Electronic delivery of lectures in the university environment: An empirical comparison of three delivery styles

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Abstract

The purpose of this study was to consider the efficacy and popularity of “Virtual Lectures” (text-based, structured electronic courseware with information presented in manageable “chunks”, interaction and multimedia) and “e-Lectures” (on-screen synchrony of PowerPoint slides and recorded voice) as alternatives to traditional lectures. We considered how three modes of delivery compare when increasingly deeper forms of learning are assessed and also student reaction to electronic delivery. Fifty-eight students in three groups took three topics of a human genetics module, one in each delivery style. Results indicated no overall greater efficacy of either delivery style when all question types were taken into account but significantly different delivery-specific results depending on which level of Bloom’s taxonomy was assessed. That is, overall, questions assessing knowledge consistently achieved the highest marks followed by analysis, comprehension, evaluation and application. Students receiving traditional lectures scored significantly lower marks for comprehension questions. Students receiving Virtual Lectures scored high for knowledge, comprehension and application but significantly lower for analysis and evaluation questions. The e-Lectures scored high for knowledge questions and were the median for all question types except application. Questionnaire analysis revealed a preference for traditional lectures over computer-based but nevertheless an appreciation of the advantages offered by them.

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1. Introduction

The statement that “a lecture is a process in which information passes from the notes of the lecturer to the notes of the student without passing through the minds of either” (attributed to RK Rathbun (Gilstrap & Martin, 1975)) is widely quoted in jest but nevertheless is reluctantly accepted as truism in many circles. Lectures have remained the popular mainstay of undergraduate teaching since universities were founded because of their efficiency (one person can teach a large or small numbers of students), because they are tutor-centred...
and because they can easily be combined with other teaching methods (Gilstrap & Martin, 1975; Good & Brophy, 1990). Within the last 20 or so years however the proponents of learning via computers have challenged the view that the traditional lecture is necessarily the most appropriate means of facilitating learning in a university environment (e.g. Inglis, Ling, & Joosten, 2002; Kulik, Kulik, & Cohen, 1980; Kulik, Kulik, & Schwab, 1986; Najjar, 1996). The revolution of computer technology, the explosion of the World Wide Web and the trend of university teaching to become more learner-centred have popularised electronic delivery as an alternative or an adjunct to traditional lectures (Inglis et al., 2002; Kulik et al., 1980; Kulik et al., 1986; Ravenscroft, Tait, & Hughes, 1998). The advantages afforded by the use of computer technology in comparison to traditional lectures are well established, namely that the student has the opportunity to “take the lecture” in a time and place of their own choosing, working at the desired pace and employing a mode of learning most attractive to them (Race, 1994; Evans, Gibbons, Shah, & Griffin, 2004).

Studies citing the value of electronic delivery are numerous and include expositions of the power of virtual learning environments in various forms (e.g. de Lange, Suwardy, & Mavondo, 2003; Green et al., 2006; Janes, 2006). Design considerations are a common feature of research into electronic delivery (e.g. Evans et al., 2004; Macleod, 2000; Greenhalgh, 2001) with special emphasis on graphical user interface (Clariana, 2004; Mayer & Moreno, 2002) and navigation options (Evans & Edwards, 1999; Moss, Redfern, & Brown, 1998; Feifer & Tazbaz, 1997; Nielsen, 2005). Other considerations include levels of interactivity (Lindstrom, 1994; Moore, 1989), longevity and cost (Jolliffe, Ritter, & Stevens, 2001; Race, 2005). Specific examples in biomedicine include the “virtual patients” of Bearman, Cesnik, and Liddell (2001), orthodontics training (Aly, Willems, Carels, & Elen, 2003), and “Web3D anatomy teaching (Brenton et al., in press) although there are many more in other subject areas.

