City Research Online

City, University of London Institutional Repository

Citation: Harrison, G. & Harris, A. (2014). Postgraduate Medical Ultrasound Programme: Have we Flipped?. Learning at City Journal, 4(2), pp. 25-38.

This is the published version of the paper.

This version of the publication may differ from the final published version.

Permanent repository link: https://openaccess.city.ac.uk/id/eprint/4894/

Link to published version:

Copyright: City Research Online aims to make research outputs of City, University of London available to a wider audience. Copyright and Moral Rights remain with the author(s) and/or copyright holders. URLs from City Research Online may be freely distributed and linked to.

Reuse: Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge. Provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

City Research Online: http://openaccess.city.ac.uk/ publications@city.ac.uk

Postgraduate Medical Ultrasound Programme: Have we Flipped?

Gill Harrison & Allison Harris
Ultrasound Programme team, School of Health Sciences, City University London.

Abstract:
In recent years due to technological advances, innovative curriculum design has been central to the developments within many health care education programmes. The Medical Ultrasound programme at City University London has been no exception. To enhance the face to face learning time within the part-time postgraduate programme a method of blended learning was developed, which involves on-line lectures and guided self-study, supported by interactive film viewing sessions, group discussions, simulation and games within the lectures. Additionally on-line case discussions are used to share clinical cases from the students' workplace and develop collaborative M-level learning and assessment in the clinical modules. To further engage students with this collaborative learning and help to develop transferable skills, students negotiate their own "rules" and take responsibility for leading the cases.

The term "flipped classroom" has appeared frequently in recent educational literature. This article will consider whether the post-graduate medical ultrasound programme has fully flipped, review some of the student feedback and share ideas that could be used within other programmes.

Key words: Flipped classroom, learning technology, interactive learning, blended learning, student engagement

Introduction

In recent years due to technological advances, innovative curriculum design has been central to the developments within many health care education programmes (Kiviniemi 2014). The Medical Ultrasound programme at City University London has been no exception. To enhance the face to face learning time within the part-time postgraduate programme a method of blended learning was developed, which involves on-line lectures and guided self-study, supported by interactive film viewing sessions, group discussions, simulation and games within the lectures. The cohort consists of health care professionals including radiographers, nurses, midwives and doctors, taking on a new role to become first post competent in ultrasound scanning. Learners undertake the clinical components of the course within their own clinical department and attend the University on a day release basis for 12 to 24 months. The HEA (no date) highlight the value of peer learning and student engagement with the learning process. To help foster this culture of active learning and peer support within the ultrasound programme, on-line case discussions were developed to share clinical cases from the students' workplace.

The term "flipped classroom" has appeared frequently in recent educational literature (Hoffmann 2014; Davies *et al* 2013). Definitions of the flipped classroom and flipped learning vary, but the general view is that the formal lecture content is delivered outside the classroom, in many cases this is via on-line lectures, with face to face contact used to

explore concepts and develop problem solving skills (Bishop and Verleger 2013; Butt 2014). This article will consider whether the post-graduate medical ultrasound programme has fully flipped, review student feedback and share ideas that could be used within other programmes.

Discussion

The core curriculum content within the programme is generally delivered via on-line lectures using adobe presenter, which provides narrative linked to a PowerPoint lecture. The programme team develop the lectures and present them on-line on the Moodle e-learning platform, in much the same way as they would previously have been delivered within the lecture setting. Adobe presenter also has a facility to enable quiz questions to be placed within the presentation for learners to answer before moving to the next slide. Learners can play the whole lecture or opt to review specific areas within the presentation. Following the on-line lecture there is an on-line quiz, which can be taken as many times as required. Instant feedback is provided from the quiz, with advice on which areas the learner needs to focus their reading on. The quizzes often contain images to help develop diagnostic skills, which is an essential component of ultrasound practice and the instantaneous feedback can be reviewed by learners. The module leader can also access the results of the quizzes, either reviewing the results as a whole or for individual questions, providing a better understanding of how individual students are progressing or identifying concepts or topics which learners find difficult. The information from the quiz results can be used to facilitate the development of additional learning activities for use during face-to-face sessions, as recommended by Davies et al (2013). One student commented "*I liked that there was a varied approach to the academic part of teaching. It was useful to be able to have numerous online lectures, quizzes, information books and links to other websites. I liked having the online lectures to access at any time, especially before exams as I could review them as many times as I needed."*

Image 1: An example of an adobe presenter on-line lecture, with interactive image labelling.

