Integrating computer assisted assessment with textbooks and question banks: Options for enhancing learning

James Dalziel
University of Sydney, Australia
& WebMCQ Pty Ltd
www.webmcq.com
jamesd@psych.usyd.edu.au

Abstract

Computer assisted assessment (CAA) can play both formative and summative roles in teaching and learning (eg, practice questions and exams respectively). In either case, the creation of questions (and feedback) is often a time consuming task, and changes in course content or textbooks can necessitate rewriting of questions. One solution to the problem of creating large numbers of multiple choice questions is provided by textbook publishers, who sometimes provide question banks to teachers as an ancillary material when textbooks are prescribed for students in the teacher's course. In some cases in the past decade, computer software has been included for the presentation of material from question banks, but this software has generally been for stand-alone (not networked) computers, and is often not user-friendly.

With the rise of the Internet in education over the past five years, new possibilities exist for the use of CAA over the Internet, and for the integration of textbook question banks with Web-based CAA systems. Advantages of using the Web for integrated question banks and software systems include easier dissemination of questions, greater flexibility for teachers in constructing and editing questions, easier sharing of questions among teachers (both within and between educational institutions), and simplified administration and support of CAA software run over the Web. As a result, it is argued that the integration of Web-based assessment software, question banks and textbooks will be a major development in the coming decade for publishers and teachers in the field of CAA. This change will lead to higher quality questions and feedback, better software tools, and greater sharing of questions among teachers. Some examples of different models for the integration of Web-based CAA and publisher question banks are provided, based on the WebMCQ CAA system, and its use by publishers in Australia and the United Kingdom. Related issues such as necessary systems for sharing of questions, networking of teachers, and copyright are addressed.

Keywords

CAA, Internet, textbook, question bank, WebMCQ, copyleft

Introduction

In a time where teachers and academics are constantly being asked to do more with less, computer assisted assessment (CAA) has been one of the technological tools which has provided some relief for teachers dealing with the assessment of large groups of students. While not all assessment is appropriately conducted via computer, there are certain features of CAA which are especially useful in the current climate, particularly the ability to automate marking.

While summative assessment has been one of the features most widely recognised among teachers as a benefit of CAA (Bull, 1999), formative CAA has much to recommend it for improving learning. Students value the opportunity to test their own knowledge prior to formal exams (Dalziel & Gazzard, 1999), particularly during the first year of university life, where early assessment and feedback is of great importance (Dalziel & Peat, 1998; McInnes, James & McNaught, 1995). A careful integration of formative and summative CAA has much to recommend it as a general strategy for many educational contexts.

However, one of the banes of using CAA is writing appropriate questions, and in the case of formative CAA, providing useful, detailed feedback to accompany automated marking. The time spent writing questions and feedback is occasionally comparable to the marking load required by non-automated approaches, but it is only with large student groups or with the use of questions over many years, that the "cost-benefit" analysis tips in favour of writing material for CAA. Where exam questions cannot be kept confidential, and are not based on simple mathematical/logical constructions which can be easily modified, the time involved in creating new questions for each test can add considerably to the overall time involved in preparing and maintaining test questions. Another time consuming factor is when course content changes, or new textbooks or references are adopted for a course, as this may necessitate the rewriting or new development of questions to suit the changed educational context. An additional problem in many disciplines is keeping questions up-to-date as new knowledge is discovered and existing theories are extended, qualified and challenged.

Publishers, textbooks and question banks

One solution to the problems of writing and maintaining appropriate sets of questions is offered by some publishers who provide question banks as ancillary materials to accompany the adoption of their textbooks for courses. In situations such as these, it is typical for the teachers coordinating a course to receive a question bank from the publisher to accompany a newly adopted textbook. This question bank is normally only available to teachers (not to students), and often provides many questions (typically over 1,000) for use by teachers. Generally these question banks are available only for textbooks targetted at courses with many students, where the adoption of the textbook represents substantial potential income to the publisher, and hence it is economically viable for the publisher to provide ancillary materials (such as a question bank) to the teachers

running the course. This approach is widely used in North America, and to a slightly diminished extent, in Australia and New Zealand. In more recent times, a few major software providers have begun to provide question banks, and this practice is likely to grow in the future.