There have been a number of studies that have compared directly the “electronic lecture” with the traditional one (Wofford, Spickard, & Wofford, 2001). For the most part, the “electronic lectures” described in these studies were text based, incorporating varying degrees of multimedia and available either on the Web or a local intranet. For instance, Dewhurst and Williams (1998) suggest that a text-based computer-based learning environment used in their study was as effective as traditional lectures in disseminating factual information but was generally less popular. Maki and Maki (2002) and Williams, Aubin, Harkin and Cottrell, 2001 corroborated these findings of popularity suggesting that the computer-based instruction was not as useful as the traditional format (despite finding it user friendly and recommending to their colleagues but Tvedten, Walter, Stickle, Henkel, and Anderson (1993) concluded that there was no significant evidence that one method was better than the other. Paradoxically Holt et al. (2001) concluded that students found the computer-based delivery easy and effective to use and “valued the course more highly than conventional lectures”. Evans et al. (2004) provided evidence that material presented in an interactive, easily navigable learning environment creates a significant improvement in the student learning experience (measured by test performance and questionnaire) over identical material presented as simply pictures and text in scrollable web pages. In so doing, the claims of previous studies were corroborated (Evans & Edwards, 1999; Feifer & Tazbaz, 1997; Mayer & Moreno, 1999; Najjar, 1996) namely that design of an interactive interface is a critical consideration if electronic lectures are to be a realistic alternative to traditional lectures. Dunsworth and Atkinson (in press) split undergraduates into three groups comparing between them the efficacy of on-screen text, narration, and narration and agent (“Dr Bob”) concluding that the agent can promote learning while simultaneously avoiding split attention problems.

A trawl of University web pages reveals that, although learning environments such as WebCT and Blackboard are becoming increasingly popular, the predominant form of electronic presentation of the actual courseware itself remains simple scrollable web pages or PowerPoint slides (presumably mostly used as revision aids). More elaborate means of electronic delivery are less commonplace but seem to fall into three categories. The first, for the purposes of this paper, we will refer to as “Virtual Lectures”. By this we mean that courseware is usually text based but presented in a structured manner (with more than one level of navigation and adequate navigational information), often in “bite-sized chunks” (Lynch & Horton, 1999) to aid learning, usually with some form of interaction (e.g. self-assessment questions) and with the liberal use of multimedia such as photographs and video. These Virtual Lectures are usually written in HTML or programmes such as Macromedia Authorware (Evans & Edwards, 1999; Evans et al., 2004). The second (again for the purposes of this paper) we will refer to as “e-Lectures” (Logic Matters). In this case, courseware is presented as a recording...
of a lecture that has actually taken place (or has been pre-recorded in a studio or office) and appears on screen as a synchrony of the PowerPoint slides and the voice (and sometimes video) of the lecturer. (e.g. Boxmind, Logic Matters home pages, DIYEL Bournemouth University, UK). The reasons for the choice of the terms “Virtual” and “e-” lectures is given in the following section.

A final category includes series of streaming media video-clips made (with varying degrees of professionalism) in a manner akin to a television programme for the purposes of demonstration. Examples might include demonstrations of how to examine a patient or perform a laboratory procedure safely (Kneebone, 2003; Learning light e-Learning Centre; Lifesign media; Click and go video).

The purpose of this study is to consider the efficacy of the first two of the above (“Virtual Lectures” and “e-Lectures”) as alternatives to traditional lectures delivered in lecture theatres. To the best of our knowledge, no studies have thus far drawn such three-way comparisons and, in this paper therefore, we describe and analyse an empirical analysis on these three different delivery styles in a human genetics module. We consider whether electronic delivery alone (either “Virtual Lectures” or “e-Lectures”) can facilitate student learning as effectively as traditional lectures. In particular we consider how the three modes of delivery compare when increasingly deeper forms of learning (knowledge, comprehension, analysis, application, evaluation – Anderson et al., 2001; Bloom, 1956) are assessed and also the student reaction to electronic delivery in either format. In order to minimise variables as much as possible, all the students were given a single mode of delivery for one topic rather than the blended approach favoured by most practitioners.

2. Methodology

2.1. Study group

A total of 58 students in groups A (n = 21), B (n = 21) and C (n = 16) began as a cohort of 76 students (with 25 or 26 in each group) but were only considered part of the study group if they completed all aspects including the assessment (hence the slightly uneven numbers in each group). All students were studying for bioscience degrees at Brunel University and, here, taking a module in human genetics.

2.2. Human genetics module

The three topics of study were as follows – (T1) “Mendelian Genetics”, (T2) “Molecular Analysis of Genetic Disorders” and (T3) “Genotype/Phenotype Correlations”. All groups of students received identical subject material for each topic but the content of each topic was taught through different delivery styles: (i) traditional lecture (ii) Virtual Lecture or (iii) e-Lecture. The terms “Virtual Lecture” and “e-Lecture” were chosen for no other reason than to reflect the names commonly used by the original developers of the software or interface employed. Table 1 summarises the delivery style received by each group of students.