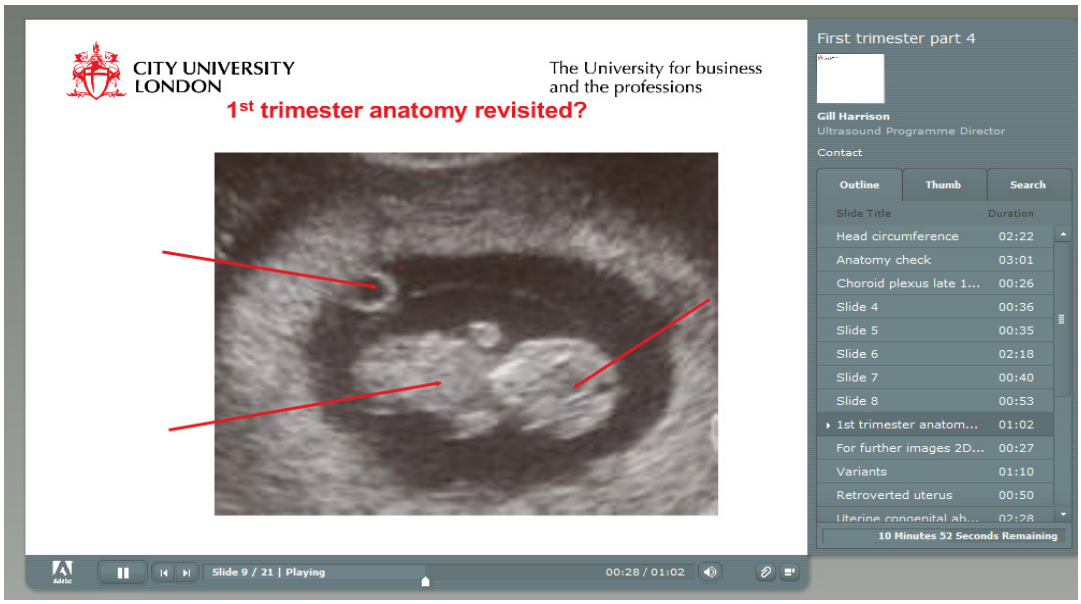


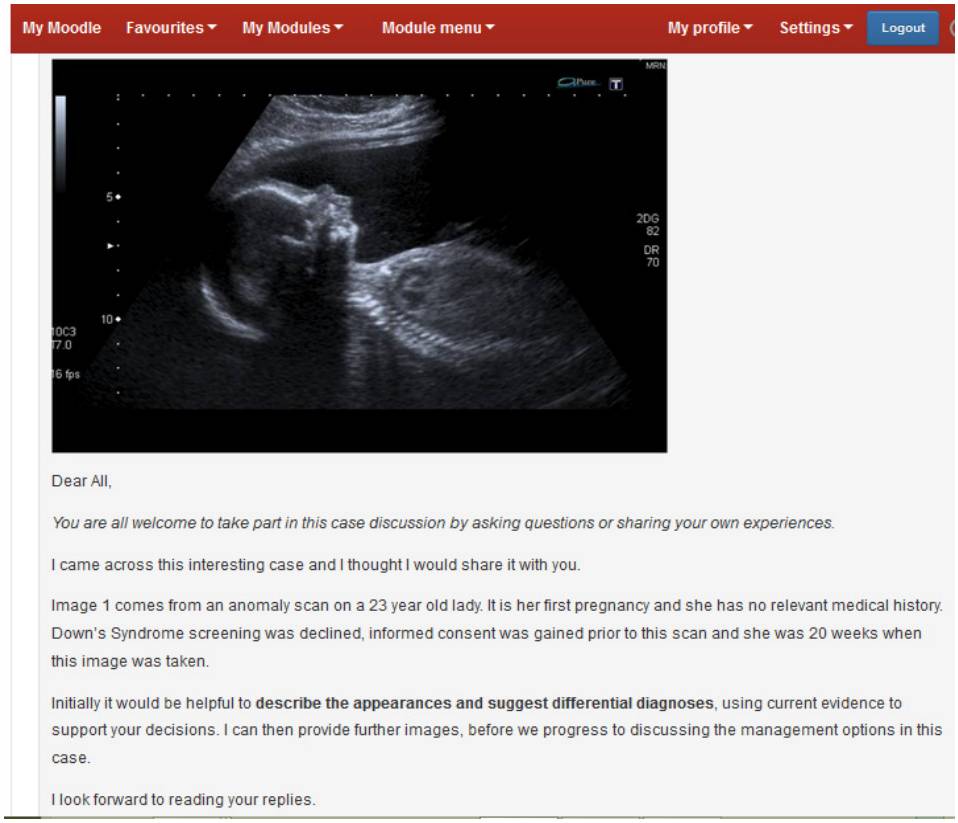
Image 2: An example of an on-line quiz question, following an on-line lecture on liver pathology. The question said “From the drop down menu, select the most likely pathology for each image”

