

Student authored and critiqued multiple choice questions benefit examination performance in anatomy – a pilot study

Paul M. Rea*
*School of Life Sciences,
College of Medical, Veterinary and Life Sciences
University of Glasgow, UK*
Paul.Rea@glasgow.ac.uk

John D. McClure
*Institute of Cardiovascular and Medical Sciences,
College of Medical, Veterinary and Life Sciences,
University of Glasgow, UK*
John.D.McClure@glasgow.ac.uk

Abstract

PeerWise is an online system in which students create, answer, rate and discuss each others multiple choice questions (MCQs). This system was trialed during a five week Student Selected Component (SSC) in anatomy for third year medical students. Participation was on a voluntary basis and did not contribute to the final examination mark. Of the 52 students enrolled, 39 (75%) registered to use PeerWise and created a bank of 38 questions. Some students wrote several questions and others none. We found that of those students who created one or more questions, they scored higher marks in the examination than those who did not ($p = 0.001$ for percentage attained in examination). For those who created at least one question, the score increased by around 14%, although only slightly less than one-fifth of the participants submitted questions. In addition, submitting more than one question did not correlate with improved examination score ($p = 0.922$). Although all registered participants answered the majority of the generated questions, no correlation was shown between improved examination performance and the numbers of questions answered ($p = 0.763$ for examination score). Although this is a pilot study, and participation is small, it does

*Corresponding Author

have some interesting preliminary results. We have shown that students who write and, to a lesser extent comment on questions in PeerWise, score higher marks in the final examination. This could be related to higher cognitive level engagement with the course material encouraged by the use of PeerWise.

Key Words: PeerWise, multiple choice questions, MCQ, examination performance, student-centered

Introduction

Anatomy education in the medical curriculum has undergone major changes in recent years. Several years ago the General Medical Council issued guidelines to medical schools in the United Kingdom (GMC , 1993) requesting a reduction in the amount of factual information (Utting & Willan, 1995; Dangerfield, Bradley & Gibbs, 2000). This is a similar situation which has occurred globally in many medical schools (Collins, Given, Hulsebosch & Miller, 1994; Utting & Willan, 1995; Holla, Selvaraj, Isaac & Chandi, 1999; Dangerfield, Bradley & Gibbs, 2000; Fitzgerald, White, Tang, Maxwell-Armstrong & James, 2008). However, medical training programs also began to change from a conventional, subject based approach to an integrated curriculum with various teaching methodologies adopted (Schmidt, 1998; Ling, Swanson, Holtzman & Bucak, 2008). More recently in the UK, Tomorrow's Doctors 2009 has placed more emphasis on the basic medical sciences related to clinical practice. This directly reflects students, clinicians and professional anatomists' viewpoints that the anatomy content had been significantly "dumbed down" previously (Fitzgerald, White, Tang, Maxwell-Armstrong & James, 2008; Patel & Moxham, 2008).

Coupled with anatomy being taught in very different ways depending on the institute and facilities available, there are many forms of assessing anatomy within the medical curriculum (Norcini & McKinley, 2007). One such format is the multiple choice question (MCQ), seen in undergraduate and postgraduate medical and surgical examinations (Muller, 1984; Farley, 1989; Wass, van der Vleuten, Shatzer & Jones, 2001; Dillon, 1990).

MCQs have many established benefits whereby they can be machine read, have perceived objectivity, can cover a wide range of course content and are a reliable and valid measure of knowledge (Saunders & Walstad, 1990; Bridgeman & Lewis, 1994; McLeod & Snell, 1996; Kuechler & Simkin, 2003). Indeed, Draper (2009) showed that MCQs have great advantages for enhancing deep learning as they can focus on learning relationships between items rather than on simply recalling disconnected items that may only be true or false.

Traditionally, MCQs have been constructed by teaching staff and used for summative assessment. Currently however, there is a shift in opinion to that of student generated MCQs to aid engagement in both learning and assessment (McLeod & Snell, 1996; Senanayake & Mettananda, 2005; Sivagnanam, Sarawathi & Rajasekaran, 2006; Blake, Rashid, Curley, Morley, & Holmes, 2008). This allows students to try out questions designed by colleagues, and provide comments to each other. This is consistent with a philosophy of students making an active contribution to learning (Hamer et al., 2008) and also offers four dimensions of self-directed learning by providing personal autonomy, self-management, learner control and an independent approach (Candy, 1991).

