly by using the ontology and the indices managed by the system. The main emphasis of this paper is on the feature extraction and the profile creation and normalisation components of this system. The first step of the profile constructor is to extract features from the video Key-frames which containing most of the static information present in a shot. The main inputs to the profile constructor are these key-frames stored in the multimedia database (Figure 2).
Figure 2: Profile construction and recognition process
The presenter detection and recognition process detects the faces in the key frame and try to match it with the presenter profiles available in the profile database. If the presenter in the key-frames matches with a profile then the system annotates the video shot with the presenter identification and maps it with the metadata database. On the other hand, if the current presenter's key-frames do not match with the available profiles then the profile creator will create a new presenter profile and insert it in to the profile database. In the following sub sections we have summarised the functionalities of profile construction, profile normalisation and threshold construction processes. In section 4, the profile construction algorithm is explained in details.

2.1 Profile construction
The profile construction is based on Principal Component Analysis (PCA) (Lorente and Torres 1998, Pentland et al 1994, Turk and Pentland (1991). The idea is to represent presenter's facial features in a featurespace where the individual features of a presenter are uncorrelated in the eigenspace. The feature space comprises of eigenvectors of the covariance matrix of the key-frame features. In this approach, PCA is computationally intensive when it is applied to the facespace. Through the experience we gained from our initial experiments we have realised that the efficiency of the PCA process in this context can be improved substantially by limiting the analysis to the largest eigenvectors of related key-frames instead of all eigenvectors of key-frames.

2.2 Profile normaliser
Profile normaliser acquires available profiles from profile database and executes the normalisation algorithm and returns the normalised profiles to the database. Since we get key-frames from different lighting conditions we have to have a proper dynamic profile normalisation algorithm to maintain the accuracy of the profile matching algorithm to an acceptable level. Therefore we concentrate on two descriptors, normally the mean intensity and its standard deviation of the data set that we use to construct presenter profiles. After investigating the variation of the illumination and the deviation of the mean intensity and standard deviation of a collection of profiles, we have identified few parameters that can be used to develop an algorithm based on these parameters to normalise the profiles with respect to illumination.

2.3 Threshold constructor
For recognition, we employee Euclidian distance algorithm to compute the distance between each profile in the database and the input face (Turk et al 1991). As the minimum distance classifier, it works well even when the key-frames have relatively small lighting and moderate expression variations. The weakness of this technique is that its performance deteriorates with the lighting variations in the key-frames. We have realised that this problem can be overcome by changing the threshold levels of the detection and recognition process by using parameters derived from key-frame intensity values. In our system the threshold constructor will calculate the light variation of each profile and adjust the threshold levels accordingly.

3. Related Work
In face recognition, a lot of problems are still open, particularly in uncontrolled environments, due to lighting, facial expressions, background changes and occlusion problems (glasses or hair for example) (Adini et al 1993, Phillips et al 2005). One of the main challenges in face recognition is to distinguish between intrapersonal variations (variations in appearance of the same person due to different expressions, lighting, etc.) and extra-personal variations (variations in appearance between persons). Among the few attempts aiming at identifying people in video sequences, Michael C. Lincoln and Adrian F. Clark of the University of Essex have proposed a scheme for independent face identification in video sequences (Lincoln and Clark 2001). The main drawback of this approach is that the recognition will only be comparable to the best front-face-only frames. Unlike this technique, eigenfaces relatively insensitive to small variation in scale, rotation and expression. A face recognition system based on Self Organising Maps (SOMs) and Convolutional Neural Networks (CNN) has been developed by Steve Lawrence. The problem with the SOM is that it arbitrarily divides input space into
a set of classes of which the designer has no control or knowledge. Another problem with the neural networks is their inability to deal with the high dimensionality of the problem. For example to process an image of size 128 × 128 pixels requires a neural net with 16,384 input neurons. Furthermore, to train such a neural network, and ensure robust performance requires an extremely large training set (much bigger than 16,384). This is often not possible in real-world applications where only a limited number of images with different variations of an individual is available. The approach proposed by Turk and Pentland in 1991 is considered as one of the most successful systems for automatic recognition of human faces (Turk et al 1991). This approach is considered as a breakaway from contemporary research trend on face recognition techniques, which focused on detecting individual features such as eyes, nose, mouth, and head outline, and defining a face model based on position and size of these features, as well as geometrical relationship between them (Zhang et al 1997). The method uses the whole face region as the raw input to a recognition system, can be classified as an appearance based method.

4. Profile construction algorithm

In this section, we describe how we have improved the profile construction algorithm presented in Premaratne (2004, 2005). In our previous approach we have constructed presenter profiles by getting the average intensity values of the faces of presenters in the key-frames of the training set. From the results gathered we have realised that, our system performance deteriorates when the video key-frames are captured at different illumination conditions. The effects of illumination changes in key-frames are due to one of the two factors: The inherent amount of light reflected off the skin of the presenter, or the non-linear adjustment in internal camera control. Both of these conditions can have a major effect on facial features recognition. In our initial profile construction approach lighting variations result in producing similar profile for different presenter and hence overlap of profiles in the eigenspace (Figure 3).

![Figure 3](image-url) Profile overlapping in the n-dimensional eigenspace where axis X₁, X₂... Xₙ are the n-dimensions.

Even when there are only the illumination changes, its effects override the unique characteristics of individual features and thus greatly degrades the performance of state-of-the-art face recognition systems. We have come across a number of face image processing techniques as potential preprocessing step to improve the accuracy of the eigenface method of face recognition method (Broomhead and Kirby 2000, Chennubhotla et al and Dinggang ad Horace 1997). Also a number of attempts have been made to discover a relationship between mean, median and standard deviation of image intensities to construct a normalising algorithm to minimise the adverse effect of illumination on feature recognition (Broomhead and Kirby 2000). Motivated by Chennubhotla et al our research focused on finding out a suitable relationship between the mean and standard deviation of intensity values to improve recognition rate by separating out the overlapping profiles in the eigenspace. After conducting several experiments using these parameters we have discovered a strategy to reduce the effect of illumination by using the standard deviation (S) and the mean intensity (X̄) of intensity values of key-frames. We have developed an algorithm to implement this strategy. The salient stage in the algorithm is the image intensity normalisation process, which is applied to all key-frames in the dataset, every time a new key-frame is added to the dataset.

\[ key-frame_{ij}(x,y) = (key-frame_{ij} \times \overline{x}) \]
key-frame\(_{i,j}(x,y) = (x, y)\) pixel value of the \(j^{th}\) key-frame of \(i^{th}\) presenter

\[
\bar{X}_{i,j} = \text{Mean intensity of } j^{th} \text{ key-frame of } i^{th} \text{ presenter}
\]

Equation 1 describes how our method transforms the key-frames of a presenter to the eigenspace. After experimenting with different parameters we have observed that the overlapping problem of eigenfaces can be controlled by introducing a parameter \(\Gamma\) to this image transformation. The parameter \(\Gamma\) is based on the standard deviation and the mean of intensity values of key-frames known to the system and computed as given in equation 2.

\[
\Gamma = \frac{S + E_1}{S_{i,j}} + E_2 - (2)
\]

\(\bar{X}\) = Mean intensity of all key-frames

\(S\) = Standard deviation of all key-frames

\(S_{i,j}\) = Standard deviation of \(j^{th}\) key-frame of \(i^{th}\) presenter

The parameters \(E_1\) and \(E_2\) in the equation 2 are constants. To derive values for \(E_1\) and \(E_2\) we carried out experiments and analysed results on the recognition levels of the known presenters and unknown presenters. The sample set we used to determine these two constants included presenters with different illumination variations. One such result is shown below in figure 4. The values for \(S\) and \(\bar{X}\) are 100.02 and 23.24 respectively. A complete result set is obtained by varying the values of \((S + E_1)\) and \((\bar{X} + E_2)\). Only the best result is shown in figure 4. The recognition level can be described as the minimum value for a known face and the maximum value for an unknown face. The maximum recognition level 0.04 is obtained when \(S + E_1=140.02\) and \(\bar{X} + E_2=33.24\). To obtain the exact values for the \(E_1\) and \(E_2\) we experimented with 20 presenters using five different datasets (Jonathon et al 2000). By evaluating this result set we achieved constants \(E_1 = 40\) and \(E_2 = 10\).

**Figure 4:** Determine the constants

After the key-frames are normalised by using the equation 1, we calculate the eigenvectors and eigenvalues of the normalised key-frames for each set of key-frames corresponding to a particular presenter. Once the eigenfaces have been computed, each face can be viewed in the eigenspace. Furthermore, good representations of the profiles can be obtained getting the largest eigenvectors available (Figure 4).

**Figure 5:** A profile developed in face space

In Figure 5, a presenter profile is developed into the facespace. Since a face captured from a video key-frame is 128*128 pixels, the dimensions of the corresponding eigenvalues generated will be 16384 * 1. We use 10 face frames from each presenter, therefore the dimensions of the covariance...
matrix is 16384 * 10. Consequently calculating this matrix would be very time consuming for the processor. This is one of the problems in using PCA in pattern. To overcome this problem, a computationally feasible method must be used to calculate eigenfaces. One such approach to reduce the dimensionality in face recognition is to sort the eigenvector according to their corresponding eigenvalues. The traditional motivation for selecting the eigenvectors with the largest eigenvalues is that it represents the amount of variance along a particular eigenvector (Turk et al 1991). By selecting the eigenvectors with the largest eigenvalues, one selects the dimensions along which the gallery key-frames vary the most. If we define $e_i$ as the energy of the $i$th eigenvector, it is the ratio of the sum of all eigenvalues up to and including $i$ over the sum of all the eigenvalues:

$$- (3) \quad \frac{\sum_{j=1}^{i} \lambda_j}{\sum_{j=1}^{k} \lambda_j}$$

Kirby (2000) defines $e_i$ as the energy dimension. The variation depends upon the stretching dimension, also defined by Kirby. The stretch $s_i$ for the $i$th eigenvector is the ratio of that eigenvalue over the largest eigenvalue ($\lambda_1$):

$$- (4) \quad \frac{\lambda_i}{\lambda_1}$$

Experiments were carried by selecting 120 key frames of 12 distinct presenters including 10 frames from each presenter. The calculated 120 eigenvector are show below in descending order.

$$(1.8787+ 1.494+ 0.952+ 0.778+ 0.446+ 0.367+ 0.307+ 0.287+ 0.223+ 0.215+ 0.200+ 0.179+ 0.167+
0.155+ 0.133+ 0.121+ 0.116+ 0.098+ 0.095+ 0.087+ 0.076+ 0.074+ 0.070+ 0.066+ 0.061+
0.060+ 0.057+ 0.054+ 0.051+ 0.049+ 0.048+ 0.047+ 0.046+ 0.045+ 0.043+ 0.042+ 0.041+ 0.039+
0.038+ 0.036+ 0.035+ 0.034+ 0.033+ 0.032+ 0.031+ 0.030+ 0.029+ 0.029+ 0.028+
0.027+ 0.026+ 0.026+ 0.025+ 0.025+ 0.024+ 0.023+ 0.022+ 0.022+ 0.022+ 0.021+
0.021+ 0.020+ 0.019+ 0.019+ 0.018+ 0.018+ 0.018+ 0.017+ 0.016+ 0.016+ 0.016+
0.016+ 0.015+ 0.015+ 0.015+ 0.014+ 0.014+ 0.014+ 0.013+ 0.013+ 0.013+ 0.012+ 0.012+
0.012+ 0.012+ 0.011+ 0.011+ 0.011+ 0.011+ 0.011+ 0.010+ 0.010+ 0.009+ 0.009+ 0.009+
0.009+ 0.008+ 0.008+ 0.008+ 0.007+ 0.007+ 0.005+ 0.005+ 0.003+ 0.003+ 0.0006+
0.00008+ 0.00006+ 0.00004+ 0.000001) \times 10^9$$

$$\sum_{j=1}^{k} \lambda_j = 10.679781 \times 10^9$$

Using the equations (3) and (4), $s$ and $e$ are calculated for the sample set of 120 eigenvectors. A set of 60 key frames, which includes known presenters in the database, were selected to test the recognition performance and for each selected eigenvector set, recognition rate is calculated (See Table 1).

