

RESEARCH ARTICLE**Blended Learning in Healthcare Education****Authors**

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Abstract

Blended learning is an approach to learning that combines face-to-face instruction with e-learning experiences. It draws on the advantages of each approach while seeking to mitigate their recognised disadvantages. The Master in Oncoplastic Breast Surgery programme at UEA is aimed at advanced surgical trainees working in approved training units in the UK and internationally. It comprises a series of complex cases discussed by the students in an on-line, asynchronous discussion forum moderated by a member of faculty. Students can participate at their convenience despite varied clinical rotas and different time zones. A case-based, flipped learning course for surgical trainees was piloted. Instructional materials for each case were provided. Students joined in an asynchronous, moderated discussion forum. 64 trainees randomised into 2 groups participated. They sat a pre-test Script Concordance Test (SCT). Group A then commenced the on-line course while Group B continued with their usual hospital-based teaching. After 8 weeks, they sat the same SCT. Group B then joined the on-line course along with Group A. After week 16, they sat another SCT. Pre-test scores for both groups were the same (A 6.45; B 6.59 p=0.78). At 8 weeks Group A's scores had improved significantly (7.96 p<0.001) while Group B's remained unchanged (6.54). At 16 weeks the scores had equalised (A 7.13; B 7.18). The trainees self-rating of confidence in managing 8 common surgical emergencies followed a similar pattern. Our experience suggests that on-line learning that is highly interactive can add value to the usual postgraduate clinical training. We are exploring its utility in other settings such as training nurse associates, and in breast care nursing in the UK and developing countries. We have introduced 360° filming and virtual reality in teaching practical skills and providing induction training for complex clinical environments.

Keywords: Blended Learning; Surgical Training; Healthcare Education

1. Background

Health care education seeks to develop the knowledge, skills and attitudes needed for health professionals to practice safely and effectively.¹ The Flexner Report (1910) emphasised the need for medical education to include an understanding of the scientific principles of medicine (knowledge) and practical experience of the clinical care (skills).² Traditionally, this has been achieved by face-to-face instruction but as technology has developed there has been increasing interest in the role that it might play in education.^{3,4} There are several perceived advantages to e-learning as it is called.⁵ One of the most important is that the student can engage with the content at their own pace and, if necessary, can review it repeatedly. This contrasts with face-to-face instructions where the pace is determined by the teacher and is usually aimed at the average student. Other advantages are that the students can access the material at different times and from different geographical locations. Importantly, a wide range of resources can be delivered electronically including videos, interactive simulations, readily updatable written material and a variety of formative and summative assessments.⁶

A potential disadvantage is the isolated nature of e-learning if the student interacts on an individual basis with the computer. Social interaction is an essential part of effective learning.^{7,8} Deep understanding of the subject is enhanced by dialogue with tutors and peers.⁹ This can be overcome in part by on-line engagement with a peer group through webinars and discussion boards and fora¹⁰ but there is a growing move to blended learning where on-line learning is combined with face-to-face teaching.¹¹⁻¹⁵ This is particularly pertinent in clinical education where hands-on contact with real patients is regarded as an essential part of developing clinical skills.

Clinical practice in all disciplines has become increasingly sub-specialised in response to the complexity of modern medical interventions.¹⁶ This raises challenges for training as the number of trainees in each subspeciality at any hospital will be small. While this provides the opportunity for concentrated clinical experience for a trainee, it limits the opportunity for peer-to-peer interaction and may not provide strong support for learning the theoretical aspects of the discipline. An on-line course may provide an effective and efficient delivery method for the theoretical aspects of the subject. In addition, the use of on-line tutorials, discussion boards and discussion fora can provide a community of learning for students in geographically dispersed settings¹³.