On-line case discussions

On-line case discussions are utilised, as a form of learning and assessment, where cases from clinical practice are shared on an e-learning forum (Harrison *et al* 2012). By engaging with the case discussions, learners are exposed to a much wider range of pathologies than previous individual case study assessments. This form of assessment also promotes collaborative learning, development of report writing skills, and consideration of wider clinical issues such as management and communication. Malik (2014) suggests that a discussion board “promotes higher level learning and critical thinking skills” (page 77). When the learner is leading the case their leadership skills are enhanced, as they have to ensure that the

discussion remains focussed to the case and relevant to local and national evidence based guidelines. All of these skills are essential to assist the learner to progress from practitioner to advanced practitioner in the health care environment and to provide high quality care for patients and service users. Current National Health Service (NHS) quality initiatives include the need for improved leadership skills within the NHS (NHS Leadership Academy 2014).

Image 3: An example of an on-line case discussion



To further engage learners with this collaborative learning and help to develop transferable skills, students negotiate their own "rules" and take responsibility for leading the cases. Morgan (2006) recognises the need for learners to have clearly defined ground rules for engaging in discussions, both in the classroom setting and on-line. Blessinger and Wankle (2012) recommend that learners are "collaboratively involved in cocreating and developing a community of practice around a course", to improve engagement with on-line discussions (page 5). Given the diverse range of academic abilities in each cohort, the on-line case discussions provide an opportunity for reviewing the way other colleagues critically evaluate the literature in relation to the cases, to help develop individuals' critical writing skills and ultrasound report writing abilities. A small study by Topping *et al* (2000) suggested that formative peer feedback improved written skills of the peer reviewer, and although this has not been formally evaluated within the ultrasound programme, the lecturers have noted an improvement in the written work and critical evaluation skills of some students during the course of the discussions. It could be hypothesised that continually reading colleagues written work could help learners to develop their own writing skills.

Feedback suggests that the case discussions provide an opportunity to share a range of interesting cases. Some learners, in verbal discussions about the on-line cases have commented that they felt nervous about writing their discussion posts initially with some preferring to watch the progress of a case before engaging with the discussion. Formative feedback is provided to the group during the module, to give advice and support on how improvements can be made. If the module leader identifies any issues with specific posts or cases, they interact with that case or will arrange to meet with the individual concerned to discuss progress and ways to develop their skills. Those learners who act on this feedback have been seen to make good progress and have generally achieved excellent marks in their assessments.

Feedback comments, from end of module or end of programme feedback, relating to the case discussions include:

- *Really great for learning around a subject*
- *The participation in case studies – teaching one another*
- *Excellent learning tool*
- *Helped cover more subjects in depth than would have been possible individually*
- *Case discussions - help learning / good way of learning and sharing knowledge*

Interactive learning:

The use of the flipped classroom method of teaching the core curriculum content enables more interaction during the face to face lecture time. Student led tutorials, presentations, simulation and discussions are interspaced throughout the modules, along with expert guest speakers. Some of the other activities used within the programme will be highlighted.

Games have been utilised to make learning more interactive, help link theory to practice and provide an element of fun, often as a revision tool or at times of the year when learners find it more difficult to focus on challenging tasks and help link theory to practice. For some pathology there are quite specific symptoms, which can help a learner to formulate a likely diagnosis prior to beginning the scan. Card games such as “gynae Rummy” can be used effectively for small group activities to promote learning. Students have pathology and symptom cards and have to match them to win the game. Bingo has been introduced successfully to display ultrasound images to help students to develop their diagnostic capabilities, by identifying the images and locating the correct terminology or pathology on their bingo card. The use of prizes, usually pens or chocolate, have encouraged active participation. Studies and reviews have suggested that games can help develop critical thinking skills, assist the learning process and promote active learning to suit a range of learning styles (Royse and Newton 2007; Blakely *et al* 2012; Boctor 2013) and develop collaborative learning (O’Connor *et al* 2011). Limitations of the use of games are numerous, they are time consuming to develop, can be challenging for some students who prefer passive learning or dislike competition and can be difficult to manage, particularly with larger group sizes (Royse and Newton 2007; Blakely *et al* 2012). Boctor (2013) highlights the challenges of developing good quality games to meet educational needs. Games need to focus on learning outcomes and not detract from that. Blakely *et al*’s (2012) study suggested that games might be used when a lecturer had more confidence in managing less formal