This idea of a contribution-based pedagogy is where the student group engages in activities involving the creation and sharing of learning resources used by each other (Collis, 2005; Hamer, 2006). This contribution should be peer reviewed and has a number of benefits. It encourages the development of higher order cognitive processes such as continual evaluation, reflection and critical thinking. By involving the student in the writing of MCQs, encourages engagement with course material, an excellent learning experience and provides immediate feedback to the student on performance and encourages retention of knowledge and appreciation of inaccurate responses (McLeod & Snell, 1996; Epstein et al., 2002; Denny, Hamer, Luxton-Reilly & Purchase, 2008; Denny, Luxton-Reilly & Hamer., 2008a,b; Pittenger & Doering, 2010). Nowadays, with the increased use of technology in education, it provides a unique opportunity to enhance deep learning of our students through novel methods.

PeerWise is a widely used web-based program which allows students to create, answer, explain, rate and discuss MCQs (Denny, Hamer, Luxton-Reilly & Purchase,

2008; Denny, Luxton-Reilly & Hamer., 2008a,b). It is completely anonymous to fellow students, with a tutor providing login details for the course, and each student creating their own unique username and password. The tutor will have access to whose student identification number correlates to their username, though will not have access to the students' password. After answering a question, the student can also assign a quality rating and provide anonymous written comments to the author. PeerWise has proved successful in creating a large repository of questions in a matter of weeks without guidance or instruction by the tutor or staff member, although the tutor can "monitor" activity to ensure appropriate behavior (Denny, Hamer, Luxton-Reilly & Purchase, 2008; Denny, Luxton-Reilly & Hamer., 2008a,b; Denny, Hanks & Simon, 2010). It has previously been shown that students enjoy using PeerWise (Denny, Hamer, Luxton-Reilly & Purchase, 2008; Denny, Luxton-Reilly & Hamer., 2008a) and create high quality questions (Denny, Hamer, Luxton-Reilly & Purchase, 2008; Denny, Luxton-Reilly & Hamer., 2008a; Purchase, Hamer, Denny & Luxton – Reilly, 2010). Statistically significant correlations exist between the use of PeerWise and improved examination performance (in computing science classes), including that of non-MCQ based examinations ((Denny, Hamer, Luxton-Reilly & Purchase, 2008).

The purpose of this study was to test whether participation in PeerWise by a group of third year medical students from an intensive five-week student selected component (SSC) in head and neck anatomy correlated with improved examination performance.

Materials/Methods

Participants

At the time of this study, the medical undergraduate degree was of five years duration and the student selected components (SSCs) comprised 15% of the entire curriculum. Five SSCs had to be completed by the students in an area of interest to them: one in second year, and two in both the third and fourth years of the course. The student could choose an established option, or when more senior, self-propose a topic provided they had a willing supervisor.

One established SSC was in head and neck anatomy entitled “A Nodding Acquaintance: Structure and Function of the Head and Neck” offered to students in their third year, and covered the gross anatomy and clinical applications of head and neck structures. Fifty-two students selected this module representing 19.8% of the whole medical year. The instructor and author of this manuscript (PR) delivered the teaching of this SSC with two other colleagues. Over the first four weeks, there was 12 hours of teaching each week: three one-hour lectures, three two-hour dissection classes, one one-hour prosection class and one two-hour prosection class. The final week was when examinations were conducted. The examination comprised of a one hour written paper (short notes style) and a 20 station “spot”, where on each station two key anatomical features had to be identified on prosected, plastinated cadaveric specimens.

Experimental procedure

The Faculty Ethics Committee, University of Glasgow, approved this research. On the first day of the course, the instructor and author (PR) provided all relevant information as to the background, initial passwords, usage instructions, relevance, past work and applications of PeerWise. Participants were provided with the student information sheet which is available on the PeerWise website. As this was the first time that this system had been utilised with medical students at this university, it was decided that marks scored would not count toward their summative assessment, and participation was entirely voluntary. Questions, answers and comments were automatically made immediately available by PeerWise to both tutor (acting as administrator) and participants. The role of the tutor/administrator was to ensure fair and professional posting of material, and if necessary remove unsuitable posts.