Oncoplastic breast surgery is a relatively new subspeciality which gained recognition in the 1990s.¹⁷ In 2002, the Department of Health for England recognised the value of the speciality and the need to provide formal training for it. They established 14 recognised training units scattered across the whole of England. Each unit has a single trainee Fellow in Oncoplastic Breast Surgery. In addition, several other recognised breast units established local training Fellowships.¹⁸ The training is based on the Intercollegiate Surgical Curriculum Programme approved by the General Medical Council and is monitored by the regional Postgraduate Deans appointed by Health Education England. In January 2011, the University of East Anglia launched a Master of Surgery programme in Oncoplastic Breast Surgery which provided on-line theoretical learning to enhance the clinical learning of this group of trainees.¹⁹ The award of the degree was contingent upon the trainee successfully completing their clinical training and being signed off as competent in the clinical and operative management of patients undergoing oncoplastic breast surgery. Students who opt not to complete the

dissertation are awarded a Postgraduate Diploma in Oncoplastic Breast Surgery.

2. The Master of Surgery in Oncoplastic Breast Surgery

The course is a three-year part-time course comprising 6 taught modules, each of 16 weeks duration, and a 1-year research dissertation. Students who choose not to present a dissertation are awarded a Postgraduate Diploma. Four of the modules are clinical; one addresses research and audit; another addresses leadership and management in healthcare. The 4 clinical modules each address 7 topics in the form of clinical cases. The first week of each topic presents a straightforward clinical case that should be managed according to national guidelines. The second week of the topic presents a complex case where the correct management is a matter of debate. The educational approach is Problem-based Learning (PBL)²⁰, and the emphasis is the development of clinical reasoning and decision-making. The students discuss the cases in an on-line discussion forum moderated by a member of faculty. Formative assessment occurs at the end of each topic and includes multiple choice questions (MCQ) to assess knowledge; a management problem to assess clinical reasoning; and a *Script Concordance Test* (SCT)²¹ to assess clinical reasoning and decision-making in cases where there is debate amongst expert clinicians as to the most appropriate management. The student receives immediate feedback on their performance and can then access an expert discussion of the management problem. Summative assessment occurs at the end of the module and now comprises a reflective essay on a complex case which must provide an evidence-based approach to the management of the patient. Clinical competence is assessed by presentation of a verified logbook of the procedures

undertaken during the student's clinical training and by an Objective Structured Clinical Examination (OSCE)^{22,23} that takes place at the end of the 2-year taught component of the degree. It is benchmarked against the expected level of competence of a consultant in their first year of clinical practice.

The course material for a topic can be accessed at any time after it is posted. The discussion board is asynchronous so students can participate at a time that suits their work pattern. The faculty are drawn from senior clinicians working in breast units all over the UK. Participation in the on-line learning is monitored and engagement with all the activities of the course is a pre-requisite for award of the degree. In addition to the inevitable face-to-face element of their clinical training, the students were also required to attend face-to-face study days at the beginning and end of each module. Since the onset of the COVID pandemic these study days have been conducted by video conference. As the clinical component remains an essential element, the course still functions as blended learning.

International interest led to modifications to the degree requirements so that evidence of clinical training in breast surgery outside of the UK could be accepted. Face-to-face workshops and OSCE examinations were run in India for candidates who were working in specialist breast units in Asia. Since it was launched a total of 182 students from over 20 different countries have undertaken the MS or the PG Diploma.

3. Emergency Surgery module feasibility study

Following the success of the Masters programme, other blended learning projects have been developed. Postgraduate training in medicine in the England takes place in a wide range of hospitals distributed across the country. It is supervised by Health Education

England, an agency of the Department of Health, through Postgraduate Deans based in every Health Region. The training takes place within the context of service delivery and is supplemented by compulsory educational sessions which are held in the local hospital and as Regional or National Training Days. The General Medical Council National Trainees Survey consistently revealed a significant level of dissatisfaction with the training that was being delivered, particularly in surgical specialities.²⁴ There was often conflict between the service needs and the educational opportunities, especially since the compulsory educational sessions are included within the statutory 48-hour working week. This led us to develop a feasibility study of a 16-week online module in Emergency Surgery aimed at trainees in the first year of surgical training.