styles of teaching, to ensure that the games do not detract from learning. Both ultrasound lecturers were initially wary of introducing the games and have had to adapt and amend them to suit different group sizes, however now feel more confident in managing the situations that arise. One cohort was much smaller than previous groups, during a transition period, so the bingo game was adapted into a monopoly board game.

During many lectures in the clinical modules, film viewing was utilised to link theory to practice and review the understanding of material covered in the on-line lectures. Film viewing consists of images from clinical cases, followed by a series of questions relating to clinical history, appearances on the images, possible differential diagnoses, national guidelines, management of the patient, other imaging modalities that might be helpful in this case and communication of findings. All students are encouraged to participate within the discussions and the personal response system (PRS) is being introduced to some sessions to engage students with the session further. The PRS (classroom clickers) allows voting on questions interspaced between cases, these can be true/false or multiple choice questions. The use of the PRS allows monitoring of group understanding throughout a lecture. If a number of participants answer a question incorrectly the lecturer can review the topic further or explain difficult concepts in more detail. Individual understanding can also be monitored, to identify specific learners who need additional support in an area. The responses from the PRS questions can be saved on the PC after the session & transferred to Moodle, to review individual progress. This can be time-consuming, however it is preferable to identify areas of weakness earlier in the programme, to offer appropriate support. Griff and Matter (2008) undertook a study looking at the PRS system and student success. Instead of reviewing the results of the PRS quizzes, they analysed grades with the time that students registered their PRS “clicker” with the University. Their study, whilst not looking specifically at the quality of responses, did highlight that “successful early intervention will increase student learning and decrease frustration” (page 1124). The implementation of PRS quizzes in sessions and the downloading and analysing of PRS results is an area the programme team are developing further.

End of module feedback from the ultrasound programme suggest that the games, simulation and film viewing were helpful learning tools, with comments such as:

- *The volume of practice questions. This enables us to view images and link them to practice – not only to help us with clinical work but also helpful for the exams*
- *The gynae film viewing enabled me to learn in a new way giving me additional knowledge and a boost in confidence*
- *Excellent teaching in lectures and good description in film viewing sessions – enabling us to transfer the descriptive skills into clinical practice – report writing.*
- *Sessions on the simulator – very helpful, able to ask questions*
- *The use of reviewing images in class and discussing with others, prepares you for clinical practice very well, when you have to make decisions quickly whilst scanning*
- *Games to revise made it fun and informative*

The use of simulation is becoming a common feature in health care educational programmes (Motola *et al* 2013) and medical ultrasound simulation has developed considerably in recent years for use in both teaching and assessment of ultrasound trainees (Williams *et al* 2013; Harrison 2014; Gibbs 2014). The ultrasound suite at City University London has a new haptic ultrasound simulator which learners have open access to, in addition to facilitated small group tutorials to develop basic hand-eye co-ordination skills and practice clinical skills in a non-threatening environment. Students often request further hands-on scanning experience within the University setting and the programme team hope to integrate the simulator further into the curriculum over time. The implementation of this does need careful consideration, as the time at University is limited, the sessions would need to have very specific learning outcomes and link to the areas learners are finding challenging, in the same way that face-to-face tutorials are currently structured, an issue highlighted in the guidelines by Motola *et al* (2013). Issues of staffing for these sessions is also a factor, with a small faculty there needs to be sufficient activities to ensure all learners are participating in some form of learning activity.

Simulation is used in other formats during small group seminars and formative assessment sessions, to review student progress in clinical and communication skills. Breaking bad news is practiced amongst students in an informal setting, with feedback from peers and the module leader, equipment manipulation relating to image quality and safety is reinforced during workshops on the skills suite and practice vivas, providing individual feedback to both the learner and clinical mentor. Motola *et al* (2013) emphasise the importance of feedback on simulation training, tailored to individual learner's needs.