Results

Student engagement

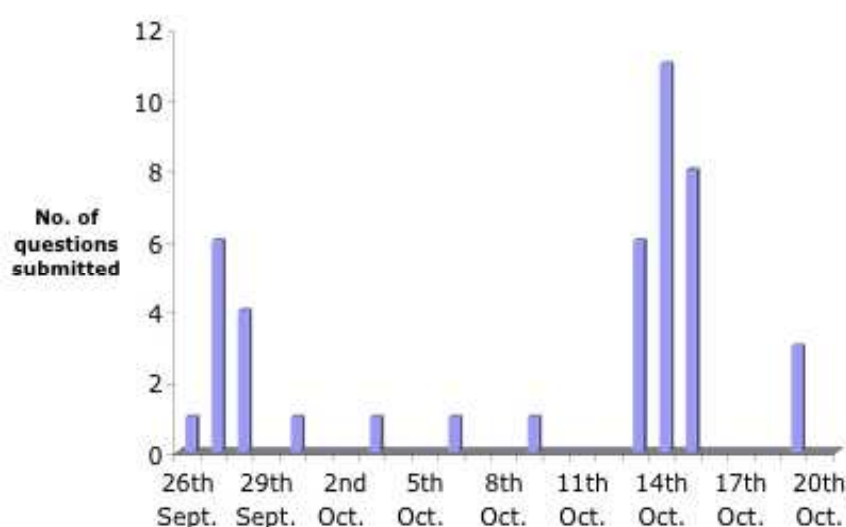
Of the 52 students initially enrolled, 51 completed the course. Of the 52 students initially enrolled, 39 (75%) students registered with PeerWise, and of those registered, all did either one or more of the following: answered, wrote and/or commented on questions.

Thirty-eight questions were submitted by the students with five questions archived/edited because of inaccuracies identified by fellow students. Only 7 (17.9%) students contributed one or more questions, and of these, 2 (0.05%) students contributed to more than half of all questions (57.9%). Ten students (19.2%) provided comments on questions and explanations suggested by classmates. Forty-nine comments were provided in total, with four students providing three-quarters (75.5%) of all comments written. In total, the students produced 1284 answers to the questions written by their peers.

Daily usage patterns

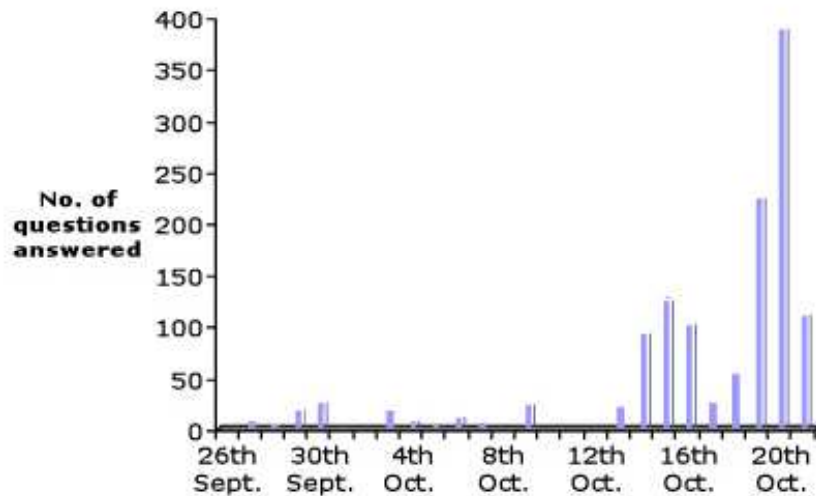
Two peaks were noted when questions were submitted – at the beginning of the second week of the course and on the approach to the final examinations (Figure 1). Almost one-third ($n = 11$; 28.9%) of all questions were submitted at the beginning of the second week, with the majority ($n=25$; 65.8%) being submitted in the penultimate week of the module. In these two peaks, the vast majority of questions were submitted during the week when classes were undertaken (97.2%). Only a single question was submitted at the weekend. The majority of all questions (80.7%) were answered during the final week approaching the examination, including the day of the examination itself (Figure 2).