3.1.Format of the feasibility study

The module is based on the Emergency Surgery requirements of the Intercollegiate Surgical Curriculum Programme, which is the GMC approved curriculum for surgical training. Sixteen cases were selected, covering the most common presentations in emergency surgery. Each case was studied for one week. We adopted a flipped classroom approach.²⁵ On the first day of the week the students were provided with recommended reading and other learning resources, including a list of the learning outcomes for the week. From day 3 – 6 they engaged in an asynchronous discussion board with other trainees moderated by a member of faculty. On day 7 they undertook a short MCQ, and a SCT. They provided a free text description of their proposed management of the case which unlocked an expert opinion on the case in the form of a video panel discussion with a transcript.

3.1.1. Study method

Invitations to participate in the study were sent to all trainees in their first year of surgical training (designated ST3) in England (n=123). Of these, 109 trainees expressed an interest taking part in the study but in the end only 64 enrolled on the module and were therefore eligible to be part of the study. All 64 students undertaking the module were randomly allocated to two groups – A and B. Group A were the study group while group B were the controls. Both groups sat a SCT based on the cases that would be considered during the first 8 weeks, and completed a questionnaire assessing their confidence in managing specified emergency cases on a Likert scale where 1 = not at all confident and 5 = totally confident. Following this, Group A commenced the course while Group B continued with their usual hospital-based teaching. After 8 weeks, both groups re-sat the original SCT and completed the confidence questionnaire. Group B then joined the online course and both groups engaged with the final 8 weeks. At this point, Group B were allowed access to the learning resources and completed discussion fora for the previous cases although they could not participate in discussion of those cases. At the end of the course, all students sat a new SCT based on the cases from the second 8 weeks and completed the confidence questionnaire and a course evaluation questionnaire. The SCT scores were compared using the paired t test for intra-group comparisons and unpaired t-test for between group comparisons.

3.1.2. Scoring of the Script Concordance Test (SCT)

The SCT comprised 10 case scenarios relating to emergency surgery followed by a proposed plan of action. A new item of information was introduced, and the student was required to say whether the new information changes their view of the proposed course of action on a 5-point scale

ranging from (-2) *absolutely contraindicated*, through (-1) *contraindicated*, (0), *not affected*, (1) *indicated* to (2) *strongly indicated*. The scenario was presented to a panel of experts who recorded their opinion using the same scale. Because the new item of information introduces complexity into the case there is inevitably a range of expert opinion. A mark between 0 and 1 is assigned to each option in proportion to the number of experts selecting that option. The student's score for the entire test is the sum of the marks for the option they selected for each scenario. The higher the score, the more concordance there is between the student's

decisions and those of the expert panel. The scores are reported as the mean for each group of students. Note that because of the format of the scoring, scores can be directly compared between students sitting the same test but not between students sitting different tests with different scenarios.

3.1.3. Results

Prior to starting the course, there was no difference in the scores on the Script Concordance test between the two groups. At 8 weeks, the scores for the control group were unchanged but the study group had improved significantly (Table 1)

Table 1 Script Concordance scores (mean) at 8 weeks

	Group A (n=32)	Group B (n=32)	p Values
Pre test	6.45	6.59	0.78
8 week test	7.96	6.54	0.005
p Value	< 0.001	0.93	

At the end of the course, there was no difference in scores between the groups (Table 2). The apparent decline in performance for Group A between the two

tests is explained by the difference in the cases that were presented. The point to note is that both groups performed equally well.