It should be noted in passing that the quality of these question banks varies widely, and unfortunately they are rarely of a consistently high standard across the full set of items. In addition, the provision of detailed feedback to accompany items (for formative assessment purposes) is rare. There are a number of reasons for this situation, but one is that question banks in themselves do not normally provide any direct income to publishers (they are typically a "sweetener" to textbook adoption, not a product in themselves). For this reason, the funding allocated to question bank creation by publishers is rarely considerable, which tends to result in the production of a large number of recall/knowledge (Bloom, 1956) type items which are easily and quickly written by poorly paid graduate students and early career academics moonlighting for publishers. While a few discipline areas have managed to create centralised question banks based on the developments of teachers in many locations, the vast majority of disciplines rely on publishers for questions banks (if they exist at all).

While question banks are not always of such variable quality, and some excellent question banks do exist, teachers should be aware of the economic forces driving the creation of many question banks, and treat them accordingly. Occasionally question banks developed over many years by experienced academics are adopted for use by publishers, leading to a question bank of greater than usual quality. The unevenness of many question banks is not as great a problem as it might seem, as few teachers would use these items without prior review, and often this leads to some degree of rewriting. The end result is typically a hybrid of existing question bank items, rewritten items and original items developed by teachers to suit their individual circumstances. In cases such as these, using a question bank of varying quality as a "starting point" for item development may be quite appropriate. There are some difficult copyright issues associated with this practice which are rarely addressed, but this topic is considered later in this paper.

In addition to the provision of banks of items, some publishers have provided CAA systems together with their question banks. While there is no single model adopted across the sector, and a range of systems have been used (sometimes by the one publisher), they have typically been stand-alone (not networked) systems developed by an company external to the publisher, and not part of an ongoing CAA system development process, but rather a "one off" development for the publisher. Some of these products have been satisfactory, but many have been difficult to use, prone to bugs, platform specific, poorly adapted to contexts outside the USA, and/or of limited functionality. Many have provided limited (or non-existent) capabilities for teachers to modify items. As a result, they have not been as widely adopted as one might expect given their potential usefulness.

The Rise of Internet CAA Systems

Many of the limitations of past stand-alone CAA systems are currently being overturned by the rise of Internet-based CAA systems such as Question Mark Perception and WebMCQ (the system I have been involved in developing, Dalziel & Gazzard, 1999). These systems are generally easier to use, as they have the common basic interface of the Web browser, and use many of the features of the Web which have made the it so popular in society over the past five years. One of the fundamental advantages of Internet CAA is the networked nature of the approach, which provides for distribution of formative or summative assessment directly to multiple client computers with little or no additional hardware or software installation needed apart from standard access to the Web. From the server side, software need only be hosted on a single computer (rather than separately on each test computer), and questions can be hosted centrally, meaning that changes need only be made to a single computer, and these can then be distributed to all users. Monitoring exams and collecting response data is also greatly improved by using the standardised network of the Internet. These and other advantages suggest that Web-based CAA will become the dominant mode of CAA in the future.

A further refinement of this model is the "Application Service Provision" (ASP) approach to software provision. In this model, the CAA system is installed, maintained and upgraded by the company who produce the CAA system (or its agents), rather than by individuals at the organisation using the software (such as a university). Due to the specialist experise of the original developers, this approach is generally more efficient than methods which require non-specialists to look after the CAA system. Hosting of the CAA software in an ASP model can still be provided physically within an organisation if it is important to retain a server onsite (such as in locations where Internet access is unreliable). In these sitautions, the software can still be installed and maintained remotely by the original developers or their agents. This approach provides economies of scale in service and maintenance, and provides for more rapid development and dissemination of new software and updates. It also provides a mechanism for sharing of content such as question banks (see below).