**Table 1: The Energy and stretching dimensions.**

<table>
<thead>
<tr>
<th>Number of Eigenvectors</th>
<th>$s$</th>
<th>$e$</th>
<th>Correctly Classified frames</th>
<th>Recognition rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.2374</td>
<td>51.96%</td>
<td>11</td>
<td>21.67%</td>
</tr>
<tr>
<td>10</td>
<td>0.1144</td>
<td>65.05%</td>
<td>19</td>
<td>31.67%</td>
</tr>
<tr>
<td>15</td>
<td>0.07079</td>
<td>72.86%</td>
<td>23</td>
<td>38.33%</td>
</tr>
<tr>
<td>20</td>
<td>0.04631</td>
<td>77.70%</td>
<td>28</td>
<td>46.67%</td>
</tr>
<tr>
<td>25</td>
<td>0.03513</td>
<td>81.08%</td>
<td>34</td>
<td>56.67%</td>
</tr>
<tr>
<td>30</td>
<td>0.02715</td>
<td>83.73%</td>
<td>37</td>
<td>61.67%</td>
</tr>
<tr>
<td>35</td>
<td>0.02395</td>
<td>85.93%</td>
<td>40</td>
<td>66.67%</td>
</tr>
<tr>
<td>40</td>
<td>0.02023</td>
<td>87.83%</td>
<td>43</td>
<td>71.67%</td>
</tr>
<tr>
<td>45</td>
<td>0.01757</td>
<td>89.45%</td>
<td>45</td>
<td>75.00%</td>
</tr>
<tr>
<td>50</td>
<td>0.01544</td>
<td>90.72%</td>
<td>47</td>
<td>78.33%</td>
</tr>
<tr>
<td>55</td>
<td>0.01384</td>
<td>92.03%</td>
<td>49</td>
<td>81.67%</td>
</tr>
<tr>
<td>60</td>
<td>0.01224</td>
<td>93.18%</td>
<td>51</td>
<td>85.00%</td>
</tr>
<tr>
<td>65</td>
<td>0.01118</td>
<td>94.23%</td>
<td>53</td>
<td>88.33%</td>
</tr>
</tbody>
</table>
Since the eigenvectors are ordered in high to low by the amount of variance found between key-frames along each eigenvector, the last eigenvectors are the smallest amounts of variance. The assumption can be made that noise is associated with the lower valued Eigenvalues where smaller amounts of variation are found among the key-frames Broomhead and Kirby (2000). This indicates that eliminating these Eigenvectors from the Eigenspace should improve the performance (Figure 6).

**Figure 6**: Performance when ordered by eigenvalue vs recognition rate.

By analysing the graph on figure 6 all Eigenvectors with s, greater than a threshold can be retained. For the eigenvector selection process, threshold value (Vₜ) is determined to select the eigenvectors which is most suitable to construct a presenter profile (equation 5). Algorithm has been developed to calculate Vₜ by analysing the behaviour of each profile projection to the face space using different number of eigenvectors (figure 6).

\[
Vₜ = (V_{max}^{1/2}) \times 3n - (5)
\]

\[V_{max} = \text{Maximum Eigenvalue} \]

\[Vₜ = \text{Threshold Value for Eigenvector Selection}\]

Using the above algorithm we eliminate the eigenvectors less than Vₜ when constructing a presenter profile. For the data set on table 1,

\[Vₜ = 1.5603830 \times 10^7\]

Using our algorithm, the first 80 eigenvectors are selected and others are omitted. From the table 1 we have observed that when s is in between the limits of 0.01 and 0.006, the system acquires the highest recognition rate. Therefore the eigenvectors should be chosen between 70 and 90 for maximum accuracy.
5. Evaluation

Experiments were performed to evaluate our profile normalisation method using different data sets (Jonathon et al 2000). Frontal face key frames with lighting variations are selected from the database. A sample set of key-frames chosen for the evaluation are shown in figure 7 and the corresponding intensity histograms are shown in figure 8.

![Figure 7: Presenter profiles](image)

![Figure 8: Colour histograms for presenter profiles](image)

If the range of intensities of features in the key-frame can be determined beforehand, the key-frame contrast can be improved sufficiently while details are retained as much as possible. Although it is difficult to detect the intensity range of valid content in key-frame, the intensity range of face luminance variations can be computed by analysing peaks and valleys within the histogram. By analysing the above presenter profiles and histogram experimental results (figure 7 and 8) indicate that we cannot obtain good results under different illumination conditions using the conventional methods. In the presence of illumination, our system suffers errors which turn into the false identification of presenters. A sample set of Presenter profiles after applying the normalisation algorithm is shown in figure 9 and the corresponding intensity histogram of the normalised profiles are shown in figure 10.

![Figure 9: Presenter profiles](image)
Figure 10: Colour histograms for normalised presenter profiles

Describing illumination conditions with a small number of parameters is quite difficult since the types or quantity of light sources have an infinite degree of freedom. Previous studies, however, have shown that illumination variations of an image can be described concisely, especially in the case of faces (Finlayson et al 1998). When comparing the intensity histograms (figure 8 and 10) we can investigate that the illumination factor in this experiment applies scaling factor to the luminance channel of the presenter, which affects the histogram and its variance. Each profile can be viewed as a set of features. When a presenter face is projected onto the facespace, its vector (made up of its weight values with respect to each eigenface) into the face space describes the importance of each of those features in the face. Figures 11 and 12 describe this process pictorially. In Figures 11 and 12, a face is developed into the facespace. The face is described in the face space by its eigenface coefficients (or weights). In Figures 11, The Face is developed using the original presenter’s face and in figure 12 the face is developed after applying the normalising algorithm. Since the face developed in the face space is indeed a face, the weight of the first eigenface should be very high, almost equal to unity. (This useful property may be used to test key-frames for face-like qualities). The value of the weights decreases as the number of the eigenface increases. This is in conformity with the definition of eigenfaces. In fact, in figure 11 the weights are lower than the weights in figure 12. These experiments have proven that after normalising, the effectiveness of the profile projection has significantly improved.

Figure 11: A profile developed without applying the normalising algorithm

Figure 12: A profile developed after applying the normalising algorithm

Our experimental results show that the performance of the proposed method achieved a good success ratio (Figure 13 and 14). Furthermore, Verification tests are carried out to gather false acceptance rate (FAR) and false rejection rate (FRR) results from a data set comprised of key-frames that present typical difficulties when attempting recognition, such as strong variations in lighting direction and intensity (Figure 13). The total error rate is computed as a single measure of the effectiveness of the system and can be compute from FAR + FRR (Table 2).

Table 2: The summary of results
<table>
<thead>
<tr>
<th>Number of Presenter Profiles</th>
<th>FAR %</th>
<th>FRR %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>14</td>
<td>7</td>
<td>6</td>
<td>13</td>
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<tr>
<td>16</td>
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</tr>
<tr>
<td>20</td>
<td>9</td>
<td>11</td>
<td>20</td>
</tr>
</tbody>
</table>

**Figure 13:** Eigenface error rate

Without any alterations to the eigenface technique itself, total error rate of 32.4% percent can be achieved (Premaratne et al 2004, 2005). By using our normalising algorithm the total error rate can be reduced to less than 20%. We tested the algorithm using two different counts of key frames of the same presenter to construct his profile. For the initial testing we have used 4 frames per presenter and for the second testing we have increased the key frames per presenter from 4 to 8. We were able to maintain an 80% recognition rate even when the profile database expanded to 20 (Figure 14). The recognition rate with the previous algorithm was 70%. Results indicate that our methodology is quite robust to both low resolution and luminance changes, which suggest that it can be used for face recognition even when with different lighting conditions.

**Figure 14:** Recognition results

The experimental results show that the performance of the proposed method achieves a better success ratio (Figure 13 and 14). As shown in Figure 15, our algorithms can successfully rearrange profiles and overcome the profile overlapping.
6. Conclusion

In this paper we have proposed a technique to deal with illumination variations in the eigenspace recognition framework. The proposed method was extensively evaluated on a database of 20 presenter profiles with varying illumination. Our experiment results show that the algorithm we have proposed can achieve a substantial improvement in face recognition. We have observed that effective normalisation of the video key-frames greatly increases the performance of the profile matching system. From the final results obtained it can be concluded that the new algorithm proposed in this paper works well under controlled environments and the recognition algorithm took advantage of the environmental constraints to obtain high recognition accuracy.

7. Future work

All current person recognition algorithms fail under the vastly varying conditions under which humans need to and are able to identify other people. Next generation person recognition systems will need to recognise people in real-time and in much less constrained situations. The work that had been done can be expanded in several directions and the algorithm can be improved to recognise more complicated video key-frames such as identifying presenters in different poses. Our system works well under small variations in orientation.

8. Acknowledgement

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Applying Web-Enabled Problem-Based Learning and Self-Regulated Learning to Enhance Computing Skills of Taiwan’s Vocational Students: a Quasi-Experimental Study of a Short-Term Module

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Abstract: Contrary to conventional expectations, the reality of computing education in Taiwan’s vocational schools is not so practically oriented, and thus reveals much room for improvement. In this context, we conducted a quasi-experiment to examine the effects of applying web-based problem-based learning (PBL), web-based self-regulated learning (SRL), and their combination to enhance students’ computing skills in a short-term module of deploying Microsoft Word. Two classes of 106 first-year students were divided into 2 (PBL vs. non-PBL) × 2 (SRL vs. non-SRL) experimental groups. Results were generally positive. This study thus provided a significant illustration of a promising design and implementation of chosen web-based pedagogies for a short-term module. With limitations in mind, we hope that the lesson learned is also useful for those teachers engaged in e-learning, specifically, in vocational schools.

Keywords: web-based PBL, web-based srl, e-learning, vocational students, computing education, short-term module

1. Introduction

Professionals with a vocational degree represent a major portion of the work force in Taiwan. The technological and vocational education in Taiwan spans over three distinct levels: (1) vocational high schools; (2) two-year junior colleges; and (3) institutes/universities of technology. The vocational education system constantly evolves to meet the needs and the new demand for highly skilled manpower, the continued progress of modern technology, the worldwide economic development, the changing industrial structure, and the social/cultural changes. No one doubts the guiding principles of practical applications in the vocational education in Taiwan (Tai, Chen and Lai, 2003). However, the courses of deploying application software traditionally emphasise memorisation by applying short, disjointed, lack-of-context examples. Take computing curriculum at National Open University in Taiwan as examples. In one class teaching Microsoft Office for on-the-job trainees through television, we observed that the trainees were taught to build up school timetables. In another similar class, diagrams were drawn to illustrate students’ grades. These are inappropriate examples that could hardly match the requirements of students’ future jobs. It seems that problem-based learning (PBL) is an appropriate pedagogy to bridge the gap between what is learned in school and what is required in the workplace (Wu, 2000). In PBL, real-world, simulated, contextualised problems of practice promote student learning and foster skill development (Dunlap, 2005). In this regard, we tend to believe that PBL could help develop vocational students’ practical skills of deploying application software.

