Improving Students’ Mastery of Biology Laboratory Techniques Using Digital Media Technology
School of Life Sciences, MVLS
Principal Researchers – Michelle Welsh, Nicola Veitch and Pamela Scott

Summary
One of the University of Glasgow’s (UoG) Learning and Teaching Strategic objectives is to deliver an ‘excellent student experience’ with a priority for ‘innovation in our provision’. Funding is sought to research and utilise technologies to implement pre-laboratory resources for Life Science students, thereby exploring novel delivery methods that hold the potential for enhanced engagement and attainment.

Teaching biology to UoG undergraduates includes lectures and laboratory classes. Studies show that students are more engaged when presented with active-learning strategies and the laboratory provides an excellent opportunity for this. During practicals, students should undertake experiments making observations, analysing data, and presenting their findings. However, some students lack adequate preparation and theory to achieve these objectives, instead following the issued instructions without engaging in active learning.

Recently, technology use has increased significantly in Higher Education; for example, pre-lab videos have been used to ‘flip’ the class, resulted in an increase in knowledge and confidence in lab techniques. The aim of this project is to develop bespoke resources, such as quizzes and videos, to enhance preparation for practical sessions enabling our students to take responsibility for and direct their own learning and encourage inquiry-based learning skills: key UoG graduate attributes to generate investigative responsible learners. These resources would be made available for students via short URLs, Augmented Reality (AR) technology and/or QR code links embedded in student laboratory manuals and within the course Moodle VLE. These resources provide an excellent opportunity to test and implement ‘classroom flipping’ at the UoG.

Student perception of these pre-lab resources and the use of technology, and the impact on grade will be evaluated. If positive, similar resources could be developed across the University. Given that student preferences for these technologies are poorly defined, this project could guide others in the use of QR codes and AR technologies. These technologies provide an opportunity to transform conventional teaching into active learning sessions founded upon material assimilated in advance, and draw students into discussion of these topics.

Aims and Outcomes
We aim to develop and implement pre-laboratory resources for identified groups of undergraduate Life Science students to encourage better student preparation before class and thus promote student-centered and independent learning during class. This collaboration covers three disciplines (Level 2 Microbiology, Level 3 Anatomy and Level 3 Molecular Biology) and many students (~ 200, 30 and 500, respectively) at Level 2 and Level 3. We have an opportunity to impact on learning for many students and evaluate the effectiveness of laboratory pre-lab resources disseminated using a variety of multimedia tools. The aims and outcomes for this project are:

Aims:
1. Determine what pre-lab resources are required and their content, and how students would prefer to access these.
2. Develop pre-lab resources to be used as informative, pre-laboratory, instructional aides to inform and engage students in the theory and preparation for practical classes.
3. Explore the use of tools such as QR codes and AR as well as short URLs to engage UoG students and improve their student experience and determine student preference and ease of use.
4. Evaluate student use and perceptions of pre-lab resources, their ease of accessibility and the impact on student learning.

Outcomes:
1. Generate UoG-branded open educational resources which will directly benefit current undergraduate Anatomy (Level 3), Molecular Methods (Level 3) and Microbiology (Level 2) students.
2. Develop responsible learners by encouraging access to pre-lab material to ensure students are engaged in/prepared for/are more confident with a specific topic in advance. This will develop investigative, resourceful, confident learners; key graduate attributes at the UoG.
3. Improve student grades and engagement thus retention and progression in these fields of biology.
4. Develop instructions via a training video for students and staff on using this new technology; these are transferable for use by other courses/services using this technology.
Develop best practice for the Learning and Teaching Centre on using this technology.

This application meets the following funding priorities:

1. Innovation in the Curriculum: Technology Enhanced Learning and Teaching (TELT) using technologies to enhance the student learning experience
2. Projects that align with QAA’s theme: Developing and Supporting the Curriculum
3. Enhancing of student learning using the University’s Graduate Attributes framework
4. Enhancing student retention by enhancing engagement of students with learning, and develop their reflective learning skills

Previous Work
Teaching biology laboratories should allow students the opportunity to investigate a biological question through designing and implementing experiments and presenting their findings. This is one of the best opportunities for active-learning in biology, which Handelsman (2004) showed encourages better student engagement. However, often students fail to adequately prepare for practicals to achieve this which leads to many students simply following given instructions in a laboratory class and not engaging in active-learning. The concept of ‘lecture flipping’ requires the student to engage with audiovisual course material before coming to classes, freeing up time for student-centred activities within class time. Educators using this novel approach note that this leads to improved student grades, engagement and independence (Sams and Bergmann, 2013). Maldarelli (2009) showed that using pre-lab videos in biology to flip the class, resulted in an increase in knowledge and confidence in lab techniques. By asking our students to engage with the basic information and content in advance of the labs, we aim to use this pedagogical approach of classroom flipping and encourage them to use their lab time to apply their basic knowledge, ask questions and evaluate concepts, leading to an increased understanding of the relevance of the laboratory session and a deeper level of understanding.

