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Line Up, Line Up: Using Technology to Align and Enhance Peer Learning and Assessment in a Student Centred Foundation Organic Chemistry Module.

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Line up, Line up: Using technology to align and enhance peer learning and assessment in a student centred foundation organic chemistry module.

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This paper describes how three technologies were utilised in combination to align student learning and assessment as part of a case study. Multiple choice questions (MCQs) were central to all these technologies. The peer learning technologies; Personal Response Devices (a.k.a. *Clickers*) and *PeerWise* (<http://peerwise.cs.auckland.ac.nz>), were implemented to achieve scaffolded, self-directed independent learning by the students which aligned to the assessment methodology through creating, analysing, answering and discussing multiple choice questions. Personal response devices enhanced in-class activity involvement, whilst PeerWise provided structure and support for independent student learning through defined outside class activities. An associated technology, online MCQs hosted through a secure virtual learning environment, was used as an aligned assessment methodology. The rationale behind this case study, its implementation and evaluation are described and discussed. Finally, the potential widespread applicability of this aligned, technology enhanced learning and assessment methodology is outlined along with suggestions and guidelines to aid practitioners wishing to implement a similar approach.

20 **Key words:** Technology enhanced learning, assessment, constructive alignment, module development, foundation organic chemistry, multiple choice question quizzes.

Research question

How effective is the use of technology in assisting peer learning and the alignment of learning and assessment in a first year, large class, foundation organic chemistry module?

Introduction

Development of an active, engaging and aligned learning environment can be a difficult task for academics; however, the selective inclusion of appropriate technology can enhance student involvement and improve alignment between the learning activities and the method(s) of assessment. It is important that this technology incorporation does not detract from the pedagogy, instead it should add to the teaching approach (Watson, 2001). Ideally, the pedagogy and technology should sustain a symbiotic relationship, which is of benefit to the student cohort and the academic (Dunne and Ryan, 2012).

40 Enhancing learning through technology integration

One such appropriate pedagogy is social constructivism; in this teaching approach the students, facilitated by the academic, work together to build on their known knowledge to bridge the gaps in their understanding (Palincsar, 1998). Biggs (2002) outlines the principles of a constructivist-based and aligned curriculum and suggests that the learner “*constructs meaning through the learning activities*” in a suitable space fostered by the academic. Through the careful use of technology, this space could be a

technology enhanced lecture hall or an online, virtual learning environment.

Aligning learning and assessment.

Assessment is an inescapable fact of education. Although it cannot be removed entirely from a curriculum, subtle changes can result in positive outcomes not only for the student, but also for the academic. Correct alignment of the learning outcomes with the assessment, the assessment strategy itself and also the quality of feedback provided to students can all influence the overall perception of assessments by students (Gibbs and Simpson, 2004). The view of students is often “*what do I have to do to pass the exam*”, or “*is this topic/concept on the exam*”, which chime with Bouds (1998) and Gibbs and Simpsons (2004) commentaries on assessments.

Academics should endeavour to address this prevalent student opinion by carefully selecting appropriate learning activities and aligned assessments that correctly, and fairly, appraise a student’s attainment of the learning outcomes. Without correct alignment the student will question the need for certain topics/group-work/assignments within a course; this questioning can lead to disinterest, lack of motivation and, ultimately, disengagement (Astin, 1999).

Technology enhanced assessment.

The use of technology to enhance an assessment can range from very simple automated scoring, through instant feedback provision upon assessment completion, to complex simulation

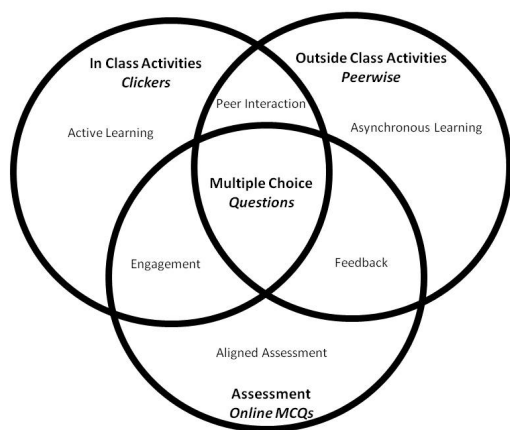


Figure One: Schematic of the interrelationships between the three technologies, their uses and the activities associated with each.