Figure 1. Number of questions submitted ($n=38$) throughout the duration of the course.



N.b. Note the two peaks – the first at the beginning of the second week, and the other in the final week of the course.

Figure 2. The number of questions answered during the five week SSC (n=1284).

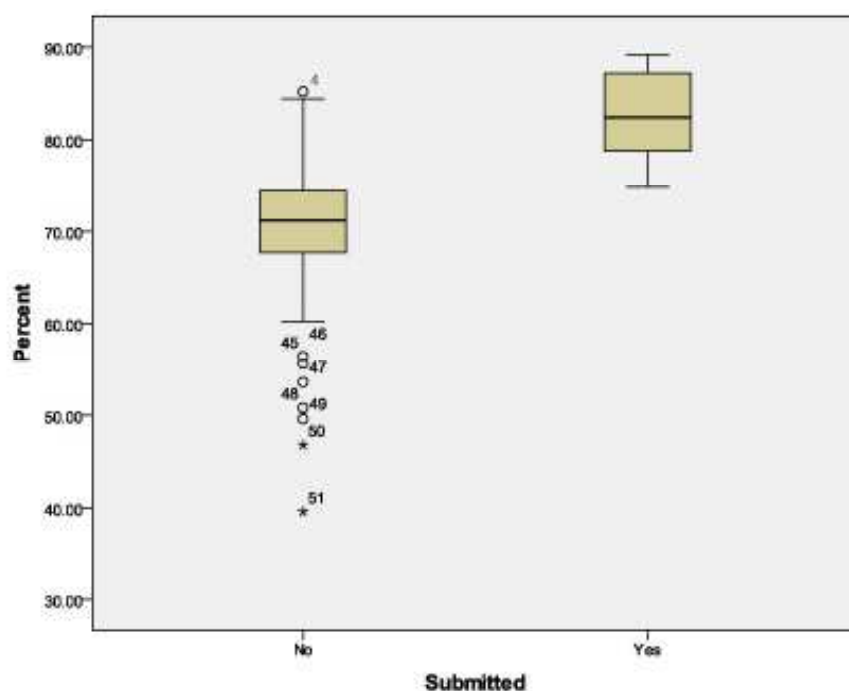


N.b. Note the marked increase in responses as the examination approached.

Correlation with examination performance

The spread of examination marks ranged from 39.6% to 89.2% with those students who submitted one or more questions achieving, on average, 14% higher in the final examination (Figure 3, $p=0.001$). The confidence interval (CI) for this indicates that we are 95% confident that the true value for this increase is between 6 and 21 percentage points higher. The results were very similar for those who submitted comments to questions, if not quite so marked. The majority of those who provided comments on other students' questions performed better in the final examinations by an average of 10% (CI 3 – 17%, $p = 0.007$). Submitting more than one question did not show a statistically significant improvement in examination performance. In addition, simply answering the created questions was not correlated with improved examination performance ($p=0.763$).

Figure 3. Boxplot showing the relationship between each student's final mark as a percentage (Percent) and whether they submitted questions (Submitted).



N.b. $p=0.001$ for Percent; 95% CI for Percent (Yes-No): (6%-21%).

Discussion

There are three main findings from this work. The first is that those who submitted one or more questions performed significantly better in the final examination than those who did not. Secondly, to a lesser extent, those that commented on student questions showed a slight improvement in examination performance compared to those that did not. Finally, performance in the final examination was not related to the number of PeerWise questions answered by the students. We believe that this is the first time that the use of an online repository of student generated questions using PeerWise, within a SSC in the medical curriculum, was related to a higher examination mark.