The applications of e-learning allow students to work on their assignments whenever and where they want (Schwieren, Vossen and Westerkamp, 2006). However, implementing e-learning for students with low self-regulatory skills inevitably runs high risks. In web-based learning environments, the physical absence of the instructor and the increased responsibility demanded of learners to effectively engage in learning tasks may present difficulties for learners, particularly those with low self-regulatory skills (Dabbagh and Kitsantas, 2005). It is a big challenge for teachers to help college students, who are often addicted to the Internet, engage in an online course in an environment with filled with millions of interesting websites, free online games, and online messenger. In this context, it is very important to develop students’ skills of self-regulated learning (SRL) to manage their learning in web-based learning environments (Winnips, 2000). Students in the online environment equipped with SRL competence become more responsible for their learning and more intrinsically oriented (Chang, 2005). However, there has been relatively little empirical research on the effects of SRL on students’ behaviours in such complex technology-based learning environments (Azevedo and
Thus, we applied SRL in this study to help students, vocational students in Taiwan in specific, concentrate on their learning, practice their schoolwork, and furthermore, take responsibility for their learning. Few studies have discussed effective online instructional methods for vocational students. Moreover, the restructuring and translation of traditional computer software courses into an online format has seldom been documented. In this study, we redesigned a short-term module in a course of deploying application software to incorporate learning technologies into instructional methods to help students learn and then apply what they have learned. Specifically, this study explored the effects of web-based PBL and SRL on the development of vocational students’ computing skills within a short-term module.

2. Literature review

2.1 Problem-based learning

PBL is an instructional method that may engage students through authentic learning activities that use professional problems of practice as the starting point, stimulus, and focus for learning (Barrows, 1985, 1986). PBL not only emphasises the learning of the subject area, but also provides opportunities for students to practice and apply skills and knowledge just acquired. It has made a significant impact on medical education since the mid-1960s (Norman and Schmidt, 1992). The application of PBL in medical education focused on clinical training. Problem relevance was considered as the most important factor for increasing motivation and developing skills of clinical reasoning (Barrows, 1986). For instance, in Dorsch, Frasca, Wilson and Tomsic’s (1990) study, where a multidisciplinary team in a problem-based format taught a ten-week critical appraisal course, the course was well received. The adoption of PBL in Information Systems (IS) helped develop students’ generic skills required of an IT professional, such as analytical, problem-solving, creative thinking, teamwork, technical, and communication (Yip, 2002). In a teaching experiment, PBL was deployed as an alternative instructional method in the domain of Information Science and its effects of improving students’ key competencies were supported (Greening, Kay, Kingston and Crawford, 1996). Similarly, Yip (2001) pointed out that PBL can enhance competencies both in professional and Information Systems education. While the interventions of PBL in the domain of medical and IS education were different, PBL is much the same in nature. It is a type of apprenticeship for real-life problem solving, helping students acquire the knowledge and skills required in the workplace (Dunlap, 2005). PBL may help students achieve learning goals such as professional reasoning, integration of scientific/academic and professional knowledge, and lifelong learning skills. For examples, students in PBL groups attained significantly higher scores than those students of control group in a course that was composed of physics, mathematics and computer science (Polanco, Calderón and Delgado, 2004). Chanlin and Chan (2004) applied PBL in a web-based environment. The results revealed that students who received the PBL treatment performed better than those in the control group.

The short-term problem-based instruction is effective for medical students in critical appraisal skills. In Wun, Chan and Dickinson’s (1999) short-term module, the PBL group scored higher than those of the non-PBL group on the Inventory of Learning Preference (ILP). On the Study Process Questionnaires (SPQ), achieving-strategy of the PBL group was significantly improved over that of the non-PBL group. By following similar arguments in the present study, we tend to believe that PBL employed in this online module may positively effect enhancing students’ computing skills.

2.2 Self-regulated learning

Zimmerman and Schunk (1989) defined SRL in terms of self-generated thoughts, feelings, and actions, which are systematically oriented to help each student to attain his goal. From a social cognitive perspective, Zimmerman (2000) indicated that self-regulatory processes and accompanying beliefs fall into three cyclical phases: (1) Forethought involves influential processes that precede efforts to act and set the stage for it; (2) Performance or volitional control refers to processes that occur during motoric efforts and affect attention and action; (3) Self-reflection refers to the processes that occur after performance efforts and influence a person’s response to the experience. Ley and Young (2001) suggested four principles of self-regulation including: (1) Preparing and structuring learning environment; (2) Organising and transforming instructional materials; (3) Keeping records and monitoring progress; (4) Evaluating performance against a standard to embody both effective and flexible guideline for embedding SR into instruction. The principles could be embedded in instruction to support self-regulation regardless of content, media, or a specific population. The principles can be
systematically applied in various contexts such as instructor-led or print-based instruction as well as synchronous or asynchronous web-based instruction.

Characteristics attributed to self-regulated persons coincide with those attributed to high-performance, high-capacity students, as opposed to those with low performance, who show a deficit in these variables (Reyero and Tourón, 2003; Roces and González Torres, 1998; Zimmerman, 1998). In one study, students who are high self-regulatory skill users, as measured by a pre-existing index, scored significantly higher than their counterparts, low self-regulatory skill users, regardless of the level of control (Yang, 1993). To examine the effects of SRL on learning computer software, Bielaczyc, Pirolli and Brown (1995) incorporated self-explanation and self-regulation strategies in the attainment of the cognitive skill of computer programming. They had found that students in the treatment group outperformed those in the control group. This study asserted that SRL is appropriate to be applied in computer software education. Young (1996) also found that users with low self-regulatory skills performed inadequately and significantly in computer-based instruction that applied learner control of the sequencing. In line with the above evidence, SRL may contribute to students learning through both face-to-face and technology-based instruction. Winnips (2000) indicated that self-regulation is particularly important when learning in Internet-supported environments. Providing students with opportunities to integrate their knowledge only through web-enabled instruction may not be effective if they lack the skills needed to regulate their learning. Thus, strategies must be put into practice in order to prepare students for the rigors of learning at a distance and increase the probability of retention and success (Chang, 2005). In other words, it is even more critical for students to be transformed into self-regulated learners in web-enabled learning. Therefore, we included SRL in this study to investigate its effects on enhancing students’ computing skills in an online module.

2.3 Problem-based learning and self-regulated learning

PBL is assumed to foster students’ motivation and self-regulation (Galand, Bourgeois, and Frenay, 2005). PBL is a specific task-based approach that teachers can apply to support the development of SRL. PBL provides opportunities for self-regulated learning by offering students choices and control about what to work on, how to work, and what products to generate. PBL facilitates SRL because it places the responsibility on the students to discover information, to coordinate actions and people, to monitor understanding, and to reach goals (Paris and Paris, 2001). Hmelo-Silver (2004) pointed out that students’ approaches to learning from solving problems are qualitatively different because of their degree of self-regulation. Learners with low self-regulatory skills may have difficulty in adapting to the kind of learning required in problem-based instruction. Ertmer, Newby, and MacDougall (1996) found that learners fluctuated their efforts according to their perception of the value of learning from solving problems. Highly self-regulated students valued learning from solving problems higher and tended to focus on the problem analysis and reflection processes. Ertmer et al asserted accordingly that students with low self-regulatory skills may have difficulty in dealing with the self-directed learning demands of a PBL curriculum. Combined training in self-regulatory and problem-solving strategies was effective for enhancing self-regulatory competences in solving mathematical problems (Perels, Gürtler and Schmitz, 2005). Kramarski and Gutman (2006) compared the treatments of e-learning with SRL and without SRL in solving mathematical problems. Their results showed that SRL students significantly outperformed the non-SRL students in problem-solving procedural and transfer tasks regarding mathematical explanations in web-based learning environment. Beyond these studies we found, however, there are very few studies investigating the effects of PBL and SRL simultaneously, particularly in the web-based learning environment. Therefore, in the present study the authors explored the effects of combinations of PBL and SRL on enhancing students’ computing skills.

3. The empirical study

3.1 Course setting

The course under study is a half-semester (8 weeks), 2-credit-hour class, targeting first-year college students from different major fields of study. Students received a study task dealing with the subject of Microsoft Word. The major focus of this module was to develop students’ skills in applying the functions of Microsoft Word. For example, students were required to change the appearance of text, format documents, present information in tables, work with charts, and apply toolbars.
3.2 Participants
The participants in this study were 106 first-year students taking a compulsory ‘Packaged Software and Application’ in a university of science and technology in Taiwan. None of them majors in information or computer technology. Students at this university were expected to spend much more time and effort in mastering a variety of technological skills as compared to those in comprehensive universities in Taiwan.

3.3 Experimental design and procedure
In the first week, the lecturer declared that this class section would be partially provided through Internet with innovative instructional methods as interventions, so students had the freedom to drop this class section and take another teacher’s class section. After this declaration, 118 students continued in this class section. The experimental design is a 2 (PBL vs. non-PBL) × 2 (SRL vs. non-SRL) factorial pretest-posttest design (see Figure. 1). Students in the four groups solved the same tasks but in different learning conditions. The participants were randomly assigned to one of the four experimental conditions; each group contained about 30 participants. However, 12 students withdrew from this class section during the instructional process. At the end, there were 106 students still in the class section. The PBL and SRL group (C1, N=30), PBL and non-SRL group (C2, N=25), non-PBL and SRL group (C3, N=24) were experimental groups, while non-PBL and non-SRL group (C4, N=27) was the control group.

![Figure 1: The variation and expected effects of instructional methods](image)

This experiment was implemented in the learning module of ‘Microsoft Word’. The skill test of this software package was held right after the completion of teaching the module (the 8th week). The detailed schedule of the experiment is depicted in Figure 2. In the beginning of the Word module, students were encouraged to adapt to learn via a course website. The teacher audiotaped every session of his lecture and later on translated lectures into HTML files with flash, video, and voice. These HTML files were then loaded into the course website. Students could preview and review the course sessions on this course website. After three weeks, most of the coursework was moved onto the website. Students were helped to adapt to learning on the Internet and lessen the feelings of isolation. Within the first three weeks, the teacher adjusted students’ learning gradually and smoothly.

PBL treatment. There were two classes in this study, one was a PBL class, while the other was a non-PBL class. Popular software was taught in the ‘Word module’. In the PBL class, the teacher created an interesting, challenging, and authentic problem situation. The teacher simulated the situation that students have to apply for a job titled “marketing assistant” located in a software company in an online game company. They were required to design and then build autobiographies and resumes by applying skills of application software that they had just learned. After that, the students were assumed to be employed by the same software company. The marketing manager asked them to develop a business proposal for the emerging new market of online games.
The marketing manager asked them to compare expenses resulting from different distribution channels. The students were required to survey and then complete a table to illustrate the difference among channels and rank them. When the optimal channel was decided upon, they had to design show bills using the skills they learned in this module. The teacher demonstrated first how to approach the situation and solved the problem accordingly through web-based multimedia. In addition to the teaching of skills of application software, similar situations and related applications were also discussed in the class. In the latter, the teacher guided students in constructing their own models of problem solving.