2.3. Creation of delivery styles

All lectures, irrespective of delivery style, were devised by the same lecturer. We were very careful to ensure that the information presented in class and electronically was identical. In order to minimise on variables there was no class discussion. The traditional lectures involved the lecturer standing in front of the class, giving a PowerPoint presentation and with printed notes being distributed. “Virtual Lectures” (see Fig. 1 – adapted from Evans & Edwards, 1999; Evans et al., 2004) were designed in Macromedia Authorware 6.5. The students

<table>
<thead>
<tr>
<th></th>
<th>Topic 1</th>
<th>Topic 2</th>
<th>Topic 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>Traditional</td>
<td>Virtual</td>
<td>e-Lecture</td>
</tr>
<tr>
<td>Group B</td>
<td>e-Lecture</td>
<td>Traditional</td>
<td>Virtual</td>
</tr>
<tr>
<td>Group C</td>
<td>Virtual</td>
<td>e-Lecture</td>
<td>Traditional</td>
</tr>
</tbody>
</table>
had to click on the navigation buttons to progress through the lecture, which consisted of material embedded in a specially designed multimedia interface. This interface was designed to both coerce and encourage the author to adopt principles of good design with particular emphasis on usability and interactivity. The material was given a hierarchical structure consisting of the topics (T1, T2 and T3) divided into subtopics, which are then divided into (non-scrollable) screens (thereby ensuring delivery as "bite-size chunks" – Lynch & Horton, 1999). Navigation was designed to be flexible at the level of topics and sub-topics, but constrained to a sequence at the level of pages. Careful consideration was given to making sure the learner knew where they were at any given point in studying the material, and also where they could go. This helps overcome common problems of disorientation (Conklin, 1987). The Virtual Lecture was intended to be highly interactive providing audio and visual feedback for navigation and frequent use of interactive self-assessment questions. Further details of many of these design principles are given in Evans and Edwards (1999) and Evans et al. (2004).

"e-Lectures" (see Fig. 2) were created using a software package, “e-Lect,” which was developed by Logic Matters Ltd. e-Lect has been designed specifically for the purpose of capturing lectures and seminars in both a ‘live audience’ environment, and in a ‘studio’ type environment (i.e. in a quiet room). Presenters can either use a wide range of visual material including: electronic images (gif and jpeg), overhead transparencies or, as in this study, Microsoft PowerPoint. Here, the ‘studio’ recording option was used to narrate three pre-prepared PowerPoint lectures (as given in the traditional lectures). Very simple editing was performed to ensure that each presentation started and ended cleanly. e-Lectures were then created and made available on WebCT and could be played using “RealPlayer”. When students viewed an e-Lecture they had the option to choose either to allow the presentation to progress from beginning to end without interaction, or to use the controls available to interact at the slide level, using the index of slides on the left hand side of the screen, or within a slide using the embedded RealPlayer controls (Fig. 2).

Fig. 1. An example of a Virtual Lecture.
Virtual Lectures and e-Lectures therefore differed in a number of ways: Virtual Lectures were largely text based but included interactions, self-assessment questions and a two tier hierarchical structure in the navigation. e-Lectures on the other hand were much more similar to the traditional lectures except that the lecturer was not present and the students could stop, start and replay the lecture at any point.

All students were given access to their personal combination of Virtual Lectures and e-Lectures through WebCT. In order to maximise the benefits of the electronically delivered lectures yet minimise the risk of collusion, students could only access the Virtual Lectures and e-Lectures by entering a personal login and password. In this way they were only given the opportunity to view the mode of delivery appropriate to the study, e.g. group A could only view topic 2 as a Virtual Lecture and topic 3 as an e-Lecture (Table 1). Students without easy web access or who had any technical problems were given their own combination of electronic lectures on a CD-ROM. Attendance at the traditional lectures was monitored through taking of a register and all traditional lectures took place on the same day. There was a period of one week between release/delivery of all the lectures and assessment.

