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Interactive Technologies to Enhance Learning and Teaching in Higher Education

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Engaging students in active learning in relatively large lecture settings can be a challenge for higher education practitioners. In such contexts the opportunities for group work and collaborative learning are limited, yet this is often the setting for many learning activities especially in first year modules. In our work within the School of Biomedical Sciences at Ulster University, we have shown that technology is successful in engaging students in relatively large learning environments where the number of students enrolled on a module may be around 200. We have identified areas where technology can engage students both in class, and outside scheduled lecture sessions, enhancing student interaction and engagement.

Our work at Ulster University follows a pedagogic model of active learning that "*involves students in doing things and thinking about the things they are doing*" (Bonwell and Eison, 1991). This is of particular relevance for students in STEM areas where active and enquiry-based approaches are required to foster skills in problem-solving, data analysis, team working, collaboration and practical laboratory techniques. Shirley Dugdale (2009) focuses on the landscape in which learning happens in higher education institutions and calls for campuses to exhibit a "participatory architecture" to support communities of learning, utilising "existing physical place and the emerging virtual space". In this report, we note the dynamic learning landscape within higher education and the opportunities to engage students in their learning by harnessing emerging virtual spaces. Specific attention is drawn to the following three themes:

1. The use of technology to engage students during lectures to promote active engagement
2. The use of technology outside scheduled sessions to foster collaborative and peer learning
3. Current student behaviours in the usage of technology in the learning context

1. The use of technology to engage students during lectures to promote active engagement:

Cloud Based Audience Response Systems

Audience response systems have been used extensively in learning contexts to engage students, increase discussion and help them to determine their level of understanding compared to their peers (Efstathiou and Bailey, 2012). The technology driving such approaches has ranged from mobile phone technology (McClean, Morgan & Hagan; 2010) through to "clicker" devices (Cain et al., 2009) and in more recent times to cloud-based technologies (Shea, 2016) which may be accessed on student owned-devices, thereby circumventing the need to purchase proprietary hardware and tools. This approach allows institutions to be much more agile in responding to new developments within this dynamic area.

In our work we chose to explore one such cloud-based audience response system, Nearpod (www.nearpod.com), though a number of similar tools now exist which perform similar functions. Nearpod was initially selected as it features a drawing palette that allows students to annotate figures, draw molecular structures or perform calculations etc. In practice, an existing PowerPoint lecture may be uploaded to the instructor's account on Nearpod and activities such as multiple choice questions, polls, collaborative exercises, and drawing activities are added. The academic member of staff then "broadcasts" the lecture to student-owned smart devices within the class, with access provided by means of a code provided to students at the start of the session. The lecturer maintains an overview of student responses as the lecture proceeds; this then provides opportunity for areas requiring further clarification to be revisited.

Out initial findings on a pilot study of Nearpod have been published (McClean & Crowe, 2017) and summarised here. We implemented Nearpod in a second-year undergraduate module PHA302 Pharmaceutical Analysis in the School of Pharmacy and Pharmaceutical Sciences at Ulster University. This pilot study took place in the 2015/16 academic year with 35 students enrolled. As the module is also delivered to students from other courses (BSc and MSc in Pharmaceutical Sciences), the potential in-class attendance was 42. Nearpod was also used to deliver lectures to first year undergraduate students in the School of Biomedical Sciences at Ulster University on BMS101 Bioanalysis for Nutrition and BMS106 Bioanalytical Chemistry modules. The total enrolment here was 125. Students were surveyed about their use of Nearpod and their views on its functionality and any perceived learning gain. Figures 1 and 2 provide a summary of the questionnaire data and demonstrate that Nearpod was well received by students and they believed that it contributed to their learning within the classroom context.