SRL treatment. There was a SRL group in both the PBL class and non-PBL class. The students in SRL groups were selected randomly and received instruction in an after-school course teaching SRL strategies. The two SRL groups from the PBL class and non-PBL class were gathered in a classroom and a two-hour lecture was delivered discussing how to manage study time and regulate their learning. The content of this SRL course was composed of the four processes addressed by Zimmerman, Bonner and Kovach (1996), that is, self-evaluation and monitoring, goal-setting and strategy planning, strategy implementation and monitoring, and monitoring of the outcome of strategy. Students were taught how to implement these four processes to become more self-regulated learners. In addition to the two-hour lecture, students in the SRL groups were required to regularly prepare and read the textbook before classes, and to review or practice the skills of application software they had learned after school. They were also required to record their learning behaviour every week. The data was recorded on the course website instead of in their notebooks in order to prevent falsification of records. The treatments in the four groups are illustrated and compared in Table 1.

**Table 1:** Teaching and learning activities in different experimental groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Teaching Activities</th>
<th>Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>The teacher...</td>
<td>The students...</td>
</tr>
<tr>
<td></td>
<td>demonstrated how to solve authentic problems and discussed its potential applications.</td>
<td>took on authentic tasks and learned by problem solving.</td>
</tr>
<tr>
<td></td>
<td>taught SRL skills and urged students to study regularly.</td>
<td>practiced SRL and recorded learning behaviours every week.</td>
</tr>
<tr>
<td>C2</td>
<td>The teaching activities were the same as C1 but without SRL lectures.</td>
<td>The students experienced authentic situations and solved the problems without extra requirements of SRL.</td>
</tr>
<tr>
<td>C3</td>
<td>The teacher...</td>
<td>The students...</td>
</tr>
<tr>
<td></td>
<td>converted his traditional way of teaching without any modification into an online format.</td>
<td>received the traditional computer software course through Internet.</td>
</tr>
<tr>
<td></td>
<td>taught SRL skills and urged students to study regularly.</td>
<td>practiced SRL and recorded learning behaviours every week.</td>
</tr>
</tbody>
</table>
3.4 Measures

Students were tested at the end of this module. In this study, we applied two practical and authentic instructional methods. It is very important to measure students’ practical skills in solving problems rather than just memorisation. In this regard, the lecturer simulated practical problems for students to solve to evaluate their enhancement of skills of deploying application software. We calculated a student’s grade judging from his correctness and completeness of problem solving, and the artistry of his design. The students got high grades if they completely solved the problems with exquisite design. Before testing, students were assigned to random seats. The questions on the test were related to the content and examples taught in the module. The test consisted of 5 to 7 questions. The teacher graded and recorded the results immediately after the test. Finally, the enhancement of word processing skills was the result of one’s grade minus his pretest grade. We tested the differences in the enhancement of the skills of WORD application software under different conditions in a short-term module.

4. Results

To examine levels of change manipulated by variants of experimental conditions, we first measured students’ computing skills as a baseline before their entering the class. In the first week, students completed three Word documents as a pretest. The problems given in this test were taken from the Certification of Microsoft Office, which is administered by a trustworthy organisation in Taiwan called the Computer Skills Foundation (CSF). Each of these documents was assigned maximum scores of 30, 30, and 40, respectively. Forty minutes was given for students to complete the three documents. The pretest grades representing students’ computing skills were similarly low. None of the participants were able to answer the pretest questions correctly. The differences among the four groups in students’ skills of application software at this beginning stage were not statistically significant (see Table 2). It confirmed that all participants in the four groups had little knowledge or skills involving Microsoft Word before they took this course. In addition, none of them had any experience in taking a web-enabled course. We thus concluded that the students had in fact been randomly and evenly divided into experimental groups.

Table 2: One-way ANOVA: Pretest of students’ computer skills

<table>
<thead>
<tr>
<th>Pretest</th>
<th>(I) Groups</th>
<th>(J) Groups</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheffe</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td>.053</td>
<td>1.663</td>
<td>1.000</td>
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<tr>
<td></td>
<td>3</td>
<td>2.183</td>
<td>1.681</td>
<td>.641</td>
<td></td>
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<tr>
<td></td>
<td>4</td>
<td>4.119</td>
<td>1.629</td>
<td>.101</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>-0.053</td>
<td>1.663</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2.130</td>
<td>1.755</td>
<td>.689</td>
<td></td>
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<tr>
<td></td>
<td>4</td>
<td>4.065</td>
<td>1.704</td>
<td>.135</td>
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<tr>
<td>3</td>
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<td>-2.183</td>
<td>1.681</td>
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<td>-2.130</td>
<td>1.755</td>
<td>.689</td>
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<tr>
<td></td>
<td>4</td>
<td>1.935</td>
<td>1.722</td>
<td>.739</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>-4.119</td>
<td>1.629</td>
<td>.101</td>
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<td></td>
<td>2</td>
<td>-4.065</td>
<td>1.704</td>
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<td></td>
<td>3</td>
<td>-1.935</td>
<td>1.722</td>
<td>.739</td>
<td></td>
</tr>
</tbody>
</table>

* The mean difference is significant at the .05 level.

We took grades on the Word module as a measure of student’s computing skills. Mean and standard deviations of grades on this module were reported for the four groups in Table 3. The 'independent samples t-test' was used to compare the different types of learning promoted by PBL and non-PBL instructional methods. As shown in Table 3, the improvement of grades at the end of the Word module in PBL class (64.29) was significantly higher than that in the non-PBL class (56.84).
Therefore, it is believed that web-enabled PBL contributed to enhance students’ skills of deploying application software in a short-term module.

| Table 3: Independent samples t-test: The improvement of grades on word |
|---|---|---|---|---|---|---|
|  | N  | Mean  | S. D.  | F    | t-value | df  | P   |
| Word  | PBL  | 55  | 64.29  | 11.063 | 2.604 | 3.147 | 104 | .002** |
|       | non-PBL | 51  | 56.84  | 13.269 |       |      |     |     |

**P < 0.05; *P < 0.1

From Table 4, one can see the results that the improvement of grades on Word in SRL group (63.11) was higher than that in the non-SRL group (58.21). The difference between SRL group and non-SRL group was statistically significant. Thus, it could be concluded that web-enabled SRL improved students’ skills in application of computer software in a short-term module.

| Table 4: Independent samples t-test: Grades on word |
|---|---|---|---|---|---|---|
|  | N  | Mean  | S. D.  | F    | t-value | df  | P   |
| Word  | SRL  | 54  | 63.11  | 11.647 | .102 | 2.018 | 104 | .046** |
|       | non-SRL | 52  | 58.21  | 13.325 |     |      |     |     |

**P < 0.05; *P < 0.1

Finally, the data from Table 5 showed that the improvement of grades on Word in group C1 was significantly higher than C4, and also higher than C2 and C3, though insignificantly. Therefore, we proposed that the combination of web-enabled PBL and SRL helped students learn better in an online module.

| Table 5: One-way ANOVA: The improvement of grades on word |
|---|---|---|---|---|
|  | Group  | Group  | Mean Difference (I-J) | Std. Error | Sig. |
| Word | LSD  |  |  |  |  |
|      | 1  | 2  | 5.447  | 3.270 | .432 |
|      | 3  | 2.825 | 3.307 | .110 |
|      | 4  | 11.433(*) | 3.204 | .007 |
|      | 2  | 1  | -5.447 | 3.270 | .432 |
|      | 3  | 2.778 | 3.451 | .885 |
|      | 4  | 5.987 | 3.352 | .368 |
|      | 3  | 1  | -8.225 | 3.307 | .110 |
|      | 2  | -2.778 | 3.451 | .885 |
|      | 4  | 3.208 | 3.388 | .826 |
|      | 4  | 1  | -11.433(*) | 3.204 | .007 |
|      | 2  | -5.987 | 3.352 | .368 |
|      | 3  | -3.208 | 3.388 | .826 |

* The mean difference is significant at the .05 level.

5. Discussion

Teachers face tremendous challenges in implementing e-learning for relatively low academic achievers and in the setting where Internet addiction is quite common. It is not immediately clear how to concentrate students’ attention and improve their learning in a web-based environment without the teacher’s on-the-spot monitoring. To improve our understanding of how to solve these tough issues, we brought in and then tested rigorously a set of hypothesis among four experimental groups. According to the findings of this study, we believed that our research has made some contributions to e-learning theory in three different ways. Firstly, our research contributed to the existing literature by specifying how teachers can simulate the situation and climate and ask students to regulate their learning by applying PBL and SRL instructional methodologies in a web-based learning environment. Secondly, our study demonstrated that computing skills of vocational students can be improved through e-learning, even in a short-term module and with only a two-hour lecture about SRL. Thirdly, this study was an early attempt to investigate the learning effect of the combination of PBL, SRL, and web-based learning simultaneously in a short-term module.

5.1 The effects of web-enabled PBL

In this study, PBL was found to play a positive role in enhancing students’ computing skills. As the data in Table 3 showed, there was a very significant difference between the PBL and non-PBL class
on the test of Word ($P = 0.002$). This demonstrated that PBL is good for computer software education in general, and e-learning in particular. It was suggested that the traditional lecturers should shift or adapt to problem-based learning and then align constructively in online teaching (Talay-Ongan, 2003). The findings of the present study were similar to those that appeared in Chanlin and Chan’s (2004) study, which revealed that students in the PBL treatment group performed better than those from the control group in a web-based learning environment. It is our observation that many computer teachers apply short, disjointed, lack-of-context examples in teaching application software modules. The effects of such lessons are usually limited and can hardly help students solve real problems chosen from practice. We suggest that teachers design their modules (or whole courses) systemically and consistently. Teachers can simulate a business situation and setup a series of problems in terms of working modules before they transfer these materials into a format of e-learning.

5.2 The effects of web-enabled SRL

The data shown in Table 4 also supported that the difference of students’ Word skills between SRL and non-SRL groups was statistically significant ($P = 0.046$). The importance of self-regulated learning in Internet-supported environments was emphasised in the literature, for example, Winnips (2000). Thus, strategies must be put into practice to prepare students for the rigors of learning at a distance and increase the probability of retention and success (Chang, 2005). According to our teaching experience, students in most vocational schools in Taiwan tend to have lower levels of academic achievement, and spend more time on their out-of-class jobs, get inadequately involved in their schoolwork, and care less about their grades. In this specific context of low achievers, teachers may take high risks in implementing e-learning. However, this study supported that SRL, once done right, helped low achievers learn better in a short-term module through Internet.

5.3 The effects of combination of web-enabled PBL and SRL

With respect to the effects of the combination of PBL and SRL, we found preliminary support from the results in Table 5. The results showed that the effects of combined training in PBL and SRL on enhancing students’ computing skills were positive and higher than those who did not receive PBL or/and SRL, although the difference between C1 and C2 and the difference between C1 and C3 were not statistically significant. These results were also similar to those that appeared in Paris and Paris’s (2001), Perels, Gürtler and Schmitz’s (2005), and Kramarski and Gutman’s (2006) studies. To conclude, this study suggested that teachers could apply PBL and SRL simultaneously in the modules rather than singly to strengthen the interaction of PBL and SRL to promote students’ learning. For those teachers who wish to stick to traditional methods of teaching, directly translating their teaching materials into electronic form may not be a fruitful approach. Students in the control group (C4) received the poorest grades among the four groups (see Table 5). It is suggested that teachers should redesign their modules (or courses) and then adopt new instructional methods and technologies to fully exploit the benefits of deploying web-based learning environments.