It should be noted that the ASP model is an example of a shift within commercial software companies from a "product" to a "service" model of business (Grice, 1999). This shift is greatly aided by the structure and protocols of the Internet, and is now being applied to many examples of "next generation software" (Dalziel & Gazzard, 1999). It is likely that the coming decade will see a major change of approach from both large and small software companies towards the provision, maintenance and development of software along the lines of this "service" model (including companies as large as Microsoft, Reuters, 1999). One economic advantage of the ASP approach to users is that licence fees are typically based on monthly or yearly "rental" of the software, rather than more expensive"puchasing" of traditional software licences. As software rental typically includes the costs of upgrades, the expenses associated with the "upgrade

treadmill" of traditional software are finally abolished. Initial expenses with ASP software tend to be less as the total cost of ownership is spread over several years, rather than being contained entirely in the one-off product cost of traditional licences.

Question banks and Internet CAA Systems

The combination of question banks and Internet CAA systems has much to recommend it. Question banks can be developed in a standard format (such as the IMS format - see below) and provided as files for uploading into major CAA systems. In some cases, CAA systems can be linked over the Internet to databases containing question banks, and these can be downloaded directly. This approach has obvious advantages for dissemination of up-to-date material, and ease of distribution to non-specialist CAA users (ie, most teachers). Further, the "many to many" nature of Internet connectivity encourages not only centralised storage and distribution of question banks, but also facilitates the sharing of newly developed questions and feedback among users. This process can be somewhat anarchic, with teachers in different locations choosing to share their questions if and when they desire, or the process can be centralised if an organisation is prepared to provide hosting facilities and some form of coordination. In the case of CAA systems using an ASP model, this sharing can be done directly from user to user by interlinking servers via some common protocols for connecting servers and sharing questions.

The practical usefulness of the approach described above is already evident in a number of CAA and related systems. Specialist Internet CAA products (Question Mark Perception) and services (WebMCQ) exist which take advantage of many of the features described above. More general course platform tools such as WebCT and Blackboard are also beginning to take advantage of some of these features within their assessment components. It now appears fairly certain that these recent development will come to dominate the field of CAA, and that the many efficiencies that arise from Web-based question editing, hosting, and provision to students (for practice or for exams) will represent a qualitative jump over past stand-alone CAA systems.

An additional important development is a number of standard formats for the structuring of item elements to allow for easier dissemination. While there are several standards currently evolving, the IMS system seems to be most advanced in this area (IMS, 2000). These approaches provide common standards to allow for interoperability of question content between different CAA systems. Even if the event that several standards systems proliferate, it is likely that software will be created to allow for the easy translation of one standard formats into another format. As a result, question banks will become largely interchangable between CAA systems, increasing the opportunities for dissemination and improvement.

A particularly important outcome of this standardisation and sharing of materials may be the development of quality, detailed feedback to accompany questions used for formative purposes. To date this aspect of CAA has not been as widely exploited as it might, in part because of the time consuming nature of writing extensive feedback. However, as CAA systems and individual teachers begin to disseminate well prepared feedback, it is argued that this feature of CAA (formative assessment with detailed feedback) will become widely used (and highly regarded) by students in their self-assessment of learning and their preparation for formal tests.

Examples of current WebMCQ models of CAA question banks

WebMCQ is one example of an Internet CAA system originally developed by the author and Scott Gazzard, based on work conducted at the University of Sydney, Australia (Dalziel & Gazzard, 1998, 1999). From its inception, it has been based on an ASP model of service provision, with servers being remotely maintained within organisations, or questions being hosted centrally on WebMCQ servers. WebMCQ has worked with textbook publishers to develop new models for the integration of question banks and Internet CAA, notably with McGraw-Hill in Australia and New Zealand. The system is now used in over a third of Australian universities, as well as in other educational insitutions both in Australia and overseas (including the UK). Some of these models are described below by way of concrete examples of the points made above.