Forth Valley College have successfully used videos linked through QR codes to better engage students in practicals (personal communication, Monica MacLeod, December 2012). Having visited them to see how this was implemented, we intend to take this concept of pre-lab videos and build on it by developing pre-lab resources for our courses such as bespoke videos and quizzes based on research papers, possibly using the more novel technology of AR to link them to their lab manuals. We asked some of our L2 and L3 Life Science students their views on the usefulness of pre-lab resources. 62 students responded to these questionnaires, with 82% indicating that a short pre-lab video of what they will do in the lab would be beneficial to their learning in practical classes. The students also indicated they would welcome quizzes linked to these videos to encourage student reflection and preparation for the class as well as later use for revision. 98% indicated that they would choose to use a mobile device such as a laptop, tablet or phone to access these resources; this is consistent with the UoG ‘Digital Natives’ study which showed that mobile internet access is on the increase and that students expect to be able to access learning resources using mobile technology (Gardiner, 2010).

We also asked which format they would prefer to access the pre-lab resources; the majority reported a preference for URL, but some indicated they would choose QR codes/AR. Therefore, we will use both media to encourage engagement with mobile technology, without disadvantaging those without smartphones/tablets. This will build on the use of videos and QR codes in L1 Biology and is in line with the university's desire to ‘keep up with the latest technologies’ as set out in the UoG E-Learning Strategy 2013 - 2020. We will produce short instructional training videos on the use of QR codes and/or AR, to encourage engagement with this innovative mobile technology. This technology allows us to add digital media to printed material then using a smart phone or tablet, viewers can scan the printed object and the digital content appears on the screen; this is the technology behind ‘Google glasses’. For us, for example, using AR would mean students can scan a picture of a pipette in their lab manual (or perhaps even a real pipette in the lab) and the video of how to use the pipette would appear on their phone. This gives meaning to the link in its own right, unlike QR codes which are simply barcodes as the link. Many institutes are now using this such as Kendal College who used it in their prospectus to make photos of people ‘come alive’ on visitor’s phones and City University London who used it for healthcare students to explore the health risks of their environment.

Student Engagement
Further to our student opinion poll discussed above, we are currently organising a focus group, comprising of students currently studying Microbiology, Anatomy and Molecular Biology to identify which aspects of their laboratory practicals they found most challenging and would most benefit from pre-lab resources. This will inform us on which areas to focus on to best aid our students and integrate these new resources directly into existing courses and teaching. The pre-lab resource will be developed using GTAs and School of Life Science undergraduate students (UGS) following
relevant training. They will also research distribution of the pre-lab resources within a course, the most appropriate software required to implement and access QR codes and Augmented Reality, and embed the pre-lab resource within lab manuals and VLE. They will also generate instructions for students to access these efficiently. This student engagement will ensure that the resource is valuable to the student body, and the technology is relevant and user friendly.

**Methodology**
To develop the videos, GTAs and undergraduate students will perform the laboratory techniques, while members of the UoG Media Production Unit (MPU) record it. We have already submitted a request for support from the MPU and discussed our needs with Kerr Gardiner. We will gain feedback from students currently on these courses to identify areas/techniques they believe would most benefit from these resources. Each video will last 3-6 minutes and will range from demonstrating simple techniques such as how to use a pipette to more complicated laboratory procedures such as how to safely dissect open the shoulder. In addition to the basic technique, these videos will also cover the theory and application of these techniques relevant for our courses, which the majority of current freely available videos do not include. We have planned for up to ten videos to be developed for each of the three courses, addressing the most challenging and important techniques first. The videos will then be edited by the MPU under the guidance of the principal researchers. Whilst there are an impressive number of video lectures, instructional videos, demonstrations and other multimedia applications freely available in many educational institutions (for example, Academic Earth, 2013), very few provide the specific information, particularly the theory and application, required to support our practical class. The resources will be made available for students via short URLs on Moodle and well as through Augmented Reality technology and/or QR code links embedded in existing student laboratory manuals to allow easy access through mobile technologies. This is also a perfect opportunity to also revise existing lab manuals to ensure they are less prescriptive and instructional, encouraging more independent thinking in the lab as well as before through the resources.

GTAs will investigate the best software to implement this technology. This information will be fed back to the Learning and Teaching Centre to help guide future use of such technology and develop best practice. Based on the videos, we will design quizzes through Moodle and/or Camtasia to encourage student reflection and check their understanding of the techniques prior to class. Teachers will check class performance in these quizzes prior to delivering lab sessions and address any misconceptions during the session. These quizzes will not just be simply testing knowledge of the technique in the movie, but will be designed to include open questions that require student thought, interpretation and analysis.