5.4 Limitations

The results of this study generally supported that there were positive effects of web-based PBL, web-based SRL and their combinations on enhancing students’ computing skills. However, there still exist some limitations, mainly due to the quasi-experimental design. A major problem with quasi-experimental design is that the four groups may not be necessarily the same before any instruction takes place and may differ in important ways that influence student performances. In this regard, the researchers empirically assessed the differences in students’ computing skills and involvement in this course among the four groups at the beginning of the study as pretests. The definition of involvement used in constructing the PII that was applied this study had much in common with motivational theory (Schmidt and Frieze, 1997), and measured three constructs: interests, needs, and values. The differences among students’ computing skills and involvement, according to the pretests, were not statistically significant. Thus, researchers ruled out initial differences and normal development as rival explanations for the differences resulting after treatments (Gribbons and Herman, 1997). Other factors might potentially influence students’ online learning. A student with readiness for self-directed learning may appropriately adapt himself to a web-based learning environment, which may further result in better grades. For example, it is observed that several students who were more self-regulative in the traditional classroom recorded their online learning regularly, and performed better than those without self-regulation. These students were relatively more self-directed and had better grades in the traditional instruction, and also had better learning effects in the online environment.
The authors of the present study did not address or rule out this possibility in their research design. Some additional problems might result from students in the comparison group being incidentally exposed to the treatment condition, being more motivated than students in the other group, having more enthusiastic teachers, etc (Gribbons and Herman, 1997). One should be aware of these contextual factors, which threaten the validity of claims made by this study. Exploration in future studies of the relationship between the contextual factors and students’ online learning would complement our understanding of these effects of web-enabled pedagogies.

6. Conclusion

PBL and SRL have been applied successfully for teaching in different academic fields for decades. These two instructional methods could make further contributions to students’ learning through Internet. In this study, PBL and SRL were simultaneously applied as web-based pedagogies to help vocational students develop their practical skills of deploying computer software in a short-term module. Results were generally positive, showing enhanced student computing skills. Providing online courses in an environment that is full of Internet addiction with browsing shopping websites and playing online games challenges both instructors and students. Without systematic redesign and reconsideration of the learning settings, teachers and students may suffer from ineffectiveness resulting from replicating traditional instructional methods through Internet. This study provides a specific reference in the context of vocational education addressing how to increase students’ interest and to help online students regulate their learning. Finally, this study may provide valuable insights and shed light on leading practices of web-based pedagogies for those schools (particularly for vocational schools) and institutes that hold short-term modules or workshops, or for scholars and teachers planning to implement, or currently engaged in, e-learning.

References


The Purpose of Focus Groups in Ascertaining Learner Satisfaction with a Virtual Learning Environment

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Abstract: This paper examines the contribution of focus groups in evaluating learner satisfaction with a Virtual Learning Environment (VLE). It explores the views of a group of introductory level Post Compulsory Education learners that have a history of disaffection, impoverished learning and challenged written and communication skills. The outcome of this study will be used to inform future VLE material design for inclusion in a School policy document. Additionally, the findings will contribute to the development of both a broader range of discrete ICT programs delivered by a VLE and embedded ICT within a range of vocational qualifications across the Post Compulsory Education Vocational Curriculum.

Key words: virtual learning environment, focus group, disaffection, impoverished learning, satisfaction, post compulsory education, policy document.

1. Introduction

The use of a Virtual Learning Environment (VLE) in Post Compulsory Education in Further Education Colleges (FE) has been increasing incrementally over the last five years. Having begun life in Universities and the more 'traditional' higher education institutions, VLEs are flexible, accessible and encourage the development of communities of practice. They encourage group activities, peer support and electronic delivery of learning but are not intrinsically designed to aid those learners at the lower end of the academic spectrum. This paper presents a case study of learners on an introductory (Level 1) FE course in ICT ascertaining their level of user satisfaction with a VLE. The outcome of this study will be used to inform future VLE material design for inclusion in a School policy document. Additionally, the findings will contribute to the development of both a broader range of discrete ICT programs delivered by a VLE and embedded ICT within a range of vocational qualifications across the Post Compulsory Education Vocational Curriculum.

Focus groups were chosen as the method of data collection for this study, based on work by Morgan (1988), using a group of learners whose academic backgrounds are similar in qualification and educational history and because they ‘generate hypotheses that derive from the insights and data from the group’ (Morgan 1988, Krueger 1988). Focus groups have been in evidence since the 1920s. At that time, they were in the guise of survey questionnaires related mainly to products and the customer requirements of a product. During World War II and up until the 1970s, focus groups were used for market research to elicit wants and needs. From the 1980s onwards, the use of focus groups has been used mainly in the health arena and in examining social issues. Since then social scientists and program evaluators have found focus groups to be useful in understanding how or why people hold certain beliefs about a topic or program of interest. Krueger and Casey (2000) identified that focus groups can be used for program development and evaluation, planning, and needs assessment. Powell and Single define a focus group as ‘a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research’ (1996) and rely on ‘interaction within the group based on topics that are supplied by the researcher’ (Morgan 1997) confirming that focus groups are an ideal opportunity to elicit information from learners in a safe, non-threatening environment (Krueger 1988). Morgan (1998, pp58) says that ‘the conversations in focus groups can be a gold mine of information about the ways that people behave and the motivations that underline these behaviours.’

David Morgan's book ‘The Focus Group Guidebook’ (1998) has been used throughout this study as the empirical work containing the methodological approach and the validated data-gathering instrument for the Focus Groups. When designing the VLE interface, factors such as navigatability, learning activities and resources for use within the computer-mediated environment (as is a VLE) were instrumental in the learner satisfaction of the VLE. The work of Robert Gagné (1965) is critical in any study using computers for learning and illustrates the importance of his Instructional Design (ID)
to an underlying theory of computer-based learning. Gagné’s theory stipulates that there are several different types or levels of learning. The significance of these classifications is that each different type requires different types of instruction. Gagne identifies five major categories of learning: verbal information, intellectual skills, cognitive strategies, motor skills and attitudes (web link accessed on 18/06/06). Gagné’s Nine Events of Instruction (a sequence of learning events borne out of his ID theory) addresses learners in terms of the logical steps that are mapped to the way they learn. The events are; gain attention, inform the learner of the objective, stimulate their recall of prior learning, present the stimulus, provide learner guidance, elicit performance, give feedback, assess performance and enhance retention and transfer of learning. Using this premise, designing a VLE with learners for whom written communication is difficult and numerical skills underdeveloped, requires ‘constant revising and adjusting of our uses of technology to better meet the needs of the program and our students’ (Bucci et al 2003), yet is ideally matched to Gagné’s theory of developing computer-based learning using his ID to change the capabilities of the learners.

By the very nature of the flexibility that can be achieved in designing a VLE, a vast range of stimulus can be embedded and these will address the learners preferred learning style and learning processes, which are not completely understood, and are different in detail from one person to another (Bostock 2005). This is clearly evidenced in this case study and its learners, where a detailed analysis of pre-VLE knowledge was essential as well as a breakdown of the learning style of the learners so as to maximise their achievement and success against specified learning objectives. The materials available on the VLE for this case study only mapped as far as Instructional Event 6 - Elicit performance (practice). Future studies are planned whereby the full set of Instructional Events is included in all ICT courses delivered via a VLE. An intrinsic part of the study was the collection of data from pre- and on-course diagnostic tests of the learners in the study particularly their literacy and numeracy level (www.keyskills4u.com), preferred learning style (www.vark-learn.co.uk) and a review of their educational history (Individual Learning Plan). Results identified that more than 30% presented with challenged written and communication skills that would require specialist intervention and support throughout their studies. The VARK (Fleming 2001) online multiple-choice learning style assessment profiled the learners learning styles as mainly kinaesthetic and auditory. Typical of auditory learners would be a preference to attend lectures, listen to speaking and like to read aloud. For kinaesthetic learners, their preference is to be ‘hands-on’ with practical activities and watch (and be part of) demonstrations. The learners’ prior educational histories contained instances of exclusion and disaffection with their 11-16 education, many learners not completing their year 10 or 11 studies. Their home postcodes indicating that they live in some of the lower socio-economic housing, mostly council owned, with 3 learners living in ‘poor’ housing in southeast London. All learners in the study completed a pre-VLE questionnaire (Table 3) that identified their personal profile, general level of computing experience (including using the internet/web), concerns they had about using a VLE in their learning and were asked to rank a number of learning activities/resources they had previously used in their educational history. This was used to inform the design of the interface of the VLE and the resources/activities within it. Care was taken in the design process such that there was ease of navigation for the learner, and a simple hierarchical structure for the relationship between the course elements to encourage the learners to make appropriate connections within or between each resource and/or activity. Usability, flexibility and pedagogy attributes were considered at all stages of the VLE design as content management shortcomings militate against making any improvements once the VLE is ‘live’ especially if those improvements involve structure (Vogel 2006).

2. Methodology
This study used a mixed methods data collection approach where agency was given to both quantitative (Likert-scale questionnaire) and qualitative data (Glaser and Strauss 1967) thereby triangulating the results. Creswell (2003, p208) makes clear that the perceived legitimacy with which the mixed methods approach is being promoted is expanding. This is supported by detailed reference to mixed methods studies in areas as diverse as occupational therapy and AIDS prevention. A new ‘Handbook of Mixed Methods in the Social and Behavioural Sciences’ (Tashakkori and Teddlie, 2003) is cited within Creswell (ibid) as the foremost publication in the field of mixed methods research. In this case study, 39 students were actively recruited and all completed the pre-VLE questionnaire before being exposed to the VLE itself. The issue of ethics is of paramount consideration in a focus group study. Informed consent must be gained prior to any focus group activity in either written or oral form. The participants must be told of the consequences of the research and care must be taken to reduce any harmful effects of the research on the participants. The usefulness of the research cannot
be under-estimated and this must be brought to bear on the participants in terms of their benefit and that they can get involved in the change that will result from the study findings. Learners in this study signed an agreement that gave permission for transcription and hard copy storage of the focus group discussions. All participants in the study had sight of the transcripts at the final stage before coding and were able to discuss changes they felt needed to be made where meaning or incorrect transcription had occurred. Whilst the learners knew each other as a group on the same ICT Program, the focus group selection process ensured that the ‘friendship groups’ that existed were separated to allow full and frank discussions to take place (Krueger and Casey 2000). Focus groups involve not only ‘vertical interaction’ or interaction between the moderator and the interviewees, but also ‘horizontal interaction’ among the group participants (Denzin and Lincoln 2003). Data emerges from the interaction of the learners in the focus groups, in a language that is native to them alone (Fine 1994). This then has to be delicately decoded to elicit the themes contained therein. Kitzinger (1994) explains that the group situation creates the group’s own hierarchy of importance, their own words and language.

Focus groups are a collectivistic method as defined by Denzin and Lincoln (2003) based on theoretical and methodological considerations. For example; consideration has to be given to how many groups will be held? How many people will be involved in each group? The focus group is an unstructured interview guide with introductory questions. There is an overt need to state that there are no ‘right’ or ‘wrong’ answers. That it is perfectly acceptable (in fact preferred) if there is disagreement on topics. There is much controversy about prior analysis by the researcher of the situation in which the subjects have been involved. Merton and Kendall say: ‘Foreknowledge of the situation obviously reduces the tasks confronting the investigator, since the interview need not be devoted to discovering the objective nature of the situation. Equipped in advance with a content analysis, the interviewer can readily distinguish the objective facts of the case from the subjective definitions of the situation’ (Merton and Kendall, 1946). In a study by Hart (2001), 8 focus groups were used and looked at the experiences and impressions and relationship teenagers in public schools in the United States had with computers. The learners were in public school in Florida, Maryland and Illinois. One of the most surprising findings was that the learners felt that the quality of their education depended on the teacher and not the technology as a better way to learn. This is supported in part by Ainley et al (2000), whose studies showed that learners, teachers and parents felt that computers have a positive effect on learning. US Research shows that the presence of computers and Internet at home has a strong positive association with academic outcomes of school children, particularly children from disadvantaged backgrounds (Wilhelm et al 2002). Interestingly, a study by researchers at the National Centre for Social and Economic Modelling (NATSEM) found that educational attainment of an individual was a stronger predictor of having home computers and the Internet than income (Hellwig and Lloyd 2000).