Image 4: The ultrasound skills suite

Challenges of the flipped classroom method of teaching

Access to on-line adobe presenter lectures on iPads was a challenge initially, causing frustration for a small number of learners. This can be overcome by the use of different browsers such as Photon or Puffin Browser (selecting "ignore mute switch" in the settings). Other access issues were related to hospital firewalls, which took considerable time to resolve in some NHS Trusts and slow internet access in some parts of the country.

The flipped classroom is time consuming. For learners, preparation is required for adequate participation in face-to-face activities. Some lack preparation and do not participate fully, which can be frustrating for staff and fellow colleagues. In a study by Cendan *et al* (2011) medical students spent more time preparing for small group sessions than for a traditional lecture, however they hypothesised that this may have led to improved knowledge. As one learner said in module feedback, any learning is time consuming to do well and it could be suggested that the on-line learning method encourages on-going learning and reinforcement of that learning throughout the module or programme, rather than last minute study for assessments. This was highlighted in end of module feedback, with comments such as "*continuous revision extremely helpful in building confidence"* [film viewing] and *"the images … used for film viewing … helped consolidate our knowledge."*

The flipped approach to teaching in a blended learning approach is challenging for staff, particularly in small faculties, where lecturers develop all the materials themselves. There is a need to develop video presentations, which can be very time consuming and the rapidly changing health care agenda and national guidelines particularly in obstetric ultrasound require frequent updating of on-line materials. Anecdotally it has been said that the flipped classroom method can reduce contact time and free staff for other activities, however Lancaster and Read (2013) suggest that budget constraints and staff workloads should not be used as justification for converting to the flipped classroom method. In practice a similar amount of face to face teaching time is used, with the additional need to develop on-line resources. O'Connor *et al* (2011) and Findley-Thompson (2014) also recognised the increased burden on staff time of using a blended learning approach and the commitment required of staff. Bishop and Verleger (2013) stress that the flipped classroom is a combination of on-line material and interactive classroom sessions, not simply a replacement for lecture time. Lecturers need to learn how to use the new technology, develop pedagogically sound methods of delivering material, produce the resources, monitor on-line case discussions and provide interactive material for tutorials, workshops and lectures.

The flipped classroom method deviates from the traditional methods of teaching, so can take time to develop confidence in this method of teaching. As Critz & Knight (2013) suggest the lecturer "supports not drives" learning, which does take time to adjust to for both staff and learners and Hamdan *et al* (2013) suggest that facilitation skills need to be developed. Planning for face to face sessions needs to remain flexible, to meet the needs of individual groups. For more mature learners, who have been out of education for some time this is also a new way of learning for them. Some learners still prefer the traditional style of lectures, where the lecturer provides the information, this has been suggested verbally and in module feedback occasionally, where a student comments that they prefer traditional lectures.

Bishop and Verleger (2013) highlight that although some learners dislike the flipped classroom style of learning, they did tend to watch the on-line lectures and although the preference was for face-to-face traditional lectures compared with on-line lectures, most learners preferred the interactive face to face time above all. It was also suggested that preparation for face-to-face sessions was improved by the use of on-line lectures in comparison to pre-session reading tasks, which few learners undertook (Bishop and Verleger 2013).

Initially some learners feel threatened by the shared learning, particularly the on-line case discussions (Harrison *et al* 2012) and interaction within the lectures. Student feedback on the on-line case discussions has suggested that they are time consuming and can be competitive (Harrison *et al* 2012). Hamdan *et al* (2013) suggest that further research is needed to determine which learners benefit most from the flipped classroom style of teaching and learning, but also which subject areas can be facilitated this way. It has been important for staff on the ultrasound programme to ensure that the teaching and learning process is facilitated in a sympathetic manner. In some instances, particularly during film viewing sessions, if a learner does not know the answer they are told they can "ask the audience". As these sessions are often interspaced with PRS questions, it gives a sense of being a participant on "who wants to be a millionaire" and encourages participation.