environments that adapt to the participants level of understanding (Tippins, 2011). Careful integration of an appropriate technology into an assessment can be beneficial to the student and the academic. Students benefit from an alternative assessment approach; for example e-portfolios can be used to document a students learning journey in a more accountable and creative manner (Wickersham and Chambers, 2006). A more common example is the use of MCQs with instantaneous scoring and automated feedback enhancing the student assessment experience (Higgins and Tatham, 2003). A technology enhanced assessment, however, need not be restricted to a right/wrong or closed answer model. The use of technology can allow sophisticated questions, with complex answers, to be asked and discussed. For example, assessments based on Web 2.0 technologies (blogs, wikis and web hosted discussion fora, etc.) allow students, and academic moderators, to delve deep into a topic promoting meaningful social knowledge construction either synchronously or asynchronously (Grosbeck, 2009). The ability to engage with an assessment, either individually or collaboratively, anytime and anywhere promotes freedom, autonomy and gives the responsibility for learning back to the student (Bates, 2011). The profit for the academic is a reusable, adaptable and engaging assessment; however, technology enhanced assessments are not a panacea for all assessment issues. The initial learning curve for the academic, the unbalanced work load in terms of resource preparation and the development of appropriate assessment rubrics are all hurdles to be overcome (Tyagi and Kumar, 2011).

Purpose of this research

Case study population

In this case study the effect of integrating three types of aligned technology into the teaching and assessment of a first year, second semester, foundation organic chemistry module was investigated. This module was delivered to a mixed class of students (Level 6, Certificate and Level 8, Honours Degree based on the Irish National Framework of Qualifications) for two hours per week over the course of a twelve week semester. The module also entailed two hours of aligned laboratory work. The module assessment weighting was split evenly between the lecture and laboratory components. The modules primary aim was to allow the students to develop their understanding of the nomenclature, classification, structure and properties of common organic compounds. Additionally, students investigated the fundamental reactions and the syntheses of organic compounds leading to a

comprehension of the underlying reaction principles on a theoretical and practical level and subsequently develop an ability to predict simple organic reactions. The module was contextualised to the various groups within the class (pharmaceutical, food and nutraceutical) and followed-on from introductory chemistry modules delivered concurrently and in the previous semester.

Rationale for change

After a number of deliveries of this module, several re-occurring issues became apparent. The students, although they engaged with in-class and out of class non-graded written activities (e.g. individual written worksheets) throughout the semester, did not perform as well as expected in the traditional terminal exam. Furthermore, although in-class activities were carried out, the overall level of social knowledge construction (e.g. pair-sharing or group work) was poor as the students could not see the point in carrying out the activities. There was some *ad hoc* social knowledge construction for the outside class activities (e.g. over coffee or breaks in class); however, this was limited to a small number of the class. Finally, it was difficult to pace the lectures appropriately as the students were receiving an aligned, concurrent basic chemistry module which resulted in some topics requiring additional time and others less. Gauging the overall student prior knowledge or current understanding was challenging for this large (n=139) and mixed-background class.

Pedagogical change: Technology enhanced peer learning and assessment

In order to address the deficiencies listed above the module was redesigned in line with best quality assurance practices within the Institute. Feedback was provided on the module strengths and weaknesses by students who had just completed the module as per standard practice within the Institute. Inclusion of student input into the redesign of a module is important as Barnett and Coates (2005) note that students must be actively engaged in curriculum development in order for positive outcomes to be achieved within the student population. This is most effectively achieved by including students as integral parts of curriculum (re)design and as key drivers of the "living curriculum" (Barnett and Coates, p.2, 2005). Student feedback, along with personal and colleague observations, provided the foundation upon which to build the redesigned module. Three major module changes were enacted, which were mirrored by the integration of three new and aligned technologies (see Table One and Figure One).

Pedagogical Evaluation Methodology

Pedagogical evaluation followed best ethical practices, and conformed to the Institutes Research Ethics Guidelines (DIT Research Ethics Committee approval number: 65/10). The data collected took several forms; an anonymous multiple choice questionnaire (n=130), an independent academic facilitated discussion forum (n=15), an anonymous evaluation sheet (n=120), an anonymous standard institute module review form (n=44) and a personal reflective diary (n=1). All data were collected once the students had completed the module with the exception of the reflective diary, which was recorded on an on-going basis. The reflective diary recorded 'informal' discussions with students, personal observations and comments. Students were asked for verbal consent to allow the researcher to record an interesting or relevant point raised during an informal discussion. Qualitative data were coded into several key themes and sub-themes based on researcher interpretation. Data triangulation was carried out during qualitative theme coding to ensure only valid

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themes were investigated and the examples and findings are based on feedback from as broad a student base as possible.