3. Research design

The group of 39 learners in this case study exhibited the following characteristics:

**Table 1: Learner characteristics**

<table>
<thead>
<tr>
<th>Learner Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of students</td>
<td>39</td>
</tr>
<tr>
<td>Males</td>
<td>35</td>
</tr>
<tr>
<td>Females</td>
<td>4</td>
</tr>
<tr>
<td>Age (years)</td>
<td>No of Learners</td>
</tr>
<tr>
<td>16</td>
<td>27</td>
</tr>
<tr>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
</tr>
</tbody>
</table>

**Table 2: Learner home postcode**

<table>
<thead>
<tr>
<th>Home Post code</th>
<th>DA1</th>
<th>DA11</th>
<th>DA8</th>
<th>DA12</th>
<th>DA2</th>
<th>BR8</th>
<th>DA15</th>
<th>DA16</th>
<th>DA9</th>
<th>SE2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of learners</td>
<td>9</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

The home postcode (zip code) for the learners was spread over a 10 mile radius from the College and included areas associated with low-status housing, either local council owned or starter homes as well as ‘poor’ housing in south east London (SE2). The pre-VLE questionnaire was aimed at establishing the learners’ pre-existing level of computing skill and those chosen for inclusion in question 2 and 3 of the questionnaire were explicitly required for the learner studying on the introductory ICT program. Learners were asked to score their response to each of the statements as 1 (no experience), 2 (some
experience) or 3 (extensive experience). Question 4 was aimed at identifying whether the learner had
found a prescriptive range of learning activities and resources useful in their learning history. Question
4 required the learner to respond to each learning activity or resource as 1 (not useful), 2 (some use)
or 3 (very useful). Question 5 required the learner to respond as 1 (no concerns), 2 (some concerns)
or 3 (extensive concerns) in respect of their anticipated concern with using a VLE in their learning.
Statistical Package for the Social Sciences (SPSS) was used to calculate Cronbach’s alpha. Cronbach’s α (alpha) is a quantity defined in multivariate statistics. It has an important use as
measure of the reliability of a psychometric instrument, since it assesses the extent to which a set of
test items can be treated as measuring a single latent variable http://en.wikipedia.org/wiki/
Cronbach’s_alpha. The Cronbach’s α value for the items in question 2 and 3 in the Pre-VLE
questionnaire were calculated as:
Q2 Cronbach’s α value = 0.791
Q3 Cronbach’s α value = 0.820
For a set of items to be considered as a scale, the Cronbach’s α value must be > 0.7. The results
obtained here, suggest that the items are measuring the same underlying construct and so have
“high” or “good” reliability.

Table 3: Pre-VLE questionnaire

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Question(s) asked/data collected</th>
</tr>
</thead>
</table>
| 1            | General learner profiling information
               | Student registration number
               | Name
               | Address
               | Postcode (zip code)
               | Gender
               | Age at 1st September 2005)                                                                        |
| 2            | General level of learner computing experience
               | Burn a CD
               | Move files
               | Insert clipart image
               | Wordwrap text
               | Insert a table
               | Merge two cells
               | Mail Merge
               | Animation in Powerpoint
               | Insert pictures
               | Insert hyperlinks                                                                                   |
| 3            | Experience of using the internet/web in their learning history
               | Send and receive emails
               | Research information from the web
               | Use MSN or equivalent
               | Download a podcast
               | Use a webcam                                                                                         |
| 4            | Usefulness of a learning activity or resource used in previous learning history
               | Essay writing
               | Report writing
               | Short answer questions
               | Reading text books and/or journal articles
               | Accessing/downloading reports/articles in word or pdf format.
               | Powerpoint presentations
               | Listening to lectures
               | Online groups activities
               | Chat rooms
               | Discussion forum/message boards
               | Watching short video clips
               | Assessment using online multiple-choice questions
               | Gapped Handouts
               | Analysing numerical data
               | Drawing charts and graphs
               | Presentation of work to peers and tutors                                                                 |
The focus group meetings were held during the learner’s weekly group tutorial sessions (one hour long) over a period of six weeks. Rooms were allocated that were comfortable and non-threatening and informal debriefs were set up so the participants could wind down post-focus group session. Data was collected against the questions asked using notes and then (latterly) recordings that were transcribed and coded. Full focus group questions reproduced below.

**Table 4:** Focus group questions (based on Morgan 1998, and Vogel 2006)

<table>
<thead>
<tr>
<th>Question no.</th>
<th>Question asked/data collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What were the learner responses when they looked at the VLE for the first time?</td>
</tr>
<tr>
<td>2</td>
<td>How did the learners find the experience of using the VLE for: Curriculum activities? User Interface (navigatability)?</td>
</tr>
<tr>
<td>3</td>
<td>What was the learner perspective on the parts of the VLE raised as not so good?</td>
</tr>
<tr>
<td>4</td>
<td>How has the VLE learning fitted in with other types of learning for the program?</td>
</tr>
<tr>
<td>5</td>
<td>What are the most valuable aspects of the VLE for the learner? (data collected on an individual basis).</td>
</tr>
<tr>
<td>6</td>
<td>Taking into consideration all the discussions so far, please rate learner satisfaction of the VLE on a scale of 1 – 5 (1 - will not lead to a chance of success on program, 5 - will greatly improve chance of success on the program).</td>
</tr>
</tbody>
</table>

Question 6 required the learner to respond on a 5-point Likert scale. The change from a 3-point Likert scale used in the pre-VLE questionnaire was intended to broaden the categories of learners response such that learners could differentiate between ‘might lead’ and ‘will definitely lead’, thereby identifying their confidence in the VLE as a contributory factor to their success. Learners were asked to score their response to the statement in question 6 as 1 (will not lead to a chance of success on the program), 2 (might lead to a small chance of success on the program), 3 (might lead to good chance of success on the program), 4 (will definitely lead to a small chance of success on the program), 5 (will greatly improve chance of success on the program). Participants in focus groups often say what they do but this might not reflect what they actually do. It is therefore essential to triangulate findings using an alternative data collection method to ensure that the data collected is accurate. Fern (2001) says that focus groups can be used to supplement other methods, hence the choice of a mixed methods approach to this study (see Methodology). McNamara (web link accessed on 01/06/06) suggests that the order of a focus group should be ‘Develop the questions, record the responses using an audio recorder, reflect the response back to the participant to ensure the correct understanding of the response’. This methodology was followed, thereby ensuring the analysis and results could be verified and validated with the learner at the earliest opportunity. Researchers disagree about the correct number of participants for a successful focus group. Many say that 8 – 12 (Kitzinger and Barbour 1999), 6 – 12 (Lindlof 1995), 6 – 8 (Krueger 1988), 5 – 8 (Green and Hart 1999). Focus groups in this case study were 5 – 8 strong to get enough groups to derive sufficient data to analyse learner satisfaction.

### 3.1 Findings

#### 3.1.1 Questionnaire:

Learners’ response to question 1 and scored response to questions 2 – 5 for the pre-VLE questionnaire were entered into a spreadsheet and analysed using numeric, statistical and graphical methods. Learners gave themselves an overall low score in the area of ‘general computing experience’ with 80% of learners replying that they had either no experience (47%) or some experience (33%) in the computing skills required for studying on the introductory ICT program (figure 1).

Unsurprisingly, all learners had a high pre-existing level of experience of using the Internet/web in their learning history with only 14% of learners replying that they had either no experience (2%) or some experience (12%) in the use of the internet/web in their learning (figure 2).
The usefulness of a range of learning activities/resources resulted in mixed responses. Some learners felt that simple activities with answers (gapped handouts, online multiple-choice questions) were much more useful than overly long essays/reports that were required in some cases. Other learners identified group activities using chat rooms/discussion forums as useful as this was something with which they felt they had ‘loads of experience’. Learners scored low in their concerns about using a VLE in their learning (figure 3) with 54% having ‘No Concerns’ (21 learners), 33% having ‘Some Concerns’ (13 learners) and 13% having ‘Extensive Concerns’ (5 learners). This is not unexpected and goes someway to validate the learners self-assessed high level of experience in using the internet/web (Q3). It is suggested that this (apparent) lack of concern with using the VLE has been translated by the learner as the learners’ expectation that the VLE will be very similar in use to the internet/web and therefore have no concerns for them.
A Chi-square test was applied to determine if male and female learners responded differently to each of the items in Q2 of the pre-VLE questionnaire. Due to the small sample size of female learners (4), the Chi square test returned an error in all cases tested, identifying that the low female count would affect the validity of the Chi-square value. This was also the case for each of the items in Q3 of the pre-VLE questionnaire. When the Chi-square test was repeated using age at 1st September, this too showed an error in the count for the number of learner’s aged 17 and 18 years. Correlation analysis (Pearson Correlation co-efficient r) and t-test analysis were inappropriate as there were no numerical values collected as part of the pre-VLE questionnaire (the scores of 1, 2, or 3 are categories or ordinal numbers and not true ‘numerical’ values).

3.1.2 Focus groups:

Results from analysis of Q6 of the focus group questions indicate that 40% of the learners are dissatisfied with the VLE content and scored either 1 (will not lead to improved chance of success on the program) or 2 (might lead to a small chance of success on the program). The focus group sessions were coded immediately following the session where every line, paragraph, or other section or text was coded for relevant themes. As these were identified, they were assigned a working code. This meant that definitions were constantly challenged and new codes developed (Glaser and Strauss, 1967). Saturation was reached after 26 transcripts were decoded. No new codes were required, no new categories emerged and any new transcripts only produced a repetition of themes already identified. Themes identified were; ease of navigation in the VLE; clear content; able to revisit difficult topics but didn’t like all the on-screen reading; the hot-links were all active; the hot-links were to good sites; charts/graphs made understanding numbers easier; audio would have helped with all the reading; the chat rooms were ‘cool to hang out in’; it was difficult to get in touch with a tutor and that scheduled real-time chats (RTC) with a tutor would have been better; email messaging system was a good way of keeping in touch if off sick or during holiday periods; the use of the diary and was considered to be useful as a reminder for homework/assignment hand in deadlines and could be used for recording all kinds of calendar events (not necessarily academically related ones); the use of group-based activities were a good way of improving skills and knowledge by sharing ideas with peers; the inclusion of a variety of small activities made the VLE much more interesting to use.

4. Conclusion

Overall the case study was considered successful in that it identified pre-existing areas of concern for the learners that were to use the VLE. These concerns would be included as part of the redesign brief for the VLE interface and learning activities. It also identified that those learners whose predominant learning style was either kinaesthetic or auditory, would require different ways in interacting with the materials in the VLE. It also confirmed that not all learners’ needs were catered for by developing a VLE that was ‘fit for the masses’ and that 40% felt that it would not improve their chance of success on the programme. It is acknowledged that the study is limited in that it focused on a narrow range of learners and ICT programs. As a pilot study, whose aim was to ascertain learner satisfaction with a VLE, using focus groups as the main data collection instrument, it is felt that the results show that that
has been achieved. In the next study, a larger female cohort will be studied as the statistical analysis was impeded by the small female representation.