2.4. Quantitative assessment of efficacy of electronic approaches using multiple choice questions (MCQ)

In order to assess quantitatively the efficacy of the two forms of electronic delivery (Virtual Lectures and e-Lectures) compared to the traditional lectures, all students were given the same paper-based assessment comprising 30 multiple choice (5 response) questions. Questions 1–10 (T1) assessed topic 1, questions 11–20 (T2) assessed topic 2 and questions 21–30 (T3) assessed topic 3. In each case the blocks of 10 questions assessed increasingly deeper forms of learning from lowest cognitive skills to highest (Anderson et al., 2001; Bloom, 1956). Thus questions 1, 2, 11, 12, 21 and 22 assessed their knowledge by simple one-word answer factual
recall questions. Questions 3, 4, 13, 14, 23 and 24 assessed their comprehension by use of assertion-reason questions. Questions 5, 6, 15, 16, 25 and 26 assessed their analysis skills e.g. with questions asking what is the most appropriate interpretation of an unfamiliar set of data related to the courseware presented in the lecture. Questions 7, 8, 17, 18, 27 and 28 assessed application skills i.e. taking the knowledge they have learned and applying it to a similar, yet unfamiliar situation. Finally questions 9, 10, 19, 20, 29 and 30 assessed the students’ evaluation skills by providing them with a statement related to the subject matter then asking them to give their assessment of what a reasonable scientist would make of it. All the questions were devised and tested rigorously among colleagues in the Virtual University Project and the Learning and Teaching Development Unit at Brunel University to establish that they were indeed assessing the level of Bloom’s taxonomy that the authors intended. Answers were marked using an optical mark reader.

2.5. Qualitative assessment of modes of delivery – questionnaire design

A paper-based questionnaire was distributed to the students on completion of the assessment test. Questions were kept to a minimum to avoid “form-fatigue” and to encourage completion. It was divided into four sections. The first investigated previous experiences with computer-based learning. The second section asked students simply to order their preferred mode of lecture delivery and which delivery style, in their opinion, promoted the best learning for them. The third section consisted of statements reflecting the students’ possible opinions regarding computing for learning in general and for the interventions specific to this study (Table 2). In this section they had to answer according to a limited five point Likert scale with anchors ranging from “Strongly Agree”, “Agree”, “Neutral”, “Disagree” and “Strongly Disagree”. In section four, unconstrained qualitative feedback was invited from the participants at the end of the questionnaire.

All statistical analyses were done using SPSS for Windows, Release 12.0 (SPSS, Inc). A mixed-model analysis of variance (ANOVA) was used to study the relationship between the students’ assessment scores and the

<table>
<thead>
<tr>
<th>Statement</th>
<th>Agree (Strongly)</th>
<th>Neutral</th>
<th>Disagree (Strongly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning from computers is boring.</td>
<td>12 (26%)</td>
<td>17 (37%)</td>
<td>17 (37%)</td>
</tr>
<tr>
<td>I prefer to learn from a real lecture rather than a computer program.</td>
<td>38 (82.6%)</td>
<td>4 (8.7%)</td>
<td>4 (8.7%)</td>
</tr>
<tr>
<td>Computer-based learning can be a complete replacement for real lectures.</td>
<td>4 (9.1%)</td>
<td>3 (6.8%)</td>
<td>37 (84.1%)</td>
</tr>
<tr>
<td>The computer-based learning approach is appealing because I could learn in my own time, location and pace.</td>
<td>28 (60.9%)</td>
<td>12 (26.1%)</td>
<td>6 (13%)</td>
</tr>
<tr>
<td>I feel I could have learnt more if I was more computer literate.</td>
<td>1 (2.17%)</td>
<td>13 (28.26%)</td>
<td>32 (69.57%)</td>
</tr>
<tr>
<td>Computer-based learning made me more motivated to work.</td>
<td>5 (9.1%)</td>
<td>18 (32.7%)</td>
<td>22 (40.0%)</td>
</tr>
<tr>
<td>The computer-based learning programs were easy to use.</td>
<td>28 (60.87%)</td>
<td>10 (21.74%)</td>
<td>8 (17.39%)</td>
</tr>
<tr>
<td>I would prefer to have real lectures with computer-based learning programs as a supplement for revision purposes only.</td>
<td>43 (93.48%)</td>
<td>1 (2.17%)</td>
<td>2 (4.35%)</td>
</tr>
<tr>
<td>I felt isolated learning via computer-based learning as there was no interaction with the tutor or fellow members of class.</td>
<td>27 (58.7%)</td>
<td>13 (28.26%)</td>
<td>6 (13.04%)</td>
</tr>
<tr>
<td>I would have preferred the computer-based learning lectures to have been supported by seminars.</td>
<td>34 (77.3%)</td>
<td>8 (18.2%)</td>
<td>2 (4.5%)</td>
</tr>
<tr>
<td>Real lectures and computer-based learning offer the same levels of information.</td>
<td>8 (14.5%)</td>
<td>15 (33.3%)</td>
<td>22 (48.9%)</td>
</tr>
<tr>
<td>I appreciate the fact that CBL allows me to learn at a time, place and pace of my own choosing and I prefer to learn this way.</td>
<td>13 (28.26%)</td>
<td>20 (43.48%)</td>
<td>13 (28.26%)</td>
</tr>
<tr>
<td>CBL (either e-Lecture or Virtual Lectures) allow me to learn the material in the way I want to learn it.</td>
<td>21 (45.65%)</td>
<td>15 (32.61%)</td>
<td>10 (21.74%)</td>
</tr>
</tbody>
</table>
groups, question sets and delivery style. Subjects were treated as a random factor. For the evaluation of the increasingly deeper levels of learning, a Student’s t-test was used.