Table 2 Script Concordance scores (mean) at 16 weeks

	Group A (n=32)	Group B (n=32)	p Values
16 Week Test	7.13	7.18	0.87

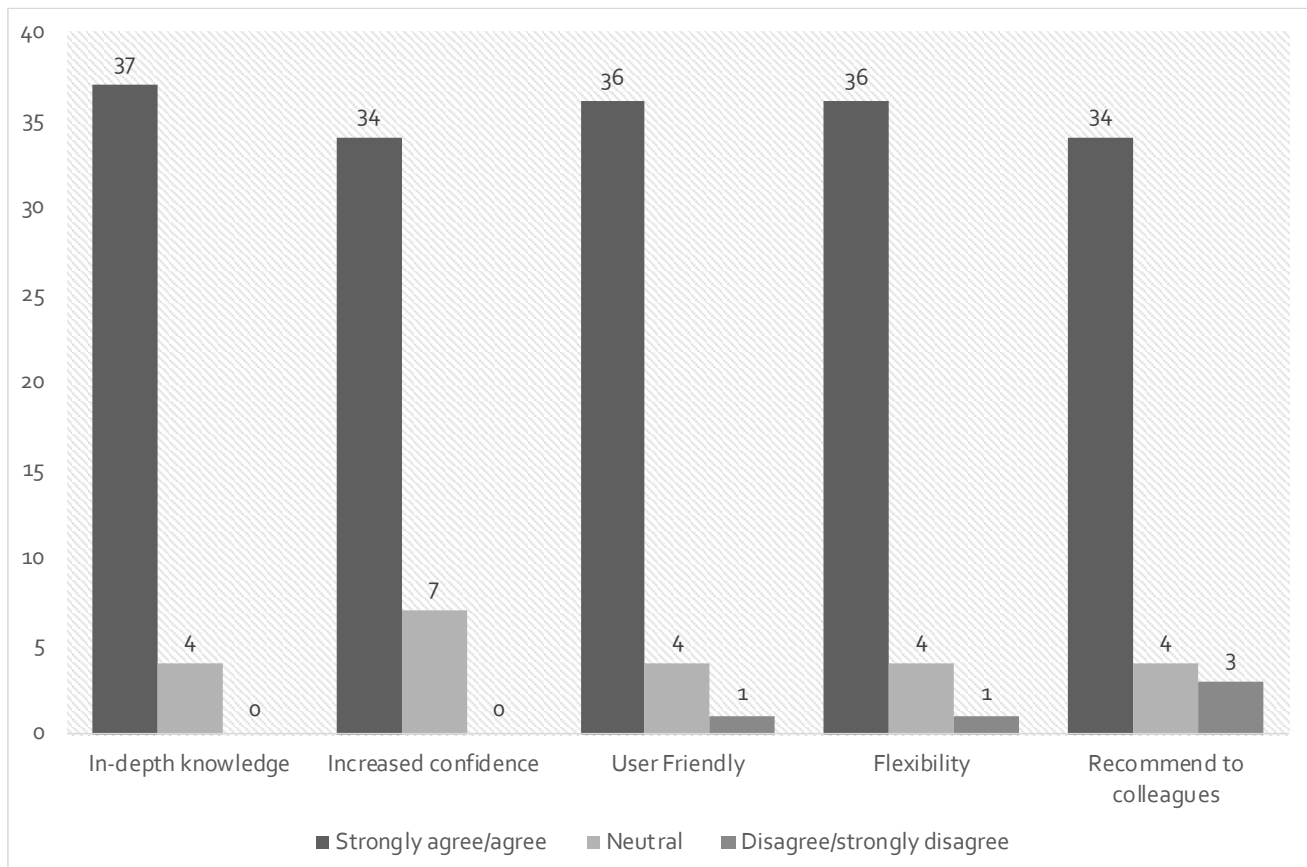
The students' self-rated confidence in managing a range of cases followed a similar pattern (Table 3). Group A scores improved from baseline to the intermediate (8-week) point. They then improved further to the post course (16-week) point. Interestingly, their confidence at the 8-week point improved

across the board and was not limited to those cases which they had studied up until that time. Group B showed no improvement at the 8-week point, but then improved at the 16-week point. Again, the rise in confidence was not limited to the cases that they had studied