Limitations

5 This study was carried out at a single institution, focusing on a single module. Additional studies can be carried out to investigate the applicability of this approach in other education settings and levels.

10 The researcher was also the lecturer involved in delivering both the theoretical and practical elements of this module. Pedagogical evaluation data were collected anonymously where possible (written reflections or online survey) or by an independent colleague (discussion forum); however, student and participating researcher bias cannot be totally discounted.

Pedagogical Evaluation Results

15 The data collected were classified into general themes, below, and included positive and negative aspects of the student learning experience (see Table Two).

Alignment to assessment

20 The central purpose of the redesigned module was to implement an aligned learning and assessment strategy. This was heavily influenced by the use of technology, both in the learning and assessment elements. As such, it was crucial that the student became comfortable with the technologies and at ease in their use as an assessment tool. Additionally, their continual use provided peace of mind to the academic that the technologies could be relied on in an assessment situation. Students developed their understanding as well as their confidence over the course of the semester through engagement with the peer learning technologies; which resulted in a more prepared and relaxed student attempting the graded continual assessment (CA) components. Student comments included “They [Clicker activities] were like a mini-test every week, without the stress” and “after using PeerWise I learnt that I had to take my time and investigate each option before selecting and this helped me in my graded MCQs”; one student commented that overall “the pressure is less as you have practiced and prepared so much with Clickers, PeerWise and the small MCQs, you know you’re ready for it [high stakes MCQ]”

Engagement

45 Engaging students inside, and particularly outside, the classroom can be difficult to achieve (Summerlee, 2010). One method is to provide aligned activities for students to work on either alone, or in this case, in groups. The technologies used in this case study provided a way for the students to engage with the learning activity with minimal additional academic workload. Student-student engagement was central and students engaged with each other and the content through questioning, answering, commenting and discussing MCQs. The introduction of technology into the module had an overwhelmingly positive effect on students; this was mirrored in the data collected by all methods. In particular students enjoyed the use of Clickers in the classroom; although perhaps the student’s enjoyment of Clickers could also be attributed to a novelty factor. Many students simply

stated that Clickers “added some fun to the classroom” and that using Clickers was “something different” compared to a more traditional didactic lecture. Care must be taken to use technology enhanced learning activities where appropriate and not to overuse them. For example, in this case study Clicker MCQs were based on the topics discussed in the previous fifteen minute section and provided a safe environment for the students to use their knowledge to answer a question. Students appreciated this and commented on how Clickers encouraged them to actively use their knowledge; one student commented “I like doing Clickers exercises in class, it keeps me engaged. It’s good when you first hear the lecture and then put it into practice”. Furthermore, student anonymity afforded by the use of technology allowed quieter students to engage without fear or embarrassment and that every student’s opinion counted; “I felt like my response was important to the class”. Finally, the ‘anytime, anywhere’ nature of the asynchronous technology enhanced learning and assessment activities suited the students lifestyle where many juggled part-time work with college studies and was well received by the students in their module evaluation.

Gamification.

80 Console based gaming has also developed rapidly, with several companies offering high resolution, interactive and engaging games (for example; Nintendo *Wii*, Sony *Playstation*, Microsoft *Xbox*; Prakash et al., 2011). Although educational activities could never compete on the same entertainment level as these consoles, in this case study, students did note associated feelings of challenge, empowerment and reward upon completing either a single MCQ or an entire set. For example students noted that the Clickers introduced a challenge and reward system into the classroom: “Clickers made class more exciting as we wanted to get the right answer”. Furthermore, many students recommended including Clicker additional ‘games’ (e.g. class A vs class B) in the suggestions section of the anonymous evaluation sheet.