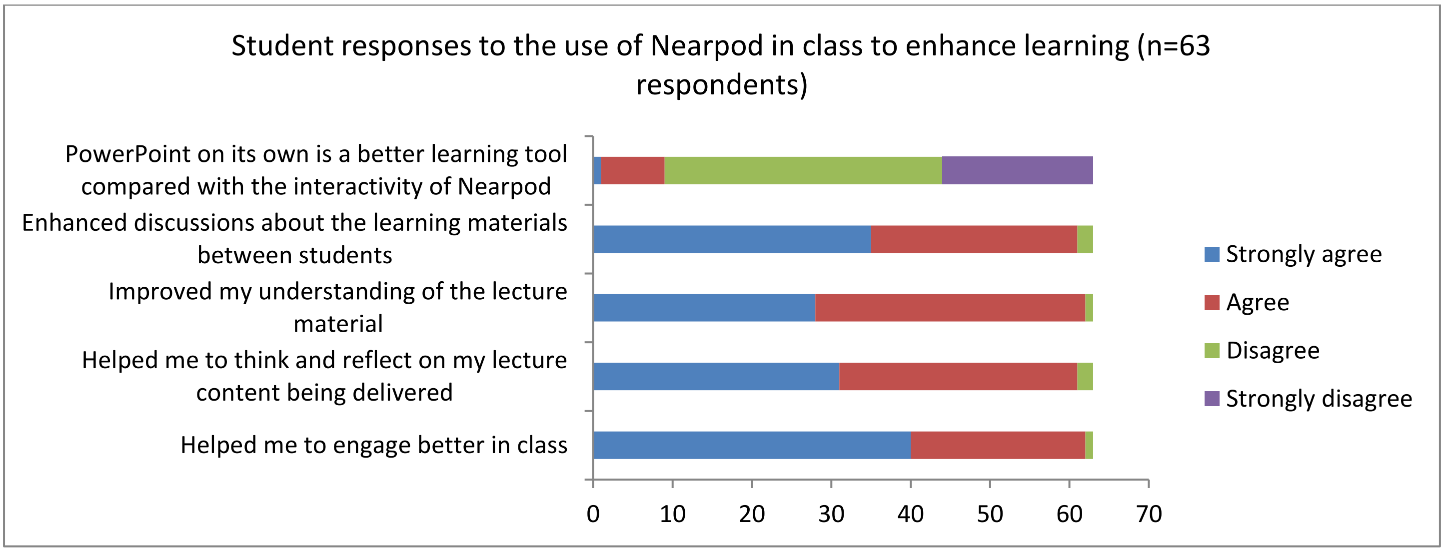

Figure 1: Student responses to the use of Nearpod in class to enhance learning; n = 63 respondents