Due to WebMCQ's ASP approach, it is easy to provide systems for interconnecting servers in order to share questions. Two models of this are currently in use in Australia. In the first, a central question bank developed by a publisher is hosted on a WebMCQ server. When teachers adopt the appropriate textbook, they are provided with an individual WebMCQ licence for use in formative and summative CAA. This licence, regardless of the location of is server, is interlinked with the central question bank so that individual questions, sections or the entire item bank can be downloaded to the individual teacher's account for use in his or her local context. The editing capabilities of the system provide teachers with the feedom to create multiple tests incorporating different hybrids of question bank items, rewritten items, and original items developed by the teacher.

The second model is somewhat more anarchic, in that individual teachers can request that WebMCQ interlink any two or more accounts to allow for the same kind of sharing of questions as that provided with the centralised question banks. However, this sharing is two way, so that teachers can (provided they have given permission) share items with each other, or with a group within an institution, or between institutions. In theory, there is no limit to the extent of sharing possible. Each of these two models have provided simple, effective means of distributing questions immediately and effeciently - with shared questions ready for use immediately upon linking of accounts. It is hoped that the second model may

provide a fertile ground for the development of feedback to accompany items in addition to the development of test items themselves.

A third model being explored with a publisher in the UK is a more simplified approach of providing a single common set of questions (without feedback) to accompany a textbook which may be widely accessed by students. While this approach does not assist teachers to customise questions to suit their local context, it does provide a very efficient method of adding value to textbooks in a way that is high valued by students. An more sophisticated adaption of this approach is currently being developed in Australia with McGraw-Hill, where students may purchase access to individualised, customisable accounts of questions with extensive feedback and textbook referencing, together with tracking of progress over time. This approach overcomes the traditional problem of question banks as an "add on" rather than as a direct revenue stream for publishers, resulting in a higher quality of questions and feedback. It is interesting to note the number of different approaches possible based on either the teacher or student as the target of the material, and the extent to which customisation, quality and feedback are provided.

An agenda for the improvement of question banks using "copyleft"

The proposal that individual teachers be able to share their questions provides a possible basis for the incremental improvement of question banks. Where teachers can rewrite items to improve their quality, and then share these items with others, there is a basis for "weeding out" poorer items within question banks, and providing a mechanism for the "natural selection" of quality items across a question bank. However, the problem of copyright looms large over any systematic attempt at this approach.

In general, most publishers have been willing to "turn a blind eye" to changes made to items from their question banks where this is to assist academics in their teaching (although it should be noted that the legal status of this practice is often unclear). In practice, many publishers also do not directly attempt to limit the usage of their questions into the future by teachers who may change their textbook selection to a competitior of the publisher over time, although it can be assumed that this practice is not enthusiastically encouraged by publishers. Publishers do, however, object to the prospect of questions from their question bank being used by other publishers, either directly, or as a result of adaption by individual teachers who are then contracted by other publishers to help write new question banks. In the area of collaborative educational development, copyright can be a complex issue to resolve (Bale, 1999).

A very different approach to traditional copyright law and enforcement is provided by "copyleft", the legal basis under which the "Open Source Software" initiative (and related movements) develop software (Free Software Foundation, 1999). This approach to software development has been enormously successful in recent years, including the development of Linux, a major operating system, and

Apache, a major Web server. The copyleft approach seeks to remedy a major deficit of putting copyright materials "into the public domain", as this process does not protect materials from being commercially exploited by others, and is generally innappropriate for academic materials regardless of some of its apparent attractions (Crews, 1999). The basic version of the licence is available on the Free Software Foundation website (Free Software Foundation, 1991).

Consider the following example based on question bank development. If a person develops a new question bank for a discipline area, and puts this material into the public domain (ie, without copyright protection), then anyone can use this material, and can potentially charge other people for its use with no obligations to the original developer. "Copyleft" changes the foundation of traditional copyright by insisting that copyleft materials be provided free for general use, under the condition that these materials cannot be sold (apart from a small distribution fee where appropriate), and any new developments based on these existing copyleft materials must also be released under a copyleft licence. This provides the possibility of a person who releases a question bank under a copyleft licence having a legal defence against misuse of their freely provided materials for commercial gain. In addition, any newly developed materials based on the original question bank must also be provided back to the general public under the same conditions as the original copyleft materials. In the case of software code, this has resulted in communities of usually unpaid developers working collaboratively to improve the quality and functions of existing software. As proposed here, the same principles of copyleft could be applied to question banks to allow for the improvement of items over time.