There has been great debate about the value and meaning of the MCQ examination with many authors claiming advantages (Zeidner (1987); Kreig & Uyar (2001) Epstein et al., 2002; Kuecher & Simkin, 2003; Draper, 2009, Burns, 2010) and disadvantages (Resnick & Resnick, 1992; Paxton, 2000; Wesolowsky, 2000). Usually, students have many opportunities to answer questions but few opportunities to design and construct them (Dillon, 1990; Dori & Herscovitz, 1999). Allowing students to participate actively in

writing questions promotes independent learning (Bruner, 1990; Marbach-Ad & Sokolove, 2000; Pittenger & Lounsbery, 2011). Schodell (1995) and Dori and Herscovitz (1999) state that the central role of education should be in developing an appreciation of posing questions. Several authors have described a wide range of benefits from this method including consolidation of knowledge and understanding, gaining immediate feedback and developing reflective practice (Boud & Falchikov, 1989; Falchikov & Boud, 1989; Topping, 1998). With all of these additional benefits in mind and the increased use of online materials, PeerWise was developed to allow students to engage actively in the question writing process.

There are several interesting points in our results. We have shown that participation in PeerWise, specifically devising questions and submitting comments on fellow students' questions, corresponds with a 14% improvement in examination marks. This is a similar result to that found in computing classes using PeerWise (Denny et al., 2008a-c; 2010). Interestingly, increasing the number of questions submitted was not correlated with a higher examination mark. In fact candidates ranked 4th-6th in examination marks did not submit any questions at all. Denny, Hamer, Luxton-Reilly & Purchase, 2008; Denny, Luxton-Reilly & Hamer (2008a,b) have shown across four computing classes, that although students believe that if they answer more questions, they will improve their examination marks, Denny, Luxton-Reilly & Hamer (2008b) found the opposite to be true.

A positive statistical correlation (improved examination marks) was associated with the question writing aspect of this system. One explanation of this may be that the student has not only to compose the question, but also produce options for the answers and plausible explanations. This engagement requires higher order cognitive processes including evaluation, reflection and critical thinking.

Previously, medical students learning anatomy have shown memorizing strategies in their approach to gaining an understanding of the subject (Pandey & Zimitat, 2007). However, Ramsden (1992) states that this superficial learning never leads to a deep conceptual understanding of the subject, because superficial learners never see the overall picture. It could be suggested that in addition to improved examination

performance, students who engaged with PeerWise have gained a deeper understanding of the subject.

Peer contribution and self assessment has a plethora of benefits. It encourages the formation of a learning community; consolidates understanding; helps to identify misconceptions and areas of knowledge deficiencies; demystifies the learning process; enhance cognitive and meta-cognitive competencies and develops autonomous, independent and reflective practitioners (Boud & Falchikov, 1989; Falchikov & Boud, 1989; Stefani, 1998; Topping, 1998; Birenbaum, 1996). Interestingly, Denny, Hamer, Luxton-Reilly & Purchase (2008) state that peer reviewed engagement with creation of learning resources enhances communication, teamwork, self-assessment, and builds the foundations for lifelong learning – something expected of future doctors as stated in *Tomorrow's Doctors* (GMC, 2009).

This study does have some limitations. The first is that it is an optional module within the medical curriculum. As SSCs within the medical curriculum form approximately 15% of the undergraduate medical curriculum at the University of Glasgow at the time of this study, those students undertaking an anatomically focused module may be more motivated to learn in this type of environment. Indeed, there are many motivating factors for students choosing a specific module during their medical training including future achievements, prior information, recommendation from friends and colleagues, internal driving factors, convenience and certainty (Richardson, 2009). Many of those that undertake an anatomy SSC are already motivated to succeed in this field, perhaps with a broadly based surgical theme as their future careers (Standring, 2009), or because the students identify that there is little in the way of anatomical training in the core undergraduate medical curriculum (Pryde & Black, 2005; Patel & Moxham, 2006). In addition, the use of PeerWise was an optional component of the course, and did not contribute to their final grade for this course. If this had been compulsory, it would be almost certain that usage rates would be higher than that found in this study. Forcing people to submit questions and comment on others could however devalue the process, and encourage tokenistic contributions. Of the 52 students initially who registered for this course, not all actually “signed up” to participate in PeerWise. However, the vast majority of those students did participate in using this tool whether that was question writing, answering their colleagues’ questions or commenting on colleagues’ questions, or a combination of these.