3. Results

3.1. MCQ assessment

The mean assessment marks for all three groups and all three topics are shown in Table 3.

With respect to the three topics (T1 = 1–10, T2 = 11–20 and T3 = 21–30), students doing set T1 achieved a significantly higher percentage irrespective of delivery style and a significantly ($P = 0.00$) higher overall mean percentage (66.9%), indicating that “Mendelian Genetics” (T1) was the topic that they found the easiest. There were no significant differences between T2 and T3.

It is evident from Table 3 that overall results were similar across groups, that is Group C scored a mean percentage overall of 59.6% followed by group A (55.6%) then group B (53.8%) but with no statistically significant difference between the groups. There was thus no evidence of a greater academic ability in any one group. It was also observed that there were no significant differences in the mean scores for each mode of delivery (i.e. traditional lectures (58.3%), Virtual Lectures (56.0%) and e-Lectures (54.6%)).

3.2. Increasingly deeper levels of learning

The results of score tests broken down by increasingly deeper levels of learning (Anderson et al., 2001; Bloom, 1956) can be seen in Table 4 and Fig. 3.

Regardless of the delivery style, the questions assessing knowledge (factual recall) consistently achieved the highest marks and the highest total mean percentage (65.4%). This was significantly greater than the mean for each other question type apart from analysis type questions (knowledge vs. comprehension $P = 0.05$; knowledge vs. application $P = 0.00$; knowledge vs. evaluation $P = 0.001$). When answering questions that assessed analysis skills, students gained significantly higher marks than comprehension ($P = 0.04$), application ($P = 0.00$) and evaluation ($P = 0.002$) type questions with application type questions being the lowest (Table 4).

When breaking down by delivery style and question type, students who had been delivered traditional lectures scored significantly lower marks for comprehension type questions (48.1%) than knowledge type questions (68.0% – $P = 0.00$) and analysis type questions (67.4% – $P = 0.004$). Indeed for comprehension type questions, students who had been delivered traditional lectures gained lowest scores compared to those receiving the electronic delivery styles – significantly lower than the Virtual Lectures ($P = 0.05$). Students taught by Virtual Lectures scored high for knowledge (61.8%), comprehension (63.4%) and analysis (64.9%) type questions but significantly lower for application (44.1%) and evaluation (45.7%) type questions ($P = 0.001$ for all

Table 3
Summary of assessment marks

<table>
<thead>
<tr>
<th>Questions 1–10 (T1)</th>
<th>Questions 11–20 (T2)</th>
<th>Questions 21–30 (T3)</th>
<th>Mean mark for groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>69.05%</td>
<td>50.48%</td>
<td>47.14%</td>
</tr>
<tr>
<td>Group B</td>
<td>62.38%</td>
<td>50.95%</td>
<td>48.10%</td>
</tr>
<tr>
<td>Group C</td>
<td>69.38%</td>
<td>54.38%</td>
<td>55.00%</td>
</tr>
<tr>
<td>Mean mark for topics</td>
<td>66.93%</td>
<td>51.93%</td>
<td>50.08%</td>
</tr>
</tbody>
</table>