PeerWise inherently contains gaming elements, ranging from simple score keeping to rewards for attainment of selected criteria. Echoing video games, the format encourages the user to continually engage with the content, leading the user onto the next question and deeper into ‘game’ and the subsequent learning spiral. Student comments reflected this also; “PeerWise felt like more of a game than an exercise”! Students felt proud of their achievements within the different ‘games’; for example their group answering a Clicker quiz correctly, receiving a reward badge in PeerWise or achieving a good score in an online MCQ assessment. Some students became very involved in the ‘game’ and the attainment of the ‘reward’, which subsequently lead to deep independent learning. For example, within PeerWise the reward for some students was the peer rating attached to each question; students competed to have the highest rated questions. Additionally, and in line with other social media platforms, users could follow people they like. As PeerWise is anonymous, students followed students whose questions (style or content) they liked. Again this was an indication of status within the PeerWise environment: “I spent a lot more time reading about the topics than I did for other modules because I was trying to come up with really good questions. I liked to get a good rating

for my questions and have people follow me. It meant that they enjoyed my questions and learnt something from them". This trend of the importance of peer learning was also a common theme noted in all forms of the student module evaluation.

Peer learning

Students enjoyed the ability to discuss relevant topics with each other both inside and outside class. Once correctly facilitated by the lecturer, peer learning took place naturally in either environment as students worked through a problem together. One student comment noted the benefit of working with peers as "different opinions were introduced which opened my mind to new ways of thinking about a topic". However, the majority of student comments focussed on the benefit of asynchronous peer learning enabled by PeerWise. Within PeerWise students worked and learned 'together' asynchronously; although an apparent contradiction, students benefitted from almost constant peer support through feedback, comments and additional online assistance (grading of questions, tagging topics etc). One student comment succinctly summarised the benefits of PeerWise: "It was like having a teacher with you at home when you logged on". Students actively supported each other in question design, creation and feedback. Additional commentary was often provided in an attempt to clear up any misunderstandings about a question. A small number of students questioned the benefit of working with peers, although a mix of learning styles will be present in every class, this preference for solo work may be a hangover from the second-level educational system which most of these students experienced. In this education system many students are 'spoon-fed' information from their teacher with little time provided for peer-discussion or constructive learning (Scharle and Szabo, 2000). These students have simply not experienced the social constructivism pedagogical paradigm and may be unwilling, or unwanting, to try it. Typically, these students did not take responsibility for their learning; instead they were passively relying on the academic to provide all the relevant information.

Student responsibility for learning

The redesign of the module through technology enhanced learning and continual assessment component appealed to most students and encouraged them to become responsible and autonomous learners. Over all the forms of module evaluation, students noted the technology enhanced learning activities were an engaging way to apply their knowledge in a safe environment. As part of these activities the student groups actively took responsibility for their learning by assisting each other through construction, answering and discussion of multiple choice questions. Students commented that in class discussion and online feedback assisted them in developing their personal understanding or highlighting areas that required them to do additional, independent and self directed learning. PeerWise provided clear evidence of students taking responsibility for their learning. PeerWise was run as a student-centred and student controlled online environment. Although a small assessment weighting (4% on a sliding scale) was associated with minimal engagement (ask six questions and answer six questions) the majority of students interacted far beyond the minimum. Instead, PeerWise acted as a place for students to interact with each other and allowed peers to assist each other in their learning. Students often created questions for their peers on topics that they themselves struggled with. To create these questions students carried out independent learning to deepen their understanding. This approach of focussing on problem areas allowed students to take responsibility for their

learning in small, defined blocks. The use of technology offered a dissemination method for a student's study, a way to showcase their learning and assist others who were struggling with similar problems. One student comment highlights the development of student responsibility: "It [PeerWise] makes you think for yourself, not having a lecturer always telling you the answer shows us how much we actually know and can do on our own".

Discussion

As outlined in the rationale, the reasons behind the proposed module changes are several-fold; however the common theme was to improve the learning experience of the students. This was achieved through aligned learning and assessment (e.g. linking lecture content to the subsequent technology enhanced learning activity and associated assessments), improved organisation (e.g. scaffolding of the content and use of technology to highlight areas of misconception), improved assessment feedback (e.g. formative feedback after completing an MCQ), blended learning (e.g. increased use of the Virtual Learning Environment and other online resources) and the use of engaging technologies (e.g. Clickers and PeerWise).