Table 3 Students' self-rating of confidence in managing cases

	Group A			Group B		
	Pre	Inter	Post	Pre	Inter	Post
Appendicitis	3.76	4.16	4.23	3.77	3.82	4.11
Lower abdominal pain	3.65	4.02	4.1	3.55	3.55	3.94
Pancreatico-biliary	3.89	4.16	4.29	3.9	3.89	4.08
Colorectal	3.5	4.01	4.21	3.79	3.61	3.98
GI haemorrhage	3.45	3.73	3.94	3.35	3.49	3.89
Anorectal	3.08	3.67	4	3.52	3.39	4.11
OG	3.25	3.48	3.84	3.21	3.2	3.95
Acute limb ischaemia	3.36	3.79	3.92	3.23	3.26	4.07
Mean	3.49	3.88	4.07	3.54	3.53	4.02

Only 41 out of the 64 students completed the evaluation questionnaire. The results were overwhelmingly positive (Figure 1).

Figure 1 End of course evaluation scores

4. Discussion

The impact of the COVID pandemic on health care is mirrored by its impact on health care education at all levels from undergraduate to continuing professional development^{26, 27, 28, 29}. The traditional face-to-face teaching has been severely restricted. At the same time, there is a need for the rapid dissemination of knowledge on the epidemiology, pathophysiology and management of the virus³⁰. The need for intensive infection control measures have restricted direct clinical encounters which, in turn, has led to reduced opportunities for clinical training³¹.

The restrictions in face-to-face teaching have led to an increasing use of e-learning in a variety of formats^{32, 33}. E-learning is an effective medium for facilitating the learning of theoretical concepts and material. Some simulated clinical material can also be delivered on-line^{34,35} with measurable improvements in students' performance³⁶. Nevertheless, real clinical contact remains an essential part of healthcare education³⁷. This is especially true in surgery. Although virtual reality³⁷ and video games³⁸ have been shown to improve surgical skills, eventually the trainee surgeon has to operate on real patients under supervision as a core component of surgical education. Blended learning, therefore, is likely to remain a necessary part of healthcare education.

Following the success of the e-learning Masters in Oncoplastic Breast Surgery, the University of East Anglia introduced similar programmes in Regional Anaesthesia and Colorectal Surgery. Feedback from international colleagues suggested that there was a demand for access to the modules for Continuing Professional Development without the need to register for the full degree. Since 2016, it has been possible for students to take individual modules. Credit is awarded that can be counted towards a degree should they choose to further their studies in

the future. To date 97 students have opted for this route.

The requirement that students pass the OSCE examination limited the geographical spread of the programme. An alternative MCh programme was launched in 2018 that covered all the theoretical components of the MS but did not include the OSCE examination. Unlike the MS it did not confirm that the holder had reached a recognised level of clinical competence, but it did provide the same reassurance of theoretical understanding of oncological principles and practice. To date 77 students are following this programme.

With the onset on COVID it became impossible to hold face-to-face OSCE examinations. In common with other institutions, we introduced an online OSCE^{39,40}. This has limitations compared to a face-to-face OSCE as the students cannot be assessed in tasks that require physical contact with patients but does provide a good assessment of other clinical tasks. We are exploring the possibility of requiring students to submit videos of operations undertaken by them personally in addition to submitting an operative logbook. This combination may allow a wider dissemination of the MS programme.

It has proved difficult to get objective evidence of the effectiveness of the Masters programmes. Because the students are widely distributed throughout the UK and globally it is impossible to measure the contribution of the course to their clinical practice and outcomes. The feasibility study of the Emergency Surgery module for junior trainees provided an opportunity to quantify the impact of the course in a controlled study. The results show that participation in an online interactive course can add value to the usual postgraduate clinical training. The Script Concordance Test, which compares the student's performance on a clinical case scenario with that of a group of expert

