

PeerWisdom: Collaborative online Learning in Biology

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Engagement for effective learning

As course organiser for large genetics and molecular genetics courses, I subscribe to the view that passive learning is rarely effective and that we should strive to engage, even to make the learning process enjoyable, and that learning method should be adaptable in order to capture diverse personal styles. One basic premise of the long-standing idea of constructivism holds that understanding is built, rather than received, and the literature is unequivocal about the learning benefits of student interaction, both between peers and with the instructor. The benefits of using clickers within lectures is now well established (Draper and Brown 2004) with a variety of novel ways to increase interaction also reported (Steinert and Snell 1999). I have used interactive voting clickers in my lectures for ten years, often to provoke consideration of the lecture topic (particularly with large classes), but for various other purposes including stimulating bioethical debate (with a smaller class). Strategies such as audience participation, striking visuals, videos, humour, real life examples and class consideration of reflective questions all prove popular with my students. Having engaged students during lectures, however, how can we help them to maintain that whetted appetite during the slog of ongoing coursework and revision throughout the course? This is a particular problem for large classes where low staff-to-student ratios preclude frequent individual support. One solution is to encourage peer-to-peer interaction and to cultivate an ongoing “community of practice” (Wenger 1998). Although collaborative learning has proven difficult to define, the benefits of working with others on a learning task are generally accepted (Dillenbourg 1999). PeerWise is an online learning tool that fosters such collaboration within the class, and also provides significant academic benefits. Using PeerWise, students can work flexibly and at their own chosen level, on topics of special interest to them (often incorporating humour or outside interests into their outputs), but always in collaboration with their peers.

PeerWise encourages student engagement and collaboration between lectures

PeerWise, originally developed by Paul Denny for computing science students (Denny *et al.* 2008), has students creating, sharing, evaluating and discussing course-related multiple choice questions and is rapidly being adopted for teaching across disparate disciplines worldwide (PeerWise community website). As a result of a hands-on Peerwise workshop and my subsequent involvement in a cross-college PeerWise implementation project (Hardy *et al.* 2014), I realised that PeerWise had great appeal with my students as well as significant learning benefits. Researching and articulating a question demands a sound understanding of not only the correct explanation but also of the common pitfalls

(Fellenz 2004), while defending of the answer during further discussion can lead to a higher level of clarity as well as opening fresh lines of thought. The online anonymity of the tool allows all students to interact as equals, while the “gaming” style might encourage the participation of traditionally less engaged students. I introduced PeerWise into my large second year genetics course (~300 students) in 2010-2011 as part of a raft of ongoing course work changes, also including self-marking, peer-marking and an online data-handling test: designed to improve course-wide student engagement and timely feedback in the most effective yet manageable way.

Effective PeerWise engagement led to significant all-round academic improvement

Introducing PeerWise to my course was easy, involving five minutes at the computer terminal and fifteen minutes of explanation, advice and encouragement during the opening lecture. After this PeerWise acts as a self-policing student space, providing students with ownership, and requires only the occasional well-spaced reminder before downloading final marks. We looked, in a variety of ways, for associations between effective PeerWise use and academic performance; looked in depth at the importance of student question quality; and looked for benefits of providing extra support. This work was done using data from three successive cohorts of second year genetics students, and demonstrated PeerWise to be a highly successful teaching aid. Students are engaged with the tool, adapting questions to suit their interests (inventing a muggle vs magic gene illustrated on a Harry potter family tree for example) and frequently employing humour within their questions. Student participation provides a bank of questions that grows in parallel with every part of the learning (lectures, tutorials and practicals) as the course unfolds. Moreover, we have found that the effective engagement of our students associates positively and significantly with high performance not only in the multiple-choice component of the course but with course-work, exam essay, exam problem and overall course marks. This effect is fairly consistent across three iterations of the course (Table1).