Table 4
Summary of assessment results broken down by increasingly deeper levels of learning

<table>
<thead>
<tr>
<th></th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Application</th>
<th>Analysis</th>
<th>Evaluation</th>
<th>Total % mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>68.01%</td>
<td>48.12%</td>
<td>52.68%</td>
<td>67.36%</td>
<td>55.51%</td>
<td>58.33%</td>
</tr>
<tr>
<td>Virtual Lecture</td>
<td>61.76%</td>
<td>63.39%</td>
<td>44.10%</td>
<td>64.93%</td>
<td>45.73%</td>
<td>55.98%</td>
</tr>
<tr>
<td>e-Lecture</td>
<td>66.52%</td>
<td>52.43%</td>
<td>45.09%</td>
<td>56.30%</td>
<td>52.83%</td>
<td>54.63%</td>
</tr>
<tr>
<td>Total % mean</td>
<td>65.43%</td>
<td>54.65%</td>
<td>47.29%</td>
<td>62.86%</td>
<td>51.36%</td>
<td></td>
</tr>
</tbody>
</table>
relevant comparisons). Indeed, the marks for the comprehension type questions were significantly higher for students receiving Virtual Lectures than traditional lectures \((P = 0.05)\) and higher, though not significantly so, than students taking the e-Lectures \((P = 0.2)\). Marks following evaluation type questions were paradoxically the lowest of the three for students taught by the Virtual Lectures although differences were not statistically significant. The e-Lectures, as with the other delivery styles, scored high for knowledge type questions and were the median for all question types except analysis where they were lower than the other two – approaching statistical significance \((P = 0.07)\) when compared with traditional lectures but not significantly different \((P = 0.17)\) when compared with Virtual Lectures.

### 3.3. Questionnaire evaluation

A total of 47 questionnaires submitted were considered for analysis based on a reasonably complete response. Section 1 revealed a 1:3 male:female ratio, over half with no previous experience of computer-based learning and students’ own assessment of their own computer skills ranged from “excellent” (25%) to “average” (35%) (40% were “good” and none were poor). The majority of students surveyed (55%) utilized only their own personal computers to learn the course material, 17% used the campus facilities alone and 28% used both.

In Section 2, the results shown in Table 5 reveal that the general consensus for both questions (“which do you prefer” and “which do you think promoted the best learning”) was that the students preferred and also gained the most from the learning experience by having traditional lectures, followed by Virtual Lectures and then e-Lectures.

In Section 3 of the student questionnaire, (the results presented in Table 2), it is evident that the majority (82.6%) of students preferred to learn from a traditional lecture rather than by either electronic mode, paradoxically 60.9% felt that the electronic approach was appealing because they could do it in their own time, location and pace. Also, 60.9% found the programs easy to use and 93.5% stated that they would prefer to have real lectures with computer-based learning as a supplement for revision purposes only.

Table 5

<table>
<thead>
<tr>
<th>Lecture delivery style in order from “MOST preferred” to “LEAST preferred”</th>
<th>Preferred order of delivery style</th>
<th>Preferred order which promoted the best learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional–Virtual–e-Lecture</td>
<td>23 (65.7%)</td>
<td>20 (57.1%)</td>
</tr>
<tr>
<td>Virtual–Traditional–e-Lecture</td>
<td>5 (14.3%)</td>
<td>7 (20.0%)</td>
</tr>
<tr>
<td>Traditional–e-Lecture–Virtual</td>
<td>5 (14.3%)</td>
<td>7 (20.0%)</td>
</tr>
<tr>
<td>e-Lecture–Traditional–Virtual</td>
<td>1 (2.9%)</td>
<td>1 (2.9%)</td>
</tr>
<tr>
<td>e-Lecture–Virtual–Traditional</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Virtual–e-Lecture–Traditional</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>
3.4. Additional feedback

The narratives in Section 4 of the student questionnaire provided several positive comments including, “I like Virtual Lectures they are informative and maybe it is because I am not a good listener when it comes to real lectures” and “The short multiple choice tests/questions in the Virtual Lecture were good”. In contrast, not all students gave encouraging opinions to the course, a few objected to being taught using three different formats and classified themselves as “guinea pigs”. Interestingly, all those who missed the traditional lectures were given the option of having them at a later date and none chose to take the opportunity. There were also comments that encouraged future adoption of a blended approach, including, “seminars would definitely be useful”, “virtual and real lectures combined are probably my preferred learning”, “it makes no difference but real lectures force people to come therefore learning early, web/virtual allow for last minute stuff” and “a combination of real lectures backed up by virtual components would be the best way to learn”.