Whilst there are studies that suggest that students perform better in assessments, when using the flipped classroom method, many studies include small sample sizes, are flawed or review student perception, rather than outcomes. For example Tune *et al* (2013) reviewed marks and feedback for graduates on a module and found higher marks with the flipped classroom. Their study did have a number of flaws as there appeared to be an additional step in the process for the flipped classroom model, where "homework practice problems" were introduced for both groups. The flipped classroom method would normally utilise the classroom time to work through the problem in an interactive way. Their study also had an uneven distribution of male to female participants in each group, which could introduce additional bias into their results, as could the timeframe for each method. The traditional method was taught over a shorter time than the flipped method. Findley-Thompson and Morbourquette (2014) found no difference between the grades of the traditional and flipped styles of teaching and Bishop and Verleger (2013) concluded that there is not enough evidence to suggest that the flipped classroom improves student outcomes. There are too many variables within the ultrasound programme to allow a clear comparison of marks pre and post flipping the classroom. The most notable being the evolutionary nature of the flipped process. Resources have been developed gradually across a number of modules and over a period of time. During that time the programme has been re-validated and assessments have been amended and further developed, making comparison difficult.

Positive aspects of the flipped classroom

The current methods of teaching provide a number of advantages, particularly relating to the on-line lectures for allowing students' access to resources at a time convenient to them and for revision purposes. Also as learners are all working and often have family commitments attendance at all lectures can be difficult. Additionally, being a central London location, travel issues can impact on attendance. Having on-line resources does enable access to the core

materials, when sessions are missed. Individuals can work at their own pace, rather than having to go at a pre-determined pace in the classroom, providing them with more autonomy as to when and how they learn. For some students for example those with dyslexia, this allows them to review material and listen to lectures again, rather than simply having to read, which can be very time consuming & challenging. Kanard and Bond's (2013) study suggested that students with learning needs accessed the on-line lectures for revision purposes, although they reported problems with accessibility and availability of on-line lectures.

With the use of on-line lectures to cover the curriculum content, face to face time can be used for collaborative learning, shared experiences, discussions, interactive learning and the review of knowledge and linking to that knowledge to clinical practice. Time can be made for clarification of difficult areas, reinforcing key points and tailoring each session to the needed of that particular cohort of learners. The blended learning approach, using both on-line and lecturer led tutorials helps to develop self-directed learning skills and collaborative learning, both of which are essential to the current health care environment & the provision of high quality health care. It has also been suggested that this method of active learning leads to deeper understanding (Davies *et al* 2013).

The on-line lectures, quizzes, film viewing and regular tests and workshops provide on-going revision and regular review of learning, but also enable lecturers to identify issues at an earlier stage than the traditional lecture format of lectures followed by end of module assessments. If students participate and engage in the learning the programme team felt that they seemed to have a greater understanding of the materials, although this has not been assessed formally.

Some of the feedback on the teaching methods used within the programme include comments relating to the different teaching styles that:

- "*kept you interested and on the ball"*
- *"getting students involved and interactive"*
- *"takes into account all learning styles"*
- *"helps you to be open minded and think outside the box"*
- *"link theory to practice"*
- *"encourages students to look deeper into subject*"
- "*the opportunity to discuss personal experience from the departments with other students"*

Learners liked "*considering the broader aspects of sonography and being able to talk about them with colleagues, with guidance from module leader" and the fact that* "w*e were always invited and allowed to participate" and could "interact with my peers and the lecturers once a week".* Other comments included:

- *One of the strengths of the course which has been extremely helpful to me is that there is a good level of student interaction which is encouraged by the lecturers. Extremely useful in developing avenues of further research, or understanding a particular topic.*

- *The course is highly interactive, practical and simulating and I believe provides the student sonographer with the necessary skills, knowledge and experience to succeed.*
- *The course has met all my clinical practice needs through a combination of online learning resources and by learning in the classroom. The course requires a lot of self study and I feel we were supported and directed well in doing this. The lectures provided the opportunity for lots of film viewing and interaction which helped put what we had learned into practice. This was very useful when it came to writing reports in the clinical environment.*
- *I found the teaching on this course geared to the adult learner, it was a good learning experience not to be spoon fed everything and yet receive guidance when necessary. I felt this helped me feel more responsible for my learning. I am quite a shy person but I found the quality of teaching and support within the classroom environment meant that learning was fun. I did not feel embarrassed asking silly questions, mixing tasks, student presentations, group presentations/ discussions/ reflections, discussing cases online and in the class room, having a forum within a structured environment to learn from my cohort who were all interested in different aspects of patient care on different academic pathways, all helped to keep learning interesting.*
- *The online quizzes/ video lectures / presentations/ ultrasound viewing were a fantastic medium for learning.*

Conclusion:

The flipped classroom has been developed for the medical ultrasound curriculum to provide a range of learning, teaching and assessment methods to meet a wide range of learning styles and encourage critical thinking, deeper learning and inter-professional interaction. The use of the flipped classroom within the ultrasound programme allows scaffolding of learning, by the provision of on-line lectures and initial quizzes to provide the core material and the use of interactive face to face lecture time to develop concepts, reinforce learning and identify areas of difficulty to focus on in group work and tutorial sessions, to provide more student focussed learning environment.

