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Evaluation of a Blended Learning Approach Used in an Anatomy and Physiology Module for Pre-registration Healthcare Students

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Abstract—This paper presents evaluation data following the revision of the delivery method for an anatomy and physiology module for pre-registration healthcare practitioners, into a blended (hybrid) model. This subject is recognized as problematic when delivered by traditional methods, therefore change was instigated to introduce stimulating, interactive material; this was presented through use of e-learning tools to supplement the face-to-face sessions. The evaluation data consists of student outcomes from the hybrid mode of delivery compared with previous cohorts using the traditional methods, plus student satisfaction surveys from the students undertaking the module by blended learning. Results of the evaluation have identified that student outcomes for the new delivery method are demonstrating a trend for improvement for a multiple-choice exam, with no significant difference noted for a seen exam. The survey determined that the majority of students indicated satisfaction with the overall quality of the module, with the teaching methods, with the content and with the support provided to them. Therefore, this study suggests that a well designed blended learning system, with good academic content and interactive exercises are motivating for learning and yields as good, if not better, outcomes as a lecture. The module delivery will continue to be enhanced through the addition of synchronous chat facilities and online social network tools.

Keywords - *Blended learning; Hybrid learning; Anatomy; Physiology; Pre-registration; ODP.*

I. BACKGROUND

This paper focuses on a significant change to the delivery method of an anatomy and physiology module in the first year of an undergraduate pre-registration course for Operating Department Practitioners (ODPs), a healthcare discipline regulated by the Health Professions Council, in the United Kingdom (UK).

Literature indicates that anatomy and physiology are amongst the subjects that many healthcare students find hardest [1,2], but this knowledge is vital as it underpins clinical practice.

Delivery of the material had traditionally been by lecture, with drawings and anatomical models, and more recently digital images and video, being used in support. Cadaver prosection and dissection have also been employed within medic (doctor) education [3], but this is not usual practice in the courses of other healthcare disciplines.

Evidence suggests that the traditional lecture-based

model of delivery may be a contributory factor in the problems encountered by students [4-8]. Also, Government policies related to higher education in the UK have indicated that effective use of technology-assisted student-focused learning is essential for the future [9-12].

In consideration of both of these factors, the module delivery was reviewed and a blended (hybrid) model was adopted, which utilizes both face-to-face and e-learning delivery of content. The theoretical foundation upon which this revision is based is constructivism and cognitive learning theory, with the 5E enquiry model [13] being applied in development of the online tools.

This change aimed to provide fresh stimuli to the delivery, in order to promote students' learning of anatomy and physiology through questioning, investigating, challenging, seeking feedback, and learning to consider interactions with other team members [14].

This paper begins by presenting evidence that supports the need for change, and offers an overview of the potential benefits and issues that may be encountered when using e-learning; this aims to explain why the hybrid system was adopted. The revised delivery structure is described, and the paper then progresses to discuss data collection and analysis of an evaluation that was undertaken on the students' outcomes and their views on the delivery. The data is analysed and then discussed in relation to current literature, and finally future developmental plans are presented.

II. RATIONALE FOR CHANGE

This study is based on a module where the students are taught normal and altered anatomy and physiology of eleven human body systems such as the Cardiovascular, Muscular, Respiratory, and Skeletal Systems, underpinned by the concept of homeostasis. The anatomy element of the content requires students to identify component parts and structure of the body systems, whereas the physiology requires them to understand the function. Homeostasis is the process of maintaining a balance across the body systems, supporting both physical and psychological function. Safe and competent clinical practice is founded upon an accurate knowledge and understanding of this material, and the variations that do occur [15].

In healthcare education literature the subjects of anatomy and physiology have been clearly identified as problematic [16, 17], as there is a strong indication that students find the

subject very difficult [1,18,19], which is almost certainly a contributory factor to the reports that students fear the subject [19-21], are dissatisfied with the teaching [4-8], have high fail rates in assessments [2], and have difficulty in applying the theory to clinical practice [4,5,22]. There is general agreement that these subjects require educators to explore, and where possible implement, innovative approaches to ensure quality learning of these important topics [2,8,23].