Finally, this is a pilot study and although it does answer some questions in relation to examination performance using this software, it also raises many others. Firstly, a very small number of students repeatedly engaged with the question writing and commenting on other students' questions, and it could be difficult to generalise that to the whole class. It may simply be that those who use PeerWise are more conscientious in their studies and would perform well even if it was not offered as an additional resource. It simply could be that those students who are more interested in the subject and who are more academically able, are willing to use other resources and simply do better in examinations, with or without PeerWise. Therefore, it is difficult to say with this snapshot study what factors may be involved in the use of PeerWise. It is difficult to disentangle these additional factors and it needs further exploration on a larger scale study, comparing previous examination performances from classes who did not use PeerWise, to identify what student approaches to learning are used in the cohort and to assess the contribution, if any, to deeper learning of anatomy and its influence on examination performance using this software.

One approach in testing this further would be in a (preferably randomised) controlled trial in the first instance. However, creating a control group could deprive a cohort of students of a tool which could improve performance, thus creating a disadvantaged group. Also, comparing use with previous or future years would also have drawbacks due to the potential for a plethora of reasons existing for differences in performance over time including student composition, teaching styles, motivating factors and group dynamics of the class.

Conclusion

This study has however shown that of those students who use PeerWise perform better in their examinations than those who do not, though the exact reasons for this could be multi-factorial, and perhaps beyond the extent of this initial study. Further evaluation of PeerWise is needed – in particular there is a need for controlled trials to be carried out, despite the difficulties in designing these. Nevertheless, it does show that those students who have submitted questions, and to a lesser extent provided comments to colleagues' questions and explanations, have gained higher marks in the final

examination. Although our numbers of participation in this pilot study are small, it does hint at potential wider benefits of this tool. In addition, the educational literature has provided support to this learning activity, showing that it results in engagement with the course content, develops both cognitive and metacognitive skills, develops autonomy for their own learning, and also enhances teamwork and communication skills. All of these are essential skills and attributes desirable in our future doctors.

Acknowledgements

The authors would like to express their enormous thanks to colleagues Dr John Shaw-Dunn and Dr Amanda Sykes who helped in reviewing this manuscript, we are most grateful. Conflict of Interest - None

References

- Birenbaum M. 1996. Assessment 2000: Towards a pluralistic approach to assessment. In: Birenbaum M, Dochy FJRC (Editors). *Alternatives in Assessment of Achievements, Learning Processes and Prior Knowledge (Evaluation in Education and Human Services)* 1st Ed. Boston, MA: Kluwer Academic Press. p 3–30.
- Blake K, Rashid M, Curley J, Morley S, & Holmes B. 2008. Bridging the gap: Using student-generated clinical case presentations in pediatrics. *Clin Teach* 5:208–212.
- Boud D & Falchikov N. 1989. Quantitative studies of student self assessment in higher education: A critical analysis of findings. *High Educ* 18:529–549.
- Bridgeman B and Lewis C. 1994. The Relationship of Essay and Multiple-Choice Scores with Grades in College Courses." *J Educ Measurement* 31:37-50.
- Bruner J. 1990. *Acts of Meaning*. 1st Ed. Cambridge, MA: Harvard University Press. p 181.
- Burns ER. 2010. "Anatomizing" reversed: Use of examination questions that foster use of higher order learning skills by students. *Anat Sci Educ* 3:330–334.
- Candy PC. 1991. *Self-Direction for Lifelong Learning: A Comprehensive Guide to Theory and Practice* 1st Ed. San Francisco, CA: Jossey-Bass. 567 p.