After initial concerns by students, their feedback has been positive in relation to all aspects of the flipped classroom, with suggestions for improvement generally requesting more interactive sessions or on-line resources. The development of the flipped classroom method has been time consuming and is on-going. The review of quiz results and development of flexibility within the interactive sessions requires a great deal of time, commitment and confidence by the academic staff. This is an area that staff are developing and gradually the programme is becoming more “flipped”.

The transition to the flipped approach to teaching the medical ultrasound programme has been over a period of time and is still being developed. As the on-line materials and interactive resources are time consuming to devise it is recommended that the process begins with a small area of the syllabus. Following review and feedback, further areas can be implemented, gradually flipping more of the syllabus, if it meets the learning outcomes

and the needs of the learners. It is possible that some areas of the curriculum would benefit from different teaching and learning methods, so careful evaluation is required as the move towards a flipped classroom is made. There is a great deal of literature on the flipped classroom method of teaching and learning, however further high quality studies are needed to determine whether this method produces improvements in quality of health care provision.

References:

Baid, H. and Lambert, N (2010) Enjoyable learning: The role of humour, games, and fun activities in nursing and midwifery education, *Nurse Education Today*, 30 (6) 548–552

Bishop, J. and Verleger, M. (2013) "The Flipped Classroom: A Survey of the Research," *120th American Society of Engineering Education Annual Conference & Exposition*, Atlanta, Georgia, United States, June 23-26. Available at: http://www.studiesuccesho.nl/wp-content/uploads/2014/04/flipped-classroom-artikel.pdf (accessed 9 August 2014)

Blakely, G. Skirton, H. Cooper, S. Allum, P. Nelmes, P. (2010) "Use of educational games in the health professions: A mixed-methods study of educators' perspectives in the UK" *Nursing and Health Sciences*, 12 (1), pp. 27 – 32.

Blessinger, P. and Wankel, C. (2012) "New Directions in Higher Education: An Introduction to Using Wikis, Blogs, and Webquests", in Charles Wankel, Patrick Blessinger (ed.) *Increasing Student Engagement and Retention Using Online Learning Activities (Cutting-edge Technologies in Higher Education, Volume 6 Part A)* Emerald Group Publishing Limited, pp.3 – 16. Available at: http://www.emeraldinsight.com/doi/abs/10.1108/S2044-9968%282012%29000006A003 (accessed 21 August 2014)

Boctor, L. (2013) "Active-learning strategies: the use of a game to reinforce learning in nursing education. A case study", *Nurse Education in Practice*, 13 (2), pp. 96 - 100

Butt, A. (2014) "Student Views on the use of a flipped classroom approach: Evidence from Australia". *Business Education and Accreditation,* 6 (1), pp. 33 - 43.

Cendan, J. Silver, M. and Ben-David, K. (2011) "Changing the Student Clerkship from Traditional Lectures to Small Group Case-Based Sessions Benefits the Student and the Faculty", *Journal of Surgical Education*, 68 (2), pp. 117 – 120.

Critz, C. and Knight, D. (2013) "Using the Flipper Classroom in Graduate Nursing Education" *Nurse Educator,* 38 (5), pp. 210 - 213

Davies, R. Dean, D. and Ball, N. (2013) "Flipping the classroom and instructional technology integration in a college-level information systems spreadsheet course." *Educational Technology Research and Development*, 61 (4), 563–580.

Findley-Thompson,S. Mombourquette, P. (2014) "Evaluation of a flipped classroom in an undergraduate business course", *Business Education and Accreditation*, 6 (1), pp. 63 – 71.

Gibbs, V. (2014) “A proposed new clinical assessment framework for diagnostic medical ultrasound students” *Ultrasound,* 22 (2), pp.113-117.