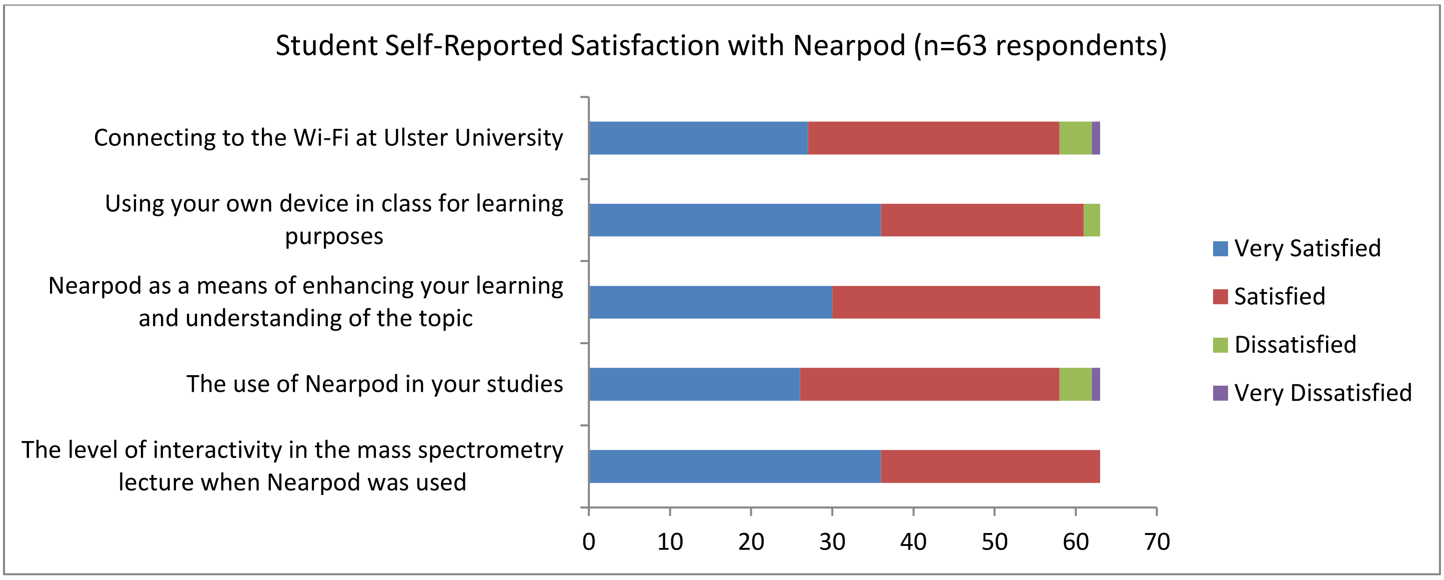

Figure 2: Student self-reported satisfaction with the Nearpod tool; n = 63 respondents. Figures 1 & 2 from McClean S, Crowe W; Making room for interactivity: using the cloud-based audience response system Nearpod to enhance engagement in lectures, FEMS Microbiology Letters 2017; 364 (6): fnx052, doi:10.1093/femsle/fnx052. Reproduced by permission of Oxford University Press on behalf of FEMS.

In a follow-up focus group, students were again positive regarding their use of Nearpod, citing aspects such a keeping attention in class, understanding of and greater engagement with lecture content. Some of the barriers to engagement included connecting to the institutional WiFi and some reported usability issues with the drawing tool and how it displayed on smaller screens.

Since this initial pilot, the tool has been used in classes with up to 175 students and engagement has been positive. The word cloud in Figure 3 indicates student satisfaction with Nearpod as derived from the online module survey in 2016/17.

Figure 3: BMS105 Chemistry in Practice module survey data 2016/17. Free response to the question: “What did you feel was particularly good about this module?” 80 responses received from a total of 167 students enrolled.

In our hands, Nearpod and similar tools represent an opportunity to engage students. Such strategies do rely on a number of requirements such as WiFi connectivity, student access to devices and central support within the University environment and learning & teaching strategy to support these initiatives. As the tools are web-based there also exists an opportunity for students to take part in sessions remotely if travel to campus is not possible. Combining cloud based audience response systems with conferencing tools such as Skype or Blackboard Collaborate could therefore provide an enriched synchronous learning experience for students during remote learning sessions.

2. The use of technology outside scheduled sessions to foster collaborative and peer learning

Collaborative and gamification approaches to engaging students with learning

While web-based technology can be used to engage students inside lectures, technology options also exist to encourage collaboration and indeed introduce a gamification aspect to enhance student learning outside the classroom confines. One such platform is PeerWise (https://peerwise.cs.auckland.ac.nz/) where students in an anonymous manner to each other (but not to instructors) create and share multiple-choice questions (MCQ) relevant to their course of study. Students then answer, rate and comment upon the questions set by their peers. As their level of engagement with PeerWise increases students earn badges and build up a reputation score thus providing further incentive to take part. From a pedagogic perspective, there are a number of gains in the introduction of such tools. For example, students provide a level of peer support for each other, and in the creation of questions with feedback, they are themselves taking ownership of learning and creating resources. PeerWise is fully web-based and means that students may engage with the platform at any time and using any internet-connected technology. This adds a further dimension to the flexibility and accessibility of the system.