- Collins TJ, Given RL, Hulsebosch CE, Miller BT. 1994. Status of gross anatomy education as perceived by certain postgraduate residency programs and anatomy course directors. *Clin Anat* 7:275-296.
- Collis B. 2005. The contributing student: A blend of pedagogy and technology. In: EDUCAUSE Australasia, Auckland, New Zealand.
- Dangerfield P, Bradley P, & Gibbs T. 2000. Learning gross anatomy in a clinical skills course. *Clin Anat* 13:444-447.
- Denny P, Hamer J, Luxton-Reilly, Purchase H. 2008. PeerWise: Students sharing their multiple choice questions. In: Proceeding of the Fourth International Workshop on Computing Education Research (ICER '08); Sydney, Australia, 2008 Sept 6–7; p 51–58. Association for Computing Machinery, New York, NY.
- Denny P, Hanks B, Simon B. 2010. PeerWise: Replication study of a student collaborative self testing web service in a U.S. setting. In: Proceedings of the 41st ACM Technical Symposium on Computer Science Education (SIGCSE '10); Milwaukee, WI; 2010 March 10–13; p 421–425 Association for Computing Machinery, New York, NY.
- Denny P, Luxton-Reilly A, Hamer J. 2008a. The PeerWise system of student contributed assessment questions. In: Hamilton S, Hamilton M (Editors). Proceedings of the Tenth Australasian Computing Education Conference (ACE 2008); Wollongong, Australia, 2008, Jan 22–25; Australian Computer Society Inc. *Aust Comput Sci Comm* 78:69–74
- Denny P, Luxton-Reilly A, Hamer J. 2008b. Student use of the PeerWise system. In: Proceedings of the 13th Annual Conference on Innovation and Technology in Computer Science Education (ITiCSE '08); Madrid, Spain, 2008 June 30–July 2; p 73–77. Association for Computing Machinery, New York, NY.
- Dillon JT. 1990. *The Practice of Questioning*. 1st Ed. London, UK: Routledge. 256 p.
- Dori YJ, Herscovitz O. 1999. Question-posing capability as an alternative evaluation method: Analysis of an environmental case study. *J Res Sci Teach* 36:411–430.
- Draper SW. 2009. Catalytic assessment: Understanding how MCQs and EVS can foster deep learning *Br J Educ Tech* 40:285–293.
- Epstein ML, Lazarus AD, Calvano TB, Matthews KA, Hendel RA, Epstein BB, Brosvic GM. 2002. Immediate feedback assessment technique promotes learning and corrects inaccurate first responses. *Psychol Rec* 52:187–201.

- Falchikov N, Boud D. 1989. Student self assessment in higher education: A meta-analysis. *Rev Educ Res* 59:395–430.
- Farley JK. 1989. The multiple choice test: Writing the questions. *Nurse Educ* 14:10–12.
- Fitzgerald JE, White MJ, Tang SW, Maxwell-Armstrong CA, James DK. 2008. Are we teaching sufficient anatomy at medical school? The opinions of newly qualified doctors. *Clin Anat* 21:718–724.
- GMC, 1993. General Medical Council. *Tomorrow's Doctors. Recommendations on Undergraduate Medical Education*. London, UK: General Medical Council. Retrieved 31 October 2012 from http://www.gmc-uk.org/Tomorrows_Doctors_1993.pdf_25397206.pdf
- GMC. 2009. General Medical Council. *Tomorrow's Doctors: Outcomes and Standards for Undergraduate Medical Education*. 3rd Ed. London, UK: General Medical Council. 104 p. Retrieved 28 October 2011 from http://www.gmc-uk.org/static/documents/content/GMC_TD_09_1.11.11.pdf
- Hamer J. 2006. Some experiences with the “contributing student approach”. *ACM SIGCSE Bull* 38:68–72.
- Hamer J, Cutts Q, Jackova J, Luxton-Reilly A, McCartney R, Purchase H, Riedesel C, Saeli M, Sanders K, Sheard J. 2008. Contributing student pedagogy. *ACM SIGCSE Bull* 40:194–212.
- Holla SJ, Selvaraj KG, Isaac B, Chandi G. 1999. Significance of the role of self-study and group discussion. *Clin Anat* 15:38-44.
- Kreig RG, Uyar B. 2001. Student performance in business and economics statistics: does exam structure matter? *J Econ Finance* 25:229–240.
- Kuechler WL, Simkin MG. 2003. How well do multiple choice tests evaluate student understanding in computer programming classes? *J Inform Syst Educ* 14:389–398.
- Ling Y, Swanson DB, Holtzman K, Bucak SD. 2008. Retention of basic science information by senior medical students. *Acad Med* 83:S82-85.
- Marbach-Ad G, Sokolove PG. 2000. Can undergraduate biology students learn to ask higher level questions? *J Res Sci Teach* 37:854–870.
- McLeod PJ, Snell L. 1996. Student generated MCQs. *Med Teach* 18:23–25.
- Muller S. 1984. Physicians for the twenty-first century: Report of the Project Panel on the General Professional Education of the Physician and College Preparation for Medicine. *J Med Educ* 59:1–208.