The use of focus groups in this study has been shown to be a sound method of inquiry by using an already validated data-collection instrument and triangulating the results with a quantitative questionnaire. Focus groups are ideally suited for small groups where a one-to-one setting can be threatening and are most effective where the groups are comfortable, there is no peer pressure and intimate topics are not being discussed. They are the data gathering method of choice for use in ‘plural voice’ situations (Fine 1994) where learners can use their own language and words leading to the participant’s involvement as key players in the future development of both a broader range of discrete ICT programs delivered by a VLE and embedded ICT within a range of vocational qualifications across the Post Compulsory Education Vocational Curriculum.

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An Innovative Junior Faculty Online Development Program

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Abstract: This study examines whether two online courses offering educational support for junior faculty have a positive effect on their attitudes and curriculum and teaching capacities (CTC) learning. The data used in the analysis are from two 2005 online University training courses. The tasks the online courses assign to faculty, the resources they provide, the learning environment they create, and the conversations they provoke proved to be consequential in shaping faculty’s attitudes. The results also indicate that junior faculty who participate in individual and collective online developing activities, such as constructing teaching episodes and communicating with other colleagues, are more likely to gain a better understanding of how to teach their scientific disciplines.

Keywords: assessment, e-learning, higher education, teaching practice, staff development

1. Conceptual framework

Literature on university faculty documents the mental challenges they face as they embark on professional careers. One example is the limited “feeling of community, in which relationships become impersonal and teamwork is undermined” (Lackritz, 2004: 714). New assistant teachers struggle with constructing approaches to classroom management, with images of the professorial status, underpaid and short-term contracts, and, if they are women, they keep particular types of resistance (O’Connor, 2000). Probationary and tenured teachers also have particular beliefs on approaches to teaching specific subject matters to students: formal lecturing, small-group teaching in classes or tutorials, large-group teaching or laboratory work. They struggle with their pedagogical and scientific knowledge of the subjects they teach and their ability to take declarative and semantic knowledge and represent it in ways that is comprehensive to students within the new scenario of the European Convergence that assumes changes in credit accumulation, modularisation of study programs, and semesterisation of the academic year (Milliken and Colohan, 2000). Moreover, university faculty and part-time teachers make great efforts while enduring difficulties with the terms and conditions of employment (e.g., many are dissatisfied with pay), the rights they have (e.g., many have excess working hours), and the teaching changes the University expects from them (e.g., some perceive workload is too heavy) (Husbands and Davies, 2000). In addition to discovering what it means to teach their subject matter, junior faculty face other difficulties as they enter the classroom. They are concerned with issues related to themselves and their own adequacy (i.e., many feel a lack of competence in the teaching methodology) (Hardré, 2005).

Most important, new entrants to the academic profession or probationary teachers are still at the beginning stages of learning to teach. Much of what they learn about teaching will depend upon their experiences in classrooms and their opportunities to continue to learn - about subject matter, about students, and about teaching - in a process of learning-by doing or socialisation into academic life (Knight, Tait and Yorke, 2006). New academic appointees have, thus, a different relationship to university policies than do experienced faculty. With regard to junior faculty, the problem for university authorities is not how to change faculty’s practices but rather how to provide the types of support junior faculty may need as they construct their teaching practice. In other words, how induction practices contribute to the process of socialisation of junior faculty so that different social practices, norms, values, predispositions and taken-for-granted knowledge become instantiated at different scientific areas and campuses (Trowler and Knight, 2000). The first educational challenge is to identify the broad trends of faculty empowerment that the university development programs seek to promote. Our distillation of this literature yielded seven broad quality assumptions of optimising university staff development programs: (a) that universities increase the learning to teach of junior and experienced faculty. As Romano, Hoesing, O’Donovan and Weinsheimer (2004: 26) note.

The Mid-Career Teaching Program (MCTP) attracted a group of experienced faculty who are quite diverse in age, in the number of years they have worked in higher education, and in the length of time remaining before retirement.
However, faculty participation in Spanish training courses depends upon such variables as the age, status and rank of teachers; (b) that higher education organisations improve formal personal, professional, career and instructional development. Many universities are establishing development programs in order to strengthen pedagogical content knowledge (Major and Palmer, 2006), as well as other forms of professional practice and personal support services; (c) that specific universities develop self-evaluation teaching (Aleamoni, 1997). One form of faculty deep involvement is typically concerned with the advancement of subject matter competence and the mastery of one’s own discipline as it is related to teaching, thereby building criteria and models as masters of their own learning; (d) that university government bodies increase faculty control over their learning. As Caffarella and Zinn (1999: 248) have pointed out, an enabling factor that enhances professional development is the following faculty personal characteristic:

**Strong personal beliefs and values about the value of continuous professional development; a sense of obligation to be active teachers, scholars, and learners throughout the career.**

Thus, by mapping their own road to professional proficiency, novel teachers sustain desired learning over time; (e) that staff development programs expand faculty’s critical abilities. Scholarly teaching requires a systematic process of inquiry into one’s own teaching practices and into students’ learning (Goldstein and Benassi, 2006). On this point, Koch *et al.* (2002: 84) grouped the differing sources used in evaluating one’s effectiveness into four discreet, but interrelated, approaches to quality assessment:

- Reflective critique, student feedback, analysis of student work, and classroom observations.

The infusion of reflective activities into online courses should be thoughtfully considered and carefully buttressed by a strong research base; (f) that supportive leadership by university administrators disseminate the idea of effective faculty program assessments. Another form of program optimising is to guarantee faculty minimum course standards for recognising faculty work. Many researchers and university leaders have become increasingly concerned with evaluating the effectiveness of professional staff development programs (Pittas, 2000). The focus now is to ensure that this professional development has the effect of adapting teaching styles to meet the demands and expectations of today’s students, providing enlarged opportunities for collegial networking and promoting institutional aims (Dixon and Scott, 2003), and (g) that staff collaboration help faculty succeed academically, providing new strategies, particularly structuring e-learning activities for building digital portfolios, which show novel teachers’ best teaching productions (Woodward and Nanlohy, 2004).

### 2. Design

In designing Online Courses of Teaching Initiation at the University of Jaén (OCTIUAJA), we make six training assumptions (a) from the perspective of social constructivism, online collegial interaction (chat, forum debates, e-mail) is imperative for faculty development; (b) facilitated debates centred on critical university issues play an important role in initiating university formative program reforms; (c) pedagogical knowledge and outcomes require exposure to new and challenging ideas and an opportunity to reflect on the possibilities that these ideas offer towards a greater engagement through multimedia, as well as the encouragement to adapt the ideas of creating narratives to one’s own teaching situation; (d) junior faculty may feel distanced from the newer instructional strategies and classroom technologies (web editors, databases, "listservs", chat groups, etc.) that serve as mediators for learning interactions in university settings; (e) faculty are interested in adapting their teaching style and subject design to meet the expectations of today’s diverse students, and (f) positive outcomes occur when enrichment programs match faculty in their field of knowledge, respectful of their learning experience, and addressing faculty core areas of teaching – content knowledge, curriculum, instruction, and assessment. The critical design issues behind the rationale of both OCTIUAJA courses include online CTC planning, organising, structuring, implementation, tracking, impact reporting, communicating assessments, and many other principles that take time and require orderliness on the part of the online program advisers (Nijhuis and Collis, 2003). Following are some other key features of the OCTIUAJA online delivery system located in the following URL: http://dpdu-jaen.cica.es. Our support conditions and measures are based on university faculty data taken from the literature: (a) they use a CTC handbook (Villar, 2004), which reviews several sources on college teaching and identifies the critical CTC related to class preparation, classroom structure and organisation, with a focus on teaching innovation and student learning; (b) they learn lesson materials – ten CTCs – which are segmented into weekly modules and released on a weekly basis with ongoing updates. All 156 pdf and htlm documents, 114 Web sites, and ten Microsoft Power Point
presentations are hyperlinked; (c) they read and practice each CTC which includes a four-step approach towards reflection following a particular order: Goals, Uses, Teaching Scenarios and Case Study; (d) they discuss two topics in asynchronous forums: ‘European Convergence issues’, and ‘Student mental effort to cope with the new European credit system’. These are organised and released on a fortnight basis, but remain accessible throughout the course. The last forum includes postings positing reflective questions (Socratic questions); (e) they access e-mail from the browser for one-on-one interactions with OCTIUJA mentors or other participant instructors; (f) they browse the material containing URL links to related articles and institutions, notes and grades from any location, at flexible time schedules; (g) generally speaking, they download Microsoft Power Point material containing URL links to related articles and institutions, notes and grades from any location, one-on-one interactions with OCTIUJA mentors or other participant instructors; (h) they submit online learning activity assignments using Web forms interface, or via e-mail; these assignments are authentic activities that have real-university relevance and which present complex teaching-learning tasks to be completed over a sustained period of time; (i) they complete ten online exams using Web forms with answers recorded in the appropriate database on the server. Each CTC exam is programmed (random selection) to be unique and to provide instant feedback to the participant instructors with the results. In other words, there is an authentic assessment, which is seamlessly integrated into the learning activity assignments, and which provides a formative assessment of their understanding of basic concepts, aiding them to gain a sense of progress; (j) they assess satisfaction with OCTIUJA courses. They assess the quality of materials and of the training process as a formative evaluation for course revision, and (k) they meet with an experienced professor of the UJA during real-time in a chat room to discuss course progress and forum contents. Supporting, motivating and developing are the aims of this mentoring function (Sosik and Godshalk, 2000).

Consequently, three main OCTIUJA goals emerge from these assumptions. We want to assess (a) participant CTC needs; (b) participant reaction to CTC lesson content and structure, delivery method, time consumption, etc., and (c) participant attention to, and learning of, the ten CTC lessons, in order to support instruction and learning in university classes, thus making university professional development more relevant.

3. Setting and participants

Funded in 1993, the UJA is a new Andalusian institution. It is considered one of the seventeen middle-sized Spanish public universities, which had, in the academic year 2005-2006, around 14,099 students, 899 teachers of various status and ranks, and 43 formative programs distributed around three campuses. Sixty-five subjects are the total sample of the two courses: 50.8% (N = 33) in the first course, and 49.2% (N = 32) in the second course. Sixty-one percent (N = 40) are male and 38.5% (N = 25) female. Forty-one per cent (N = 27) are between the ages of 30-34, 27.7% (N = 18) between 25-29, 23.1% (N = 15) between 35-39, and 7.7% (N = 5) between 40-44. Typically, faculty members hold higher education degrees. Fifty-three per cent (N = 35) have a doctorate degree, 44.6% (N = 29) a Bachelors’ degree, and only 1.5% (N = 1) a Graduate College Degree (a three-year College). Faculty members are hired at the lowest rank. Forty-seven per cent (N = 31) are Assistant professors, 24.6% (N = 16) Lecturers, 12.3% (N = 8) College professors, 7.7% (N = 5) Probationary faculty members, 6.2% (N = 4) Scholarship holders, and 1.4 (N = 1) an Associate professor.

The number of teaching years ranges from 1 to 19. Forty-one (N = 27) respondents have up to three years of teaching experience; 38.5% (N = 25) between 4-6 years; 9.2% of the participant instructors (N = 6) have 7-9 years, and 7.7% (N = 5) have 10-12 years. Finally, 1.5% (N = 1) has 13-15 years teaching experience, and also at 1.5% (N = 1) one participant has 16-18 years of experience. When disciplines are broken down into scientific areas, thirty-six faculty members (N = 24) teach in the Social Sciences; 27.7% (N = 18) in Technical Sciences; 16.9% (N = 11) in Experimental Sciences; 12.3% (N = 8) in Humanities, and 6.2% (N = 4) in Healthcare Sciences. Besides, participants in Course I teach thirty-two different subject matters, and participants in Course II teach thirty-four different disciplines. Demographic measures are used as independent variables in analyses. The OCTIUJA courses took place during the year 2005, and lasted 11 weeks each.