III. DELIVERY METHODS

Lectures have traditionally been viewed as a very inexpensive way of presenting new ideas and concepts to a large group of students. However, lecturing has been described as an ineffective tool for promoting theoretical understanding of concepts [24], and lectures rarely stimulate student thinking and get information beyond the students' short-term memory [25,26]. In lectures students usually assume passive roles as listeners while the tutor imparts the information. Educating in this way is too focused on what is being delivered, rather than the learners and their needs [27]. But, teaching the same content can be made more interesting, and students can become active, independent learners, if different delivery methods are used [28].

However, just as an effective educator should consider individual differences among students and adjust teaching strategies accordingly [29], the selection of appropriate technological tools needs the same consideration [30], and their use should be integral to the process of learning, not obviously an addition [31].

An evaluation of technology-enhanced learning (also commonly referred to as e-learning) used in healthcare education identified that the different tools that are available span from instructivist to constructivist approaches, as set out in the e-Learning Ladder [32, adapted by 33] (Figure 1). Instructivist learning theory is teacher-focused where

knowledge is transferred from the 'instructor' to the passive recipient (the student). Whereas in Constructivist theory it is the student, rather than teacher, who is the focus and 'constructs' new knowledge through analysis, experience and understanding. The latter describes the approach that is needed in order to move away from the traditional delivery of anatomy and physiology, and the Ladder identifies that opportunities for learners to be active in creating their own knowledge and understanding can be offered through Web 2.0 technologies, such as discussion boards. These Web 2.0 applications allow students to not only retrieve information but also provide a platform to create and own the data within them [34]. These tools can be used as an alternative or in addition to traditional lectures; either way results in more learner-centred teaching [35].

When used appropriately in education, interactive technological strategies have been identified as enriching student learning [36,37], and this occurs through decentralizing the teaching process, and in doing so facilitating learner independence [38] and through active engagement in the learning process [39]. The potential of e-learning to deliver innovative approaches specifically in healthcare education is recognized [40,41], and interactive multimedia e-learning systems have been highlighted as working particularly well when used in biological science courses [33,42,43].

One determination of effectiveness can be student satisfaction, and the last decade has produced clear empirical evidence of positive attitudes by healthcare students toward e-learning [44-50].

Another, equally as important consideration, is the effect that this mode of delivery has on student outcomes, and evidence supports the supposition that technology-enhanced teaching used in the fields of health and science positively influences students' learning outcomes [51-55]. Indeed, in a study of a blended learning course [56], students had higher final grades compared to students studying the same course in a traditional manner. Also, another group of students studying a Cardiovascular element of a course demonstrated significant improvement in their performance after using the technological tools that were made available to them via a website [37]. Similar improvements in performance by both on-campus and distance-learning students undertaking e-learning anatomy courses suggests that this method can be used successfully to teach this subject [57, 58].

There are also indirect benefits in using technology-enhanced learning, such as the development of students' computer skills [59]. However, this is directly relevant to one problem commonly associated with e-learning, because just as with any genre of course, learners need to have the appropriate resources in order to be successful. These resources in an e-learning context can be classified as 'External' to the learner, such as slow Internet connections or older computers, and 'Internal' to the learner, which may be a lack of the necessary computer skills. Without these resources, accessing the course materials can be difficult and

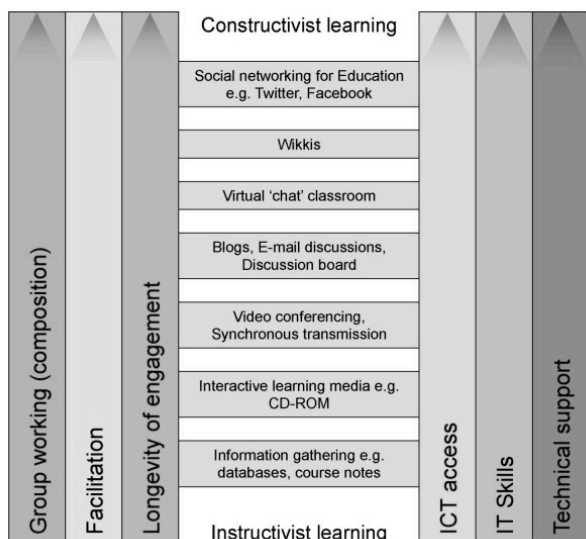


Figure 1. E-learning ladder [33]

the learners' performance can be hindered [60], and it can also cause anxiety [61], which can lead to lack of motivation [44,62,63], which may ultimately result in students becoming frustrated and giving up [64-66], or could even cause them to avoid enrolling on e-learning courses [67,68]. So although, as indicated previously, the students' information technology (IT) skills may unintentionally be enhanced through this mode of learning, the very fact that improvement in these skills may be needed, could in itself adversely affect students' uptake and progress on an e-learning course. However, it has also been identified that an initial lack of confidence can be replaced by positive excitement once the initial experience of e-learning has taken place [69-74].