4. Discussion and conclusions

It is well established that computing in learning can offer many advantages over traditional lectures: It can augment student learning by allowing the student to “rewind” sections of the lecture they feel they did not grasp the first time, it offers greater flexibility and empowers the student into learning at a time he or she chooses, thereby offering a dynamic and interactive environment generally absent from the lecture room (Greenhalgh, 2001). To the best of our knowledge this is the first study to evaluate two different types of electronic delivery (“Virtual Lectures” and “e-Lectures”) with the traditional didactic lecture approach using quantitative and qualitative outcomes and taking into account increasingly deeper forms of learning.

Our results from this particular cohort show that the traditional lecture was the most popular of the three (as determined by the questionnaires) despite the fact that, overall, each was equally effective in terms of mean test scores. These results corroborate those of Dewhurst and Williams (1998), Maki and Maki (2002) and Williams et al. (2001) but not those of Tvedten et al. (1993) nor Holt et al. (2001) the latter two whose students valued the electronic course more highly than traditional lectures. There are also interesting parallels with Susskind (2004) who compared a traditional lecture format to a PowerPoint multimedia format. In so doing they observed that students thought themselves to be equally as capable if they had learned by a format similar to the e-Lectures in this study as they were when learning via traditional lectures. Paradoxically, this was not reflected in their performance in the exams that seemed unrelated to the presence or absence of multimedia delivery.

Clearly there are many issues pertaining to learning that are very group-dependent and dependent on the skill of the tutor in each form of delivery. For instance, a group for which e-learning is a relatively new concept might be less receptive than one that has used it quite extensively in the past. A particularly entertaining lecturer might be more popular in the lecture room than in cyberspace, a shy lecturer who mumbles but writes text with great clarity might be the opposite. A further factor, the so-called “Hawthorne Effect” (Gillespie, 1993), needs to be taken into consideration. That is, in this study, the students knew that they were part of an experiment (it would have been difficult to pretend otherwise); such knowledge might have affected their behaviour, opinions and even learning processes. It is particularly interesting however that the overall test scores did not differ significantly by delivery mode despite the differing popularity and despite the fact that the electronic delivery in either mode was not supported by seminars.