4. Faculty questionnaires

Faculty members complete two types of questionnaires. The first questionnaire assesses CTC reactions and attitudes, which are adapted from common themes in the University training literature, that is, what faculty think might be true and say they want regarding OCTIUJA quality, in order to
capture potential stances among all participants. Faculty rate ten online five-point Likert-type scale CTC sheets. Each sheet consists of ten declarative statements (e.g. ‘This capacity is pertinent to my teaching’) with an additional open-ended question. A Cronbach’ alpha coefficient (α = .955 standardised) computed for this instrument indicates a high degree of internal consistency. A second questionnaire assesses their CTC learning. Ten multiple-answer teacher-made CTC tests are used for measuring learning attainment; taking a test is understood as a time on-task learning activity (e.g. ‘A process of group dynamics can be constituted by the following phases’). Once again, Cronbach’ alpha coefficient (α = .979 standardised) for all tests shows a high degree of internal reliability. Responses require selecting from a range of four item possibilities, and tests are administered at the end of each CTC lesson. Face validity, stem clarity, correct keying answer, and spelling of distracters are some of the determinants of the quality of capacity tests to be considered. Overall, these α scores indicate that respondents are highly likely to answer consistently on items belonging to the same instrument or test.

5. Results
We analysed the data results for all faculty members who participated in both courses.

5.1 Evaluating OCTIUJA quality measures
We compare participants’ ratings on reactions and attitudes separately for each item. Our hypothesis that both course participants would have significantly different OCTIUJA quality reactions and attitudes was not supported. The results by gender show the following significant findings: CTC 1 – Knowledge of student motivation and ability to promote students’ positive attitudes – (t (63) = -.312, p < .003); CTC 2 - Awareness of students’ diversity in all its forms – (t (63) = -3.27, p < .002); CTC 3 - Capacity to solve students’ problems – (t (63) = -2.780, p < .007); CTC 4 - Capacity to develop metacognitive skills in the trainee – (t (63) = -3.126, p < .003); CTC 5 - Capacity to provide effective and free curriculum time – (t (63) = -2.779, p < .007); CTC 6 - Knowledge of area being supervised (learning tasks, research, assessment, etc.) – (t (63) = -3.499, p < .001); CTC 7 - Teaching and didactic skills for large groups – (t (63) = -3.037, p < .003); CTC 8 – Grasp of questioning skills - (t (63) = -3.091, p < .003); CTC 9 - Knowledge of formative and summative evaluation - (t (63) = -3.008, p < .004), and CTC 10 - Capacity to conduct own self-assessment process - (t (63) = -3.378, p < .001).

On participants’ age range, we found significant differences in the following capacities: CTC 1 – Knowledge of student motivation and ability to promote students’ positive attitudes – (F (2, 56) = 3.50, p < .037); CTC 2 - Awareness of students’ diversity in all its forms – (F (2, 56) = 4.82, p < .012); CTC 3 - Capacity to solve students’ problems - (F (2, 56) = 4.15, p < .021); CTC 4 - Capacity to develop metacognitive skills in the trainee – (F (2, 56) = 3.97, p < .024); CTC 6 - Knowledge of area being supervised (learning tasks, research, assessment, etc.) – (F (2, 56) = 4.41, p < .015); CTC 7 - Teaching and didactic skills for large groups – (F (2, 56) = 3.48, p < .037), and CTC 8 – Grasp of questioning skills – (F (2, 56) = 4.24, p < .019).The one-way ANOVA was also significant regarding scientific area in CTC 5 - Capacity to provide effective and free curriculum time – (F (3, 56) = 3.72, p < .016); CTC 6 - Knowledge of area being supervised (learning tasks, research, assessment, etc.) – (F (3, 56) = 3.26, p < .028); CTC 7 - Teaching and didactic skills for large groups – (F (3, 56) = 2.89, p < .049); CTC 8 - Grasp of questioning skills – (F (3, 56) = 3.04, p < .036); CTC 9 - Knowledge of formative and summative evaluation – (F (3, 56) = 3.14, p < .032), and CTC 10 - Capacity to conduct own self-assessment process – (F (3, 56) = 3.35, p < .025). Across academic degree, status and rank, and teaching experience there were no significant differences.

5.2 Assessing learning activities
Our goal was to examine the change needed in CTC learning to reflect the way the curriculum and didactic knowledge will be used in real university environments. Over time, the focus on activities highlighted critical decisions for designing a valid use of telecommunications. The activity(ies) give(s) meaning and structure to the study of the OCTIUJA courses. In this sense, participant instructors completed 1,351 learning activities in Course I and 1,741 learning activities in Course II. An overview of Figure 1 reveals a higher flow of answers for the cognitive demands of CTC 2 – Awareness of students’ diversity in all its forms - and a sense of difficulty of CTC 9 – Knowledge of formative and summative evaluation -. Males completed more activities than female participants in both courses (i.e., 57.6% men and 42.4% women in Course I, and 65.6% men and 34.1% women in Course II);
Course I participants of ages 30-34 completed 51.5%, while Course II participants of the same age range completed 31.3%; Course I Doctors completed 54.5%, while those in Course II completed 53.1%, with Doctor participants realising more activities than Bachelor's degree participants in both courses; Assistant professors in Course I (46.5%) completed more activities than those in Course II (46.9%), and again, Assistant professors completed more activities than Lecturers in both courses; finally, Course I participants completed more activities than Course II participants in the two cycles of teaching experience (up to 3 years, and between 4-6 years). Course II Social Sciences participants completed 43.8% of activities, which was the highest percentage both in comparison to other areas of the same group course and to other areas in Course I.

Figure 1: Frequency of CTC activities realised in course I and course II.

Our hypothesis that course participants would show significant differences in lesson learning in the two courses was supported. The t-test analyses revealed that junior faculty in Course I experienced a commitment to CTC learning and had better defined academic goals after joining the OCTIUJA program than participants in Course II. This suggests that Course I participants remained concerned about their academic performance while participating in OCTIUJA and then benefited from having clearer defined academic goals and greater self-efficacy in their ability to succeed in the course. The results of CTC learning across the various demographic groups show that tests yield significant differences in age groups, once categories have been collapsed into three independent variables. There were significant differences in only two of the ten capacity tests: CTC 8 - Grasp of questioning skills - \(F(2, 56) = 4.14, p < .021\), and CTC 9 - Knowledge of formative and summative evaluation - \(F(2, 56) = 3.44, p < .039\). For teaching experience, we grouped the independent variables into two; there was a significant difference in only one of the ten capacity tests: CTC 3 - Capacity to solve students' problems – \(t (50) = -1.276, p < .066\). Regarding scientific area, we redistributed independent variables into four; there were significant differences in only two of the ten capacity tests: CTC 4 - Capacity to develop metacognitive skills in the trainee - \(F(3, 56) = 2.91, p < .028\), and CTC 5 – Capacity to provide effective and free curriculum time - \(F (3, 56) = 2.62, p < .043\). Across gender, academic degree, status and rank there were no significant differences.

5.3 Discussion, implications, and suggestions

This is the first OCTIUJA study to include all categories of faculty staff, and to relate the findings of CTC needs, attitudes and learning to worker demographics, job conditions, and factors, which pertain to the general academia. Taken together, the results indicate that a teaching change in university staff is widespread and needed. Furthermore, these results provide support for the consideration that junior faculty perceive CTC needs (79%). This perceived level of teaching needs is a concern. A staff program such as OCTIUJA is one way to address the needs of junior faculty to better serve an increasingly diverse and growing student population. The majority of younger faculty (between 25 and 29 years of age) also felt that they needed training in new teaching skills, in valuing the improvement
of their teaching styles, and in trusting and increasing their confidence in the classroom learning evaluation. Faculty had the same views about the qualities of OCTIUJA (e.g. structure, procedures); they did not vary across participants in the two courses. Nevertheless, according to some demographic variables (e.g., gender, age range or scientific area) faculty members have different stances from their colleagues on the characteristics of some CTC attitudes. However, it is particularly surprising that CTC training attitudes did not differ by category of academic degree, status and rank, or teaching experience. One plausible explanation for this result relates to the faculty's belief systems regarding the goals and structure of each CTC. They might also have considered OCTIUJA quality (opinions and attitudes) questionnaire at the end of each CTC lesson too repetitive, and hence, have answered with similar scores. Nevertheless, faculty members' reflections on CTCs have helped to identify areas that might need to be redesigned and implemented in future university staff online trainings.

Do CTC development activities assist in a faculty member's professional success? Our belief is that they do. Are the faculty member's learning activities the core factor of OCTIUJA? We believe this is the case, and we have attempted to bring to light the principles from which these influences arise. We hope that the formal activities provided enabled them to reflect on pedagogical sources of support to bring about a change in teaching knowledge. The average number of activities by faculty is 40 in Course I, and slightly higher in Course II (54). Can a faculty member control the degree of influence that such learning activities exert on his or her professional development? We assume, like other researchers (Caffarella and Zinn, 1999), that the learning that takes place as a result of course experiences have an impact on university careers and on the success of university faculty as professionals. Differences in levels of activities among faculty yield interesting results. For instance, female faculty members realise fewer training activities than men, who have a higher percentage of participation in both courses. Our percentage results in completed activities also demonstrate that the direction of the differences between types of faculty and course participants may be related to the size of the faculty samples. Interestingly, faculty members of the two courses showed discrepancies in the test scores of all CTCs. It seems that junior faculty in Course I were committed to increasing their awareness of their CTC training goals, such as the ability to keep student interest and attention high, and the ability to promote student learning. Age, teaching experience and scientific area are three independent variables that yielded significant differences between groups.

There are significant implications for University administrators, who should be concerned about the CTC change of their faculty members. We offer some insights into the challenges of OCTIUJA. Mentoring by expert professors who provide an advisory role for new faculty can increase the latter's awareness of learning strengths and weaknesses (Brancato, 2003). Junior faculty believed that mentors were responsive to the needs of the group and that sharing ideas with colleagues in the two forums had been useful. As Dixon and Scott (2003) noted, being able to discuss problems related to teaching and learning had been of benefit in improving pedagogical content knowledge. Having said that, the authors note a limitation in that the data collected on OCTIUJA attitudes and learning are just a snapshot of the faculty members' belief system at the time of the study. As faculty applicants can clearly vary from course to course, professional teaching improvement could result, not from the current online program, but from a build-up of courses taken in early years.

6. Conclusions

There is no debate that junior faculty development is a significant key to the continued success of higher education, as Camblin and Steger (2000) have written about regarding another university. The impact is best summed up by a comment made on the faculty survey by a faculty member while referring to a CTC,

The aggregate knowledge I have gained attending face-to-face weekend workshops does not equal the positive effect that this blended course has produced in me.

CTC activities have provided opportunities for discussion, reflection, and connection of learning at a personal and professional level, such as improving course content, method of instruction, course and instructional organisation, relation of course content to course objectives and course and instructional organisation.

The results suggest that the online programme should continue with minor amendments to structure and content such as an increased use of case-study approaches and more opportunity to witness and discuss best practice in teaching and learning, and possible formal certification for attendance and achievement of programme outcomes by junior faculty.
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References