PeerWise is used by a number of universities in various discipline areas including organic chemistry (Ryan, 2013), physics (Bates, Galloway, & McBride, 2012), biosciences (Tierney & Sykes, 2011), teacher education (Mackey et al, 2012), medicine (Rea & McClure, 2012), nursing (Rhodes, 2013), computing (Devon et al, 2012) and biochemistry (Hancock et al, 2018). The literature describes a number of reported advantages of PeerWise such as increased student engagement (Rea & McClure, 2012), effectiveness with large groups of students; e.g. 600-700 (Tierney & Sykes, 2011), enhanced digital capability skills (Mackey et al, 2012) and higher examination scores for students who engage (Bates, Galloway, & McBride, 2012). A very recent paper has reported a 4% uplift in examination scores for students who engage with PeerWise compared with those who don’t (Hancock et al, 2018).

At Ulster University PeerWise was first introduced in 2013/14 to a year one biochemistry module with 195 students enrolled. Biochemistry is a foundational topic for courses such as Biology, Biomedical Science, Dietetics, Food & Nutrition and Human Nutrition. Concepts within biochemistry can be challenging for some students, as the level of learning is much higher than that covered by GCSE or A-level courses. As University study aims to equip students to be independent learners, we wanted to implement a means of supporting students where they took on a greater level of ownership and created their own support resources. PeerWise was chosen as the tool to implement such an approach and a case study on our practice has been published (McClean, 2015).

Implementing & Evaluating PeerWise

For the BMS102 Biochemsitry activity, students were asked to complete the following tasks on PeerWise:

1. Create 1 MCQ per week of teaching during the biochemistry course;
2. Answer 3 MCQs (created by other students) per week of teaching;
3. Comment on 2 MCQs (created by other students) per week of teaching.

A small number of coursework marks were assigned to students who successfully completed the activity. Student engagement was measured at two checkpoints, one in week 8 and the other in week 12. Some of the

PeerWise questions written by students were included in two summative class tests during the semester providing a further incentive for engagement. Students were provided with a guide on how to write good MCQ questions along with guidance on the activity to be completed.

Engagement with PeerWise as a tool for active learning has been very positive as evidenced in Table 1, which summarises total number of questions written, answered and commented upon.

Table 1 – student engagement with the PeerWise tool on module BMS102 Biochemistry in the School of Biomedical Sciences, Ulster University.

Academic Year	No of Students Active	Questions Authored	Questions Answered	Comments Provided
2013/14	194	2,411	28,256	9,275
2014/15	201	2,144	26,013	4,794
2015/16	162	1,690	24.339	3,999
2016/17	157	1,615	24,796	5,252

Usage statistics above demonstrate a high level of student engagement with PeerWise and feedback from students has been very positive. However, in our work to date we do not see any direct correlation between PeerWise usage and performance in final sessional examination mark as measured for years when PeerWise was / was not used. That said, it is clearly seen that the model used here engages students with learning and facilitates building a resource to support peers. As seen in Figure 3, engagement with PeerWise peaks at key times such as before summative class tests and the “checkpoints” to measure engagement. Furthermore, PeerWise continues to be used as a revision tool for the sessional examination in May each year.