A lack of computer skills may also result in students on an e-learning course feeling isolated from the tutor, due to them struggling to use the online communication methods; this has resulted in them indicating a preference for face-to-face teacher-centred learning [75,76]. Also, younger students who had just recently finished years of compulsory education, with its requirement for attendance in class, felt that they too were more comfortable face-to-face with a tutor [77]. So, for the tutor using any form of technology-enhanced learning, there is a clear requirement that human-to-human interactions must take place, for teaching, support, and to build a sense of community amongst those undertaking the course [62].

IV. PROGRAMME STRUCTURE

The theoretical foundation of the module delivery is constructivism, however cognitive learning theory is also considered [78], which suggests that if students are active in their learning, they will achieve more, through assimilation of the knowledge, leading to better comprehension. Alongside this, the online elements were developed using the '5E enquiry cycle' [13], as indicated in Table I. The 5E inquiry process is recommended as an effective means to help students to understand science-related subjects, and to

TABLE I. APPLICATION OF THE 5E INQUIRY PROCESS

Engagement
Within the forums, the students are asked questions to stimulate response and maintain interest
Exploration
The students have to study the material in order to be prepared for the discussions in the forum
Explanation
The sequence of the systems and their related questions require the students to find answers to the virtual patients' daily updates
Elaboration
The tutor facilitates discussion in the forum to focus the direction, to ensure the students consider what has gone before, to promote retention of information and to move the learner toward possible application in practice
Evaluation
The weekly testing determines learning progress, providing immediate and timely feedback.

apply theory to authentic situations needed for the real world [79].

The delivery pattern for the module includes both face-to-face and e-learning sessions, the latter through use of the University's virtual learning environment (VLE). VLEs provide a repository function and allow space for online interactions between students and staff; they are reported as being widely used in subjects such as nursing and social sciences [80-82]. The rationale for using this blended (hybrid) delivery was to utilize a variety of systems that would potentially appeal to a range of students' preferred styles of learning, to promote interactions, both face-to-face and online, and to foster a sense of community.

The module is timetabled for delivery over a three-week period, and the division of the delivery methods is split 30:70 in favour of e-learning. The first day of the module takes place on campus, where the required logistical and administrative activities are initially carried out, followed by team building exercises, which are designed to introduce the students to each other and to facilitate the creation of social networks. The students are then placed into groups, which relate to how they will be distributed within the VLE, and a further team-based activity takes place, this time online, using the computers in the lab. This introduces the students to the virtual learning environment and aims to provide a guided tour through the system. During this activity the tutor demonstrates what is required via projection of their own computer onto a large screen in the lab, which gives real-time assistance and support; whilst reviewing progress during the activity, the tutor also takes this opportunity to identify any students who appear to lack basic computing skills, and discreet guidance is provided on the appropriate student support mechanisms that are available within the institution.

The remainder of the first day, and each of the face-to-face sessions that follow, consist of 'traditional' lectures and some active-learning methods that encourage student learning [83-85]. All of the material that is delivered during the on-campus sessions is also provided within the VLE, alongside the resources for the e-learning activities.

The second day of the module is an e-learning day, with the third being on-campus again; the latter provides the tutor with an early opportunity to address any computing issues that the students may have encountered during the second day's activities. The remainder of the programme is allocated across the days that are left, ensuring that the virtual learning is interspersed by face-to-face sessions on regular intervals.

On days designated for e-learning, the students are not required to attend campus, providing they have access to appropriate computing equipment. If they do not, or if they just choose to come onto the campus, then the resources are available within the computing labs. The activities for each day are in the VLE, within folders labeled by date, providing a structured plan for the students, setting the pace of learning within the framework of the time available; this strategy

aims to encourage the students to develop basic time management techniques [86-87].