Academic Year	Exam MCQ marks	Exam Problem Question marks	Exam Essay marks	Overall Exam marks	Coursework marks	Overall Course marks
2011	0.186**	0.187**	0.052(n.s.)	0.204**	0.156**	0.192**
2012	0.213**	0.101(n.s.)	0.181**	0.241***	0.231**	0.241***
2013	0.166**	0.117*	0.143*	0.197**	0.323***	0.195**

Table 1: r values from first order partial correlations (one-tailed) between PeerWise Score and several GGA course components, controlling for prior ability. PeerWise marks were subtracted from coursework marks and final course marks for the purpose of these analyses, as they themselves contribute a small percentage. Significant correlations are shown in bold. p<0.05 * p<0.01 ** p<0.001 *** not significant (n.s.) (McQueen *et al.* 2014).

Using our own question quality rating scheme that recognizes the cognitive learning domains of the revised Bloom's taxonomy (Anderson *et al.* 2001), we found that only a third or less of our students were using simple factual recall in their questions with the majority of students entering higher learning domains (McQueen *et al.* 2014). Moreover, we found that students' assessments of each others questions were strikingly correlated with our measurements of quality, indicating that such time-consuming question assessments by staff are not necessary. We also found that our additional support sessions led students to spend more time on PeerWise but not to further improve marks. Both of these latter findings support the notion that PeerWise is highly effective without significant instructor input or scrutiny, making it also very attractive to over-stretched academics.

Students appreciate the benefits of PeerWise and commend its use.

In the 2011 and 2012 end of course student questionnaires, more than 90% of respondents agreed that PeerWise had improved their understanding of the course "a lot", and quotes from the free response section included:

"PeerWise is a really good idea, kept me actively involved with the course"

"I started using Peerwise around week 2 and I found it a lot of fun - it not only allowed me to check my understanding of the course material but it also allowed me to be a sort of a critic".

Each year one or two student PeerWise question(s) were used in the final exam. Students liked this recognition, and the fact that questions were of sufficient quality testifies to student application to the task.

In response to a class competition 2013 students constructed written and video PeerWise guides (from a student perspective), three of which are now available to our new PeerWise users. The majority of responding students from the 2013 class have said that they would have supported PeerWise introduction into the assessment profile of their third year course.

Happily, we were able to include one undergraduate honours project student in our PeerWise engagement research team for 4 months. This afforded us access to an insider view (as this student had himself been a PeerWise user), and gave the student co-authorship of a pedagogical paper: unusual in our wet research-led environment.

PeerWise scoring systems and differential benefits require consideration

In 2013, the overall quantity of student PeerWise contribution was significantly higher than in previous years. However, opinions expressed in student feedback were divided between negative and positive viewpoints, and anxieties over scoring, which is dependent

on peer ratings, were high. This situation led us to reappraise our implementation and to introduce a transparent scoring system and a cap on activity; a system that has been adopted by four more biological and biomedical science courses introducing PeerWise for the first time this year.

Although engaging with PeerWise improves course scores for students of all ability levels, the difference is only significant for two quartiles in our study (McQueen *et al.* 2014). This inconsistency of benefits across students of different prior abilities, also recognised by others (Denny *et al.* 2008, Bates *et al.* 2012, Hardy *et al.* 2014), suggests that further improvements might be possible, by targeting students from those quartiles showing less improvement; an area for possible future study.

PeerWise is an excellent tool, but one of many.

Despite there being some work to do to reap the maximum benefits of PeerWise, this tool has more than paid its way in terms of costs versus benefits, being free, light on time-commitment and richly beneficial to students. Benefits from engaging with PeerWise include academic improvement, and student enjoyment, and possibly unseen benefits of improvement in collaboration skills and in building a sense of community (Anderson *et al.* 2001b). Although introduction of PeerWise on this course has proven to be both simple and effective it seems important to remember that this and our other engagement-improving measures, such as self-marking and online peer-marking, are just tools; none of which are universally applauded by all students; and none of which will ever fully substitute for a person to person discussion.

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