Despite a positive evaluation by students and observed improvements in student engagement with, and preparedness for, the redesigned assessment strategy students will always be heavily influenced by how a module is assessed. Ramsden (1992; p.187) noted "from [the] students' point of view, assessment always defines the actual curriculum", and in many ways this is still true for the redesigned module described here. Although the majority of students appreciated the technology enhanced, aligned learning activities and the re-designed assessment strategy, a small number of students still remain 'slaves' to the assessment. One student comment, collected in the anonymous survey, highlighted this: "The lack of an end of module exam really influenced my lecture attendance; I didn't attend as many lectures as I would have normally if there was an exam at the end".

Overall, in this study at least, student responses noted positive experience following the re-designed module; engaging in technology enhanced activities both inside and outside class, identifying their learning gaps and using social technologies to take ownership of their learning: "Initially I thought this module was going to be impossible until I saw the breakdown of the module; how we we're going to learn and be assessed. This made it much more do-able". With correct alignment of the curriculum, through suitable learning activities, to the assessment (and not the other way around) students were encouraged not to see the assessment solely as the principle outcome of the module. An important aim of assessment is to "engage students in intellectually challenging tasks that are realistic and relevant in the context of a discipline" (Webster, 2007; p.2). The academic must define suitable assessments that seek to uncover the student's true understanding of the module and achievement of the learning outcomes. By maintaining a level of challenge, reality and relevance in the assessment the benefit of the assessment will be more obvious to the student. In this study several students commented on the challenge (and reward) of MCQ based learning and assessment. The level of challenge and reward must align to the standard of student. Nobody would play a game that was too easy or too hard; there must be scope for success. MCQs are often considered low level assessment, based on fact regurgitation; Gibbs (1992; p10) outlined the potential issues with such an assessment:

"Assessment systems dominate what students are oriented towards in their

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learning... students often recognise that what is really necessary is to memorise”

To avoid this situation careful learning activity and assessment design must be considered. In this study students commented that they could not answer the assessment MCQs just by learning the notes, they had to apply their knowledge. The inclusion of higher order skills into the MCQ design can elevate this learning and assessment method from fact regurgitation and a memory game. Encouraging active student participation in the MCQ process, through question and feedback design, can further heighten cognitive processes used by the student and subsequently deepen their learning (see Table Three).

The importance of feedback featured heavily in all sources of student module evaluation and is consistent with Higgins and co-workers (2002) work which noted the positive impact feedback had on students in higher education. Higgins and colleagues noted that the modern student in higher education is highly motivated and will actively seek feedback as a means to improve their understanding of the content and help them to engage with their subject in a 'deep' way. In this study feedback was available through many avenues from two primary sources; lecturer provided or peer provided. Initially the students depended heavily on lecturer feedback, however, with time and experience students became accustomed to providing and receiving peer feedback. In this study the relationship between lecturer and student group evolved from Wood's (1987; pg. 242) symbiotic relationship where 'the teacher and student collaborate actively to produce a best performance', to a more student centered collaboration with the academic acting as facilitator and background moderator.

Recommendations for Practice

Redevelopment of a module to align learning activities and assessment takes time. The inclusion of technology may speed up this process and should not be considered an inhibitory factor (Dunne and Ryan, 2012). A mixture of free and purchased technologies are outlined in this case study; however, there are several free or cheaper alternatives for the purchased technologies (e.g. *Socrative* (www.socrative.com) could be used as a substitute for Clickers and *Moodle* could be used for a purchased VLE). Whichever technology is chosen, there will be a learning curve associated with it. The academic should ensure that they are comfortable with each technology before they introduce it to the class. This is particularly important when dealing with graded assessments for large classes; any problems (e.g. non-functional MCQ) will be magnified resulting in frustrated students and additional stress for the academic. Table Four describes the use on a practical level and Table Five outlines some technology specific recommendations for practitioners interested in applying this approach as based on suggestions from this study.

Conclusions

In this study, three technologies were used in aligned and orchestrated manner to enhance the student learning and assessment experience in a foundation organic chemistry module. The technologies used in the learning activities encouraged

students to work collaboratively and socially to construct their knowledge. These learning activities were aligned to the continual assessment methodology, which was also technology based. Student evaluation of the technology integration was, in the majority, positive; from an academic perspective increased engagement and student responsibility for learning was observed. Overall, students enjoyed learning with their peers in a safe, technology enhanced environment.

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