Within each activity folder, the students are presented with various resources, including podcasts, videos, and links to online resources outside of the institution. Having reviewed the materials, the students then access their group discussion board, where they aim to address questions relative to their virtual patient.

This virtual patient is first introduced to the groups during the VLE activity on day one, where they are given an image of the patient (created by the tutor using an avatar building tool), and a brief pen picture giving information such as age, height, and weight; each group has a slightly different character. As the programme progresses, the tutor adds information to the patient profile, relevant to the body systems the students have studied that day, either on-campus or via e-learning. At the same time as building the profile, the tutor challenges the students' understanding by setting questions relevant to their particular patient and the body systems being discussed. For example, on the day where the endocrine system is studied, the virtual patients' blood sugar levels might be made available, and the students then need to determine if they are within normal parameters, and if not, what might be the cause, how it might be managed and the long-term effect on the patient. This patient-based approach allows students to look for solutions by engaging in independent study, reviewing data, and reflecting on their own learning experience. Learning anatomy through a clinical perspective is said to result in better recall and understanding amongst students [88].

All of this takes place within asynchronous discussion forums, with both the students and the tutor contributing to the content. The tutor's role is that of e-facilitator, or e-moderator, ensuring that the appropriate learning takes place in the discussions and that all members of the group make contributions. To promote this, all group members are given an identifier, a number 1 to 6, and the tutor targets the questions to a particular member of the group, by number. Once this person has satisfactorily responded to the question, the tutor opens it for contributions by the other members of the group. This aims to mimic the control that the tutor has in the traditional classroom, and prevents any enthusiastic members of the group from contributing more than their less eager classmates [33]. This method of control also addresses the issue of lurkers, namely those who access and benefit from others' contributions without interacting themselves [44,89].

Small group learning was implemented as it has emerged as being well suited to developing anatomical understanding, as has peer assisted learning [23]. The group process enables students to develop problem solving skills fundamental to developing their understanding; in doing so they learn to search for knowledge using the available resources, and to work in teams. Based on the contributions to the forum, the tutor evaluates progress based on the students' knowledge building, problem solving and development of their

interpersonal skills [90].

Formative testing takes place once a week during one of the on-campus days, and it is based on all of the body systems that have been covered up to that point. The testing is carried out in the computer labs using the computer-based examination tools that are used for the summative assessment for the module. This not only provides both the tutor and the students with feedback on the students' progress with their studies [91], but also allows the students to practice with the interface and process prior to the final assessment, which has been shown to improve student performance [92-94].

The final day of the module delivery is on-campus. Here the students are presented with a new virtual patient, one not previously used by any of the groups, and the same type of question and answer process that the students have experienced within the discussion forums takes place in the classroom, but based on this new patient's parameters. The activity takes place within a quiz format with the groups competing against each other, and points being awarded for correct answers; a token prize is awarded to the winning group. Presenting the material in this way acknowledges the importance of the cognitive component of the activity (e.g., selecting, organizing, and integrating knowledge) to promote meaningful learning [95].

The two summative examinations take place several weeks later, following a period of time where the students undertake self-directed study and have tutorial support, as requested.

V. DATA COLLECTION

The module is delivered twice per academic year, September and March, with approximately 32 and 24 students per cohort respectively; the revised programme was implemented two years ago.

Overall student performance in the module was measured by outcomes in the two computer-based summative assessments; data is presented for two cohorts prior to the implementation of the revised programme (the control group), and four cohorts since. Assessment one is a multiple-choice exam, which is divided into the body systems that have been covered in the teaching, with ten questions per system. Assessment two is a seen exam that includes fill-in-the-blank items, diagram labeling, and two or three short-answer essay questions.

The grading scale used is the standard institutional system for Foundation-level modules, where grades 40% and above are awarded a Pass; 39% and below are Referred. (N.B. students are given their actual grades in the feedback, to inform their development).