- Norcini JJ, McKinley DW. 2007. Assessment methods in medical education. *Teaching and Teacher Education* 23:239-250.
- Pandey P, Zimitat C. 2007. Medical students' learning of anatomy: Memorisation, understanding and visualisation. *Med Educ* 41:7–14.
- Patel KM, Moxham BJ. 2006. Attitudes of professional anatomists to curricular change. *Clin Anat* 19:132–141.
- Paxton M. 2000. A linguistic perspective on multiple choice questioning. *Assess Eval High Educ* 25:109–119.
- PeerWise. 2011. Welcome to PeerWise. The University of Auckland, Auckland, New Zealand. Retrieved 25 November 2011 from <http://peerwise.cs.auckland.ac.nz/>
- Pittenger AL, Doering AH. 2010. Influence of motivational design on completion rates in online self-study pharmacy-content courses. *Dist Educ* 31:275–293.
- Pittenger AL, Lounsbury JL. 2011. Student-generated questions to assess learning in an online orientation to pharmacy course. *Am J Pharm Ed* 75:1-8.
- Pryde FR, Black SM. 2005. Anatomy in Scotland: 20 years of change. *Scott Med J* 50:96–98.
- Purchase H, Hamer J, Denny P, Luxton-Reilly A. 2010. The quality of a PeerWise MCQ repository. In Clear T, Hamer J (Editors). *Proceedings of the Twelfth Australasian Computing Education Conference (ACE 2010)*; Brisbane, Australia, 2010, Jan 18–21; p 137–146. *Conferences in Research and Practice in Information Technology Series (CRPIT, volume 103)*. Australian Computer Society Inc., Darlinghurst, Australia.
- Ramsden P. 1992. *Learning to Teach in Higher Education*. 2nd Ed. London, UK: Routledge. 288 p.
- Resnick LB, Resnick DP. 1992. Assessing the thinking curriculum: New tools for educational reform. In Gifford BR, O'Connor MC (Editors). *Changing Assessments: Alternative Views of Aptitude, Achievement and Instruction* 1st Ed. London, UK: Kluwer Academic Publishers. p 37–75.
- Richardson J. 2009. Factors that influence first year medical students' choice of student selected component. *Med Teach* 31:418–424.
- Saunders P and Walstad. 1990. *Multiple Choice Tests for Principles of Economics Courses in The Principles of Economics Course*. New York: McGraw-Hill.

- Schmidt H. 1998. Integrating the teaching of basic sciences, clinical biopsychosocial issues. *Acad Med* 73:S24-S31.
- Schodell M. 1995. The question-driven classroom: Student questions as course curriculum in biology. *Am Biol Teach* 57:278–281.
- Senanayake MP, Mettananda DS. 2005. Standards medical students set for themselves when preparing for the final MBBS examination. *Ann Acad Med Singapore* 34:483–485.
- Sivagnanam G, Sarawathi S, Rajasekaran A. 2006. Student-led objective tutorial (SLOT) in medical education. *Med Educ Online* 11:7.
- Stefani LAJ. 1998. Assessment in partnership with learners. *Assess Eval High Educ* 23:339–350.
- Standing S. 2009. New focus on anatomy for surgical trainees. *ANZ J Surg* 79:114–117.
- Topping KJ. 1998. Peer assessment between students in colleges and universities. *Rev Educ Res* 68:249–276.
- Utting M, Willan P. 1995. What future for dissection in courses of human topographical anatomy in universities in the UK? *Clin Anat* 8:414-417.
- Wass V, van der Vleuten C, Shatzer J, Jones R. 2001. Assessment of clinical competence. *Lancet* 357:945–949.
- Wesolowsky GO. 2000. Detecting excessive similarity in answers on multiple choice exams. *J Appl Stat* 27:909–921.
- Zeidner M. 1987. Essay versus multiple choice type classroom exams: The student's perspective. *J Educ Res* 80:352–358.