**Potential applicability, transferability and sustainability**
If evaluation demonstrates that these pre-lab resources aid student engagement, learning and grades, these resources can be used again in future years and further such resources could be developed both in the courses addressed in this application as well as others across the University. For example, the resources developed could easily be utilised by the Medical School for undergraduates and in various research-based and taught postgraduate courses. We also surveyed 18 GTAs in our opinion poll on the development of pre-lab videos, and many commented on that this would be a valuable resource for GTA training, providing added value and applicability for these student resources. Based on the findings from this project and given that this technology is new and innovative for delivering pre-lab resources at the UoG, this project will be a useful guide to others in the use of QR codes and Augmented Reality technologies, disseminated through University of Glasgow Learning and Teaching Centre. We aim to share the findings of our project through local seminars at the UoG, national conferences such as the HEA Annual Teaching and Learning Conference and the wider education community, through publication in an appropriate education journal (e.g. Biosciences Education).

**Evaluation**
To evaluate the use of these pre-lab resources, Google Analytics will be used; this will allow us to gather data continuously and specifically view how students are accessing the resource, what technology is being used and when this pre-lab resource is being accessed. This will inform us if the instructions provided allow the students to successfully access the pre-lab resource and so will help guide future use of such technology. Student feedback from both the pre-lab resource content and implementation will be evaluated using a questionnaire and focus groups for each of the three courses; these will be designed by the principle researchers and led by GTAs involved in the project following training. GTAs using the resource for training purposes will also be evaluated using the same means, with the focus of the questioning tailored to the different cohorts. To assess the impact of the resources on student learning we will carry out pre- and post-lab surveys, such as the Participation Perception Indicator first developed by the University of Michigan (Stuckey-Mickell, 2007), to compare student understanding and knowledge of the information contained in the resources. Ethical approval from the MVLS College Ethics Committee will be sought prior to the start of these activities in order to disseminate project findings.
Benefits:
1. Links with Learning and Teaching strategic objectives 6, 7 and 9 and the priority of ‘Innovation in our Provision’.
2. It is driven by student feedback and will use students to generate the new resources.
3. Generate pre-lab resources which will improve student responsibility and engagement, allowing them to reflect on and revise laboratory techniques. This will be particularly useful for the UoG’s increasingly international student body and will allow flexible access for those with increasing time commitments.
4. The findings will provide guidance to future studies using these technologies.
5. The project is sustainable as the videos can be used in subsequent years and be built upon.
6. The project is transferable as the videos, instructions and software can be used by other courses.

Timetable
May-July 2013
Focus groups with students and evaluate the data; ethics application; recruit GTAs/students
August 2013-April 2014
Planning, developing and filming short videos; pre-lab resource development
January-April 2014
Research and creation of student guide to access material
May-August 2014
Integration of QR codes/AR into VLE and lab manuals
September 2014-May 2015
Implementation of pre-lab resource within courses; evaluation and dissemination of findings

Budget

<table>
<thead>
<tr>
<th>Item</th>
<th>Year 1</th>
<th>Year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary costs</td>
<td>£7,920</td>
<td>£1,980</td>
</tr>
<tr>
<td>GTAs X6 x 100 hours each @ £16.50/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>School of Life Sciences UGS X3 x 5 weeks @ £150/week</td>
<td>£1,800</td>
<td>£450</td>
</tr>
<tr>
<td>Travel costs</td>
<td>£2,500</td>
<td></td>
</tr>
<tr>
<td>Conference X3 Pls and 1 GTA and 1 UGS @ £500/person</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andy Ramsden visit</td>
<td>£500</td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>£1,200</td>
<td></td>
</tr>
<tr>
<td>Tablet x 3 for GTAs/PIs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumables</td>
<td>£250</td>
<td>£150</td>
</tr>
<tr>
<td>General printing/admin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>£12,070</td>
<td>£5,080</td>
</tr>
</tbody>
</table>

The GTAs and UGS will generate, implement and evaluate the pre-lab resources; they can work intensively or over a longer period to suit their availability. The tablets will work on different platforms (one per GTA/UGS team) to enable the working group to generate and test the technologies on different operating systems. The general administration funding will support the running of the project such as transcribing the student interviews. In addition, to keep abreast of the current practices with use of technology in Higher Education and disseminate our results, we propose presenting at a relevant conference, such as an HEA Annual Teaching and Learning Conference. We also propose to invite Andy Ramsden, e-Learning Development Manager at University of Bristol, to give a seminar at the UoG on the effective design of location aware learning, with a particular emphasis on QR Codes and Augmented Reality technologies. This will benefit the applicants and other staff. In kind services will be provided by the UoG MPU.

References
- Gardiner, K. (2010). First Year Use of Technology and their Expectations of Technology in their Courses. UoG.

Approval
Should this application be successful and be granted funding, I give consent for this application to be published on the Learning and Teaching Centre website.

Signature of project leader: [Signature]