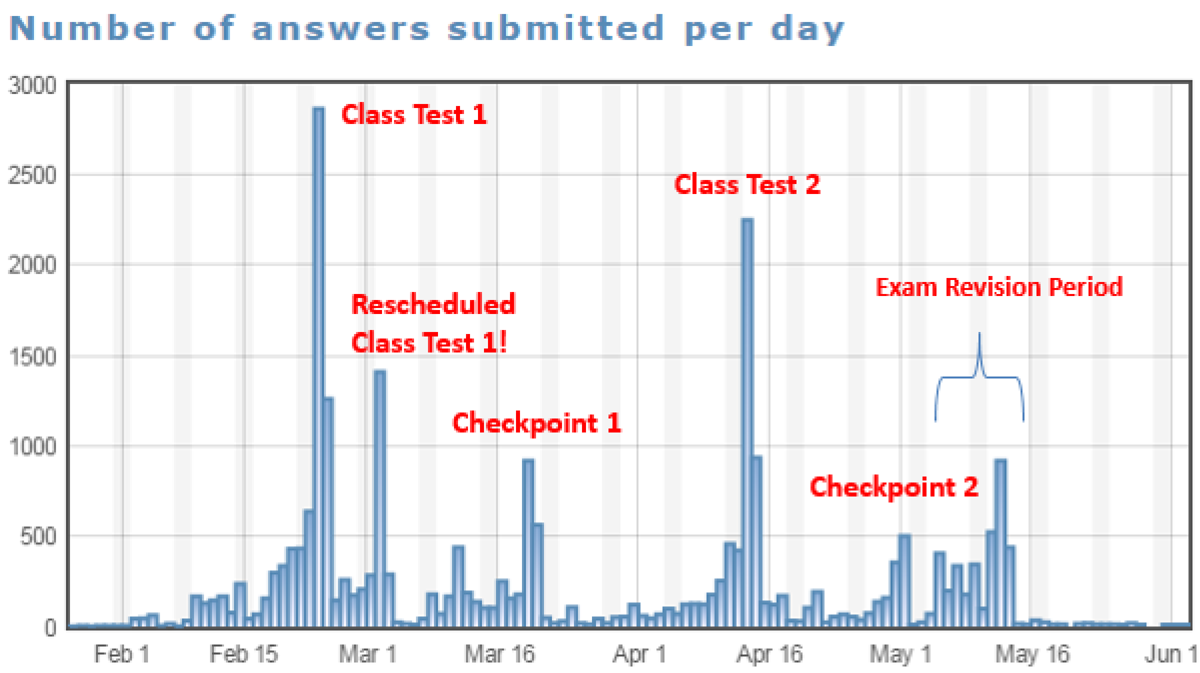

Figure 3: Typical student engagement profile with PeerWise (number of answers submitted per day in 2014/15 academic year). Checkpoints refer to time points when student engagement is measured for assignment of coursework marks.

3. Current student behaviours in the usage of technology in the learning context

The two case studies above demonstrate the value of interactive technologies in the student learning process. While the work reported here was conducted within a science / bioscience context, similar findings are evident across the higher education sector. The JISC Student Tracker survey for 2017 has shown that students value the flexibility offered by accessing learning materials using digital tools (Newman & Beetham, 2017). Sarah Knight of JISC made the following comment on the 2017 survey;

> "*Our survey showed digital technology is most often used for accessing information and for the production of work in a digital format, and is valued for its convenience and is a great way to fit learning into the busy lives of students. It's clear that students want the same convenience they get from using digital in their day to day lives, at university.*
>
> *What they don't want, is a deluge of different technologies and ways of using them. Institutions need to adopt a joined-up approach to digital, in order to meet the needs of students"* (JISC, 2017).

A closer look at Ulster University student responses reveals that they would like to see more interactivity both in class and online. However, they also express that variety in presentation styles is welcome; not everything should be moved online and face-to-face sessions should not be reduced (McCloy, 2017). While technology can never replace an excellent lecturer, it does have potential to significantly augment and enhance the student experience. It is clear that appropriate infrastructure is required to ensure that universities are equipped with appropriate architecture to make learning experiences productive and engaging both inside and outside of the lecture theatre.

Key recommendations from our work to date in utilising interactive technologies in higher education.

1. Technology should be seen as an enabler or a means to augment and assist the pedagogic experience of students.
2. University departments should actively listen to the student voice to be aware of technology trends followed by their student cohorts and respond accordingly
3. Exposing students to a range of carefully chosen digital platforms develops digital confidence and student practical, digital skills.
4. Agility in procurement can be a challenge especially for higher education establishments trying to collaborate with smaller start-up companies. Scaling up successful pilot studies to an institutional context can be a challenge due to procurement thresholds.
5. Analytics and the availability and use of individual learner identification numbers is not yet mature. Tracking new entrants to HE from Primary School through feeder schools to HE and on to the work place would be valuable.
6. Educational data is not open, nor is deprivation data. Ulster University does a lot of analysis of data (NISRA/Department of Education) and know how to get access to what they need but more openness of some data would allow local developers to build applications using School data (exam results, demographics etc) so that universities can be more proactive in supporting students. 9Data from interactive educational technologies could also be included).

Points 4 – 6 by Andy Jaffrey, Head of the Office for Digital Learning at Ulster University.

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