clinicians, assesses the student's clinical reasoning and decision-making. We did not directly assess improvements in their knowledge as an adequate knowledge base is subsumed in their clinical reasoning. After the first 8 weeks, those students who had undertaken the module showed a marked improvement in their SCT scores indicating that their decisions were more in line with those of the experts. The control group showed no change. After the second 8 weeks, both groups had similar scores on SCTs based on the cases for that part of the module suggesting that the improvement in decision-making and clinical reasoning was case specific. The improvement in clinical reasoning was mirrored by an improvement in their confidence in managing common surgical emergencies. While the confidence levels for Group A increased from baseline to the 8-week point, those for Group B did not. After a further 8 weeks of study, the confidence levels of Group A had increased further. Group B showed no increase at week 8 and lagged behind Group A at week 16, except for anorectal disease and acute limb ischaemia which were covered in the second 8 weeks. The gain in confidence was not limited to the cases that they had engaged with in the online course. The SCTs at the end of each week provided them with regular feedback on their clinical reasoning and decision-making and it may be that this reassured them that their performance in these domains was satisfactory. The differences between the two groups suggest that the improvements over time were related to participation in the module and not to their ongoing clinical training.

The students agreed that the module was effective with 90.2% agreeing or strongly agreeing that their in-depth knowledge of Emergency Surgery had increased, and 82.9% agreeing or strongly agreeing that their confidence in handling emergency cases

had increased. The majority reported that the interface was user-friendly and flexible.

The outcome of the feasibility study and the success of the Masters programmes led us to explore other potential uses for a blended learning approach. Experienced clinicians may identify the need to develop new skills as new technologies become available. A module is under development for upskilling practicing midwives with the latest approaches in obstetrics. There is increasing recognition that being able to carry out ultrasound scanning will enhance the clinical performance of surgeons. Safe and effective use of ultrasound demands an understanding of the theory and the equipment in addition to the practical training. A blended learning course for breast ultrasound is being developed for specialist breast surgeons.

The onset of the Covid pandemic led to a surge in the need for intensive care and high dependency beds leading to an urgent need to redeploy non-ITU staff into these areas. Following the flipped classroom principle, we produced a short online induction package to provide a basic orientation to the ITU before their face-to-face induction on the unit. This package utilised 360⁰ filming with a virtual reality option to enhance the realism of the experience. This technique has also been applied to the production of short training packages for practical clinical procedures such as venepuncture, venous cannulation and urinary catheterization that can be viewed by the student prior to hands-on training in a clinical skills laboratory and can be used by the student as review material prior to actual clinical application.

The 360⁰ filming has been incorporated in the production of interactive modules that can be used to introduce students to the functioning of clinical areas with which they will have to interact. For example, a module on the pharmacy department has been produced for trainee Nursing Assistants which enables them to "experience" how a prescription is

processed when they deliver it to the pharmacy. It can be delivered as virtual reality if the student has the necessary equipment, as an increasing number do. The module is delivered as part of the routine pharmacology teaching of the trainees as an addition to their normal classroom tuition. It can easily be incorporated into the learning of other groups such as medical and nursing students. The educational content was guided by the hospital lead pharmacist who sees it as a tool for his own staff training. A similar module is used to introduce medical and nursing students to operating theatre etiquette.

A recognition of the need to recruit specialist Breast Care Nurses in middle- and low-income countries led to the development of an Introduction to Breast Care Nursing programme comprising two 16-week modules to support new entrants into the field. A parallel programme with some modifications was produced for UK-based nurses. Other applications that are in development include programmes for endoscopy training and programmes for

physiotherapists, dieticians, and speech and language therapists. We are exploring the utility of blended learning in patient and carer information and education.

5. Conclusions

Blended learning is an effective approach to health care education that can be applied at undergraduate, postgraduate and continuing professional development stages of training. It is applicable to all categories of health care workers. It can range from short, targeted, skill-specific modules to full length degree courses. The on-line component is constantly being enhanced as new media technologies become available. The spread of blended learning during the COVID pandemic has forced its widespread adoption and demonstrated its benefits to a large constituency. It is likely that it will remain a mainstay of healthcare education in the future.

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