Griff, E. and Matter, S. (2008) Early identification of at-risk students using a personal response system. *British Journal of Educational Technology*, 39 (6), pp. 1124–1130

Hamdan, N. McKnight, P. McKnight, K and Arfstrom, K. (2013) *A Review of Flipped Learning, Flipped Learning Network*. Available at: http://researchnetwork.pearson.com/wp-content/uploads/LitReview_2014_FlippedLearning_vFinal_JK_WEB.pdf (accessed 20 August 2014)

Harrison, G. (2014) "Summative Clinical Competency Assessment: A Survey of Ultrasound Practitioners' Views" *Ultrasound.* Published online September 17, 2014, doi: 10.1177/1742271X14550238.

Harrison, G. Mulloy, B. Harris, A. Flinton, D. (2012) “On-line case discussion assessment in Ultrasound: The effect on student centred and inter-professional learning”. *Radiography,* 18 (3), pp. 160 – 165.

HEA (no date) “Effective learning and teaching in UK higher education. The Higher Education Academy”. Available at http://www.tlrp.org/pub/documents/UKHEfinal.pdf (Accessed 9 August 2014)

Hoffman, E. (2014) “Beyond the Flipped Classroom: Redesigning a research methods course for e3 instruction”. *Contemporary Issues in Education Research*, 7 (1), pp. 51 – 62.

Kanard, A and Bond, S. (2013) *Neurodiversity and lecture recordings.* Centre for Learning Technology, London. Available at: http://eprints.lse.ac.uk/54434/1/__libfile_REPOSITORY_Content_Bond,%20Stephen_Neurodiversity%20lecture%20recordings_Bond_Neurodiversity%20_2013.pdf (Accessed 12 September 2014)

Kiviniemi, M. (2014) “Effects of a blended learning approach on student outcomes in a graduate-level public health course”. *BMC Medical Education*, 14; 47. Available at: http://www.biomedcentral.com/content/pdf/1472-6920-14-47.pdf (accessed 26 March 2014)

Lancaster, S. and Read, D. (2013) Flipping lectures and inverting classrooms. *Education in Chemistry*. Royal Society of Chemistry. Available at www.rsc.org/images/EIC0513-flipped-classroom-inverting-lectures_tcm18-234703.pdf (Accessed 12 September 2014)

Malik, K. (2013), Engaging Learners as Moderators in an Online Management Course, in Wankel,C and Blessinger, P. (ed.) *Increasing Student Engagement and Retention in e-learning Environments: Web 2.0 and Blended Learning Technologies (Cutting-edge Technologies in Higher Education, Volume 6 Part G)* Emerald Group Publishing Limited, pp.175 – 197. Available at: http://www.emeraldinsight.com/doi/abs/10.1108/S2044-9968%282013%29000006G009 (accessed 20 August 2014)

Morgan, K. (2006) Ground Rules in Online Discussions: help or Hindrance? *Family Science Review*, 6 (1), pp 285 – 293. Available at https://www.uwyo.edu/learn/_files/docs/brownbag_docs/onlinediscussions.pdf (accessed 10 August 2014)

Motola, I. Devine, L. Chung, H, Sullivan, J and Issenberg, S (2013) "Simulation in healthcare education: a best evidence practical guide. AMEE Guide No. 82." *Medical Teacher*, 35 (10), e1511 - 1530

NHS Leadership Academy (2014) Responding to Francis, Keogh and Berwick reviews, Available at: **http://www.leadershipacademy.nhs.uk/about/our-work-and-its-impact-on-the-nhs/responding-to-francis-keogh-and-berwick-reviews/ (accessed 10 August 2014)**
O'Connor, C. Mortimer, D. and Bond, B. (2011) "Blended Learning: Issues, benefits and challenges" *International Journal of Employment Studies*, 19 (2), pp. 62 – 82.

Royse, M. and Newton, S. (2007) "How gaming is used as an innovative strategy for nursing education". *Nursing Education Perspectives*, 28 (5), pp. 263 - 267

Topping, K. Smith, E. Swanson, I. and Elliot, A. (2000) "Formative Peer Assessment of Academic Writing Between Postgraduate Students" *Assessment & Evaluation in Higher Education*, 25 (2), pp. 149 – 169.

Tune, J. Sturek, M and Basile, D. (2013) "Flipped classroom model improves graduate student performance in cardiovascular, respiratory and renal physiology". *Advanced Physiology Education*, 37 (4), pp. 316 – 320.

Williams, C. Edie, J. Mulloy, B. Flinton, D. and Harrison, G. (2013) "Transvaginal Ultrasound Simulation and its Effect on Trainee Confidence Levels". *Ultrasound*, 21 (2), pp 50–56.