Students' perceptions of the module were also measured using the institution's end-of-semester online student evaluation system. This comprises twelve statements divided into two sections, plus a free-text area for qualitative responses. All statements were linked to a 5-part Likert-scaled data collection tool: strongly agree – agree – neutral –

disagree – strongly disagree [96]. All statements were worded positively; in other words, a higher score indicated a more favorable response. The online evaluation system was only recently introduced, so data is only available for the four cohorts who have undertaken the revised module structure.

VI. DATA ANALYSIS AND DISCUSSION

As indicated previously, four cohorts have undertaken the revised module structure. The assessment results indicate a trend of improvement in exam one with the multiple-choice questions, and no significant difference in exam two, the seen exam, among the study group (cohorts 3 to 6) as compared with the control group (cohorts 1 and 2); see Figure 2.

The outcomes for exam one reflect previous findings that students experiencing computer-enhanced delivery have significantly higher post-test scores than groups receiving the same content by lecture; indicating that a higher level of cognition was achieved by these groups [97,98]. This is in contrast to a report where no significant differences was found in a multiple-choice test that compared lectures and e-learning groups [99], and disagrees with recent evidence which found that students being taught by traditional methods achieved better performance in multiple-choice examinations when compared with e-learning students [100].

In comparison, the results for the seen exam (exam two) agreed with reports of no statistically significant difference in the post-test scores between a group on a technology-enhanced course and a lecture group [75,101,102]. These findings appear to indicate no significant difference in the retention of material, as has been reported between groups who learned by e-learning and by traditional methods [103,104]. This is in contrast with findings that traditionally taught students have demonstrated slightly better performance in examinations in comparison with online students [105].

Similar to other findings [106,107], the majority of students in all four of the groups that have experienced the blended delivery model indicated satisfaction with the overall quality of the module within their evaluations. The responses to the Likert-scale evaluation significantly reflected positive views that the majority of the students

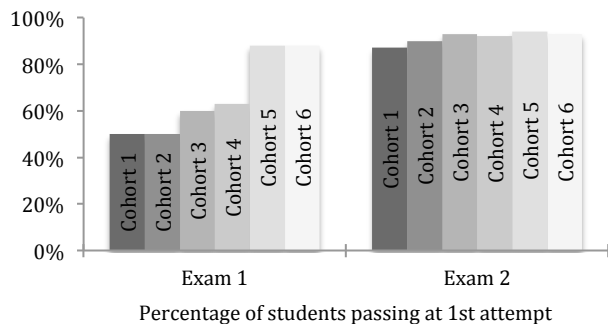


Figure 2. Assessment results

TABLE II. PERCENTAGE OF POSITIVE RESPONSES TO EVALUATION QUESTIONS

	Cohort 1	Cohort 2	Cohort 3	Cohort 4
Quality Assurance				
The teaching methods used in this module were effective in helping me learn.	89%	86%	89%	92%
This module has improved my knowledge and understanding of the subject.	86%	84%	85%	92%
The assessment criteria specified for the module were clear.	93%	95%	96%	100%
The module is well structured and the workload, including assessment, is appropriate.	98%	93%	93%	94%
Feedback on my work, in relation to this module, has been useful and prompt.	93%	94%	88%	94%
The availability and quality of support in relation to this module have been good.	93%	94%	100%	97%
I am satisfied with the overall quality of this module.	96%	98%	98%	97%
Module Specific Questions				
There are sufficient opportunities for student participation in lectures/tutorials/seminars.	100%	98%	100%	97%
This module is intellectually stimulating.	96%	95%	97%	100%
The rooms for lectures/tutorials/seminars are of a suitable quality.	93%	94%	98%	97%
The Virtual Learning Environment has made a valuable contribution to my learning on this module.	93%	94%	97%	97%
This module has been relevant to my course/pathway and career aspirations.	96%	95%	98%	97%

found the module to be well sequenced and stimulating, the discussion forum format clear and simple to follow, and that there was good quality feedback and support available to them when needed, (Table II). This is in accordance with other studies where students positively rated technology-enhanced courses [101,108-110], and would recommend it to other students [109].

Many students also utilized the ‘Any other comments’ free-text box to provide further responses; one common theme being that the weekly formative tests were helpful, motivating, and deepened their understanding of the material.