We have also provided evidence that differing modes of delivery can affect the different depths of learning as classified by Bloom’s taxonomy (Anderson et al., 2001; Bloom, 1956). All aspects of Bloom’s taxonomy were considered (including the deepest – evaluation) apart from synthesis, which is not feasible to assess by MCQ. Again it seems likely that similar study designs might produce contrasting results depending on the skill and enthusiasm of the tutor, nevertheless the significantly different mean marks in particular areas suggest effects attributable to the mode of delivery. It is worth bearing in mind, that the lecturer’s voice predominantly delivered the traditional lectures and e-Lectures while Virtual Lectures were predominantly text based and contained interactive exercises (e.g. self-evaluation questions) that were absent in the other two. Also, traditional lectures involved face-to-face contact with a prescribed lecture time and place whereas the other two were not similarly constrained but lacked the human interaction. Finally, PowerPoint was a prominent feature of the traditional and e-Lectures.
The impressive performance of the Virtual Lectures in three levels of Bloom's taxonomy (Knowledge, Comprehension, Analysis) but the dramatic drop for the other two (Application, Evaluation) is interesting. Given that both other approaches scored high for knowledge, it should be no surprise that Virtual Lectures did so too. Why students should be better at comprehension skills (as assessed by assertion-reason questions) is possibly attributable to the fact that the Virtual Lectures themselves contained a high degree of interaction through a series of exercises checking that the students understood the material. Such “putting in to practice” (Race, 1994) might also explain why Virtual Lectures were also effective in teaching application skills. Such practices were absent from the e-Lectures which might explain why those students did less well in application skills, however they were also absent from the traditional lectures where they did slightly (though not significantly) better. In this case, a compensatory effect of having the lecturer present might be a possible explanation. The drop in the efficacy of these particular Virtual Lectures when assessing analysis and evaluation skills might be explained by a paucity of such skills being practiced in the Virtual Lecture. The fact however that they were also not practiced during either of the other forms of delivery might suggest an effect of the lecturer’s voice might be more powerful in teaching evaluation or analysis skills. In the context of e-learning therefore, a greater degree of seminar/tutorial support might be appropriate to develop evaluation and analysis skills. Another possibility is that there is an effect attributable, at least in part, by the use of PowerPoint – in use by two of the approaches presented here (traditional and e-Lectures). The advantages of the numerous features of PowerPoint have been dealt with elsewhere (Jones, 2003; Parslow, 2003a, 2003b; Voss, 2004). Szabo and Hastings (2000) state that the “efficacy of PowerPoint lecturing may be case-specific rather than universal”. Such a statement could be interpreted in a number of ways but it might be argued that the results presented in this paper support this statement. Herder, Subrahmanian, Talukdar, Turk, and Westerberg (2002) examined lectures recorded with a digital video camera and accompanying PowerPoint slides to teach a course at two different global locations at the same time. The study revealed that both students and instructors derived different opinions on a subject, which improved their learning process regardless of location and presence of the lecturer. Spickard, Smithers, Cordray, Gigante, and Wofford (2004) established the effect of an online lecture featuring PowerPoint slides with and without audio. The results showed students using the audio-feed (similar to our e-Lectures) spent more time on the lecture and were more satisfied than students who did not use it.

In conclusion, all three styles are distinct and it would be imprudent, based on test scores and questionnaires in a single cohort, to recommend one specific delivery style alone. Comparisons such as in this study are of course vulnerable to the criticism that they reflect the accidents of the construction of the material and someone could have constructed the material so that the outcome is different. We suggest therefore that our findings reinforce the notion that a range of strategies, both “real” and “virtual” should always be considered in university teaching, sometimes alone, sometimes in combination and individual cohort considerations should always be taken into account (Yazon, Mayer-Smith, & Redfield, 2002). Riffell and Sibley (2005) developed a hybrid course format combining online and face-to-face lectures, where three hours of lectures per week were replaced with two-thirds of this time with online assignments. The post-course assessment test indicated the hybrid format was equivalent or better than the traditional approach and that active-learning exercises were more efficient when coupled with online activities. Lieblein (2000) stated “online is neither weaker nor stronger than on-campus in terms of student learning; it is just different (social issues aside), so there’s no reason to compromise learning outcomes”. We would support this notion with the additional statement that, in certain circumstances, different approaches to teaching (e-based or otherwise) may lead to improved learning in particular circumstances, depending on the student cohort, subject matter and level in Bloom’s taxonomy. In other words the teaching method one selects should be dictated by the goals one is attempting to achieve; and there is at present no reason to think that most worthwhile educational goals cannot be achieved through some form of e-learning.

How then does a regular tutor make sense of (often conflicting) messages from the literature to decide on how to adopt e-learning in order to improve their teaching? In our experience adoption of e-learning can sometimes be unpopular among students, even if it does improve their learning. In this study it might be argued that a degree of unpopularity can be attributed to participants feeling like experimental subjects (the Hawthorne effect) however, in our experience, other adoptions of e-learning have also been unpopular (Evans et al., 2004). In the current study, certain students complained of being “deprived of real lectures”
but, when given the opportunity to take the lectures (albeit at a later date after the test) none turned up to do them; moreover, there was general agreement that e-learning can be effective and easy to use. Learning is far more complex than the simple transfer of knowledge; different people learn in different ways, different tutors adopt different teaching styles more readily. The traditional lecture is certainly in no danger of extinction but e-learning is proving key to replacing the discouraging theory of the *tabula rasa* approach and replacing it with a more multifaceted model. It is our opinion that electronic delivery has the capability to accommodate the changing face of the modern educational establishment; this is the key to its success. One can only hope that the quality assurance standards remain sufficiently flexible to allow tutors to experiment with their teaching methods and, in the name of overall quality enhancement, occasionally get things wrong.

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**References**