Some students commented on computer problems; they reported a few ‘teething problems’ during the early stages that could have become more serious, but the students positively mentioned how these were discussed and addressed by the tutor during the face-to-face sessions. This supports earlier findings that a frequently experienced negative comment related to e-learning programs was students’ early frustration with the use of the computer itself [111]; in this study it was the access to the tutor that prevented possible escalation of what were initially perceived as minor issues.

Comments were also made regarding the use of the

discussion forum. Some students indicated that they felt able to think more deeply and carefully about the subject before writing a response, as compared to giving verbal responses; this has previously been reported [112,113]. They particularly favoured the opportunity to review literature and prepare informed evidence-based responses, although at times this was felt to slow the discussions somewhat.

A number of students also made comment on the positive interactions they had experienced with the tutor within the virtual environment, and how there appeared to be a continuous tutor presence. The tutor, obviously, was not online 24/7, but by using the subscription facility within the VLE, the tutor was able to receive email notification of student participation in the forum, which promoted timely review and contributions as appropriate. This provided the students with the perception that the tutor was constantly checking the discussion board, which in turn produced the positive feedback. These comments suggest that the tutor was able to overcome one area of support commonly receiving negative feedback; participants in an earlier study [112] reported that they felt a lack of immediacy in responses in the online element of their course, in comparison to what they expected from a face-to-face class discussion. This appears to be especially obvious in asynchronous interactions taking place within discussion boards, where students have reported frustration due to delays in getting responses [113,114].

The regular face-to-face sessions also received positive comment, with the students indicating that these enabled members of the group to 'make connections' with the tutor and other classmates. These connections could be interpreted as the building blocks associated with forming a community, which would continue within the virtual learning environment. This is significant, as a relationship between students' perceived feelings of community and apparent cognitive learning has been indicated [115]; the stronger the online learners' sense of community, the less isolated they felt. Continuous support and feedback as noted in the literature [44,61,106,116] appear to be essential in facilitating effective e-learning; this would support suggestions that technological tools alone cannot completely replace traditional teaching methods [117] as they both have their own advantages and disadvantages. Therefore, delivering anatomy and physiology using traditional methods along with technological methods could benefit various learners to achieve the course objectives [37].

VII. LIMITATIONS

This is a small-scale study and the data was drawn from a specific module with a limited number of participants. The study may have been influenced by factors specific to the student groups, which are not immediately evident from the findings. Also, experiences external to the module content and delivery may have contributed to student outcomes and opinions. Finally, the student satisfaction data is only gathered from those who have undertaken the revised

module structure, so no comparison in this area can be made with students who have undertaken this module in the traditional mode of delivery.

VIII. CONCLUSION AND FUTURE WORK

In this module, the application of constructivist learning theory means following a pedagogy that provides learners with the opportunity to interact with sensory data, and build their own understanding; whilst cognitive learning theory requires students to be active in their learning, leading to further understanding. Integration of the 5Es enquiry process further allows this to be applied by giving students the opportunity to review their prior knowledge and construct new comprehension that arises from solving problems. The revised programme evaluated in this paper aims to combine these principles through enhancing the traditional content delivery with technological tools in a blended mode of delivery.

The electronic resources not only enhance the traditional methods of teaching but also offer new and exciting ways of presenting the material to the students. However, in designing the programme it was acknowledged that the benefits of using technology are accompanied by challenges, which were best overcome by not totally moving away from some elements of traditional delivery. Whilst teaching and learning are no longer confined to the classroom, spending some time in this environment would appear to positively contribute to the overall experience of the learner. Technology is not a solution for all learning environments, but through careful determination as to which interventions can be used to effectively teach content, the optimum conditions may be achieved.

In addition it is important to acknowledge that students require the necessary resources to make optimum use of the materials, therefore the responsibility of educators is to appropriately support programmes to ensure learners are not disadvantaged, through provision of adequate hardware, and evaluation of student abilities. Finally, there is a need to promote the creation of a community or feelings of connection in virtual learning environments; including strategies for community building into the design of the course, particularly in the role of the tutor to facilitate such, appears to assist with this.

Future work will include continual evaluation of the module to ensure the students continue to demonstrate satisfaction with it. Also, a synchronous (chat) discussion tool will be added to the e-learning component of the structure, and an in-house social network environment, similar to Facebook, will be produced, both are in consideration of furthering the constructivism foundation of the module.

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