If publishers can be persuaded that this approach is in their long-term interests (due to the resultant higher quality question banks arising from the work of a community of question developers), then existing question banks could be released under copyleft licences to the benefit of teachers, students and publishers alike. Should publishers be nervous of the broader implications of this approach, they could be encouraged to trial it within a few specific areas first. Alternatively, academics with their own question banks could release these to others under a copyleft licence to begin the process of incremental improvement and expansion of the question bank's scope. Both of these processes could happily co-exist, with benefits for both teachers and publisher arising from a larger pool of quality, freely available items. This model could equally be applied to the development of associated feedback for formative assessment, although an alternative approach would see feedback remain under traditional copyright laws so as to provide a basis for income generation for the ongoing development of question banks by publishers and teachers.

The main obstacle to this approach is a system for sharing, cateloging and vetting new materials. The ASP model of Internet CAA systems provides one method for dissemination, and the use of common standards for question formatting (such as IMS) provides another (complementary) approach. However,

to avoid confusion and duplication, there may be a need for numbering/coding system for all items in a way that tracks their original developer, their topic, their stage of development, and perhaps their position in a "tree" of items if they have been developed from a single original item. A numbering/coding system such as this could be a useful additional feature of standards groups such as IMS. Just as in the world of open source software development, their will need to be hierarchies of experts able to assess newly developed items for inclusion in future "base" versions of improved question banks, and organisation to help coordinate this process (both publishers and CAA software providers could assist in this area).

Most of the detail needed to implement this approach can be acquired from the work of existing open source software development, where the structures and processes needed for tracking shared development are well established and understood. The end product of this new approach should be higher quality question banks, and greater collaboration among developers of these items, which should provide a basis for better teaching and assessment of students.

Conclusion

This paper has provided an overview of the way in which question banks may be integrated with Internet CAA systems, and the likely future of developments in this area. It has reviewed methods of dissemination of questions, including those provided by formatting standards (such as IMS) and ASPbased CAA systems (such as WebMCQ). An innovative model of question bank development is proposed on the basis of "copyleft" licencing of materials. It is argued that the benefits that have accrued from this approach in the development of software are apt to be enjoyed by those with an interest in the use and development of question banks, such as pbulishers, teachers and, ultimately, students.

References

Bale, E. (1999). *The Rights Stuff: Ownership in the Digital Academy*. Learning Technologies Report, Fall 1999, Volume 1 Number 2. London, Cananda: The Node Learning Technologies Network.

Bloom, B.S. (1956). *Taxonomy of Educational Objectives: The Classification of Educational Goals*. (Ed.) Handbook 1: Cognitive Domain. New York: David Mackay.

Bull, J. (1999). *Update on the National TLTP3 Project: The implementation and evaluation of computer-assisted assessment*. Proceedings of the Third Annual Computer Assisted Assessment Conference Loughborough, June 1999.

Crews, K.D. (1999). *An interview with Kenneth Crews*. In E. Bale (Ed), The Rights Stuff: Ownership in the Digital Academy. Learning Technologies Report, Fall 1999, Volume 1 Number 2. London, Canada: The Node Learning Technologies Network.

Dalziel, J.R. and Gazzard, S. (1998). *Using WebMCQ for Formative and Summative Assessment*. Proceedings of The University of Sydney Physics IT Workshop, (Ed. A. Fernandez), 34-37, Sydney: UniServe Science.

Dalziel, J.R. and Gazzard, S. (1999). *Next generation computer assisted assessment software: The design and implementation of WebMCQ*. Proceedings of the Third Annual Computer Assisted Assessment Conference Loughborough, June 1999.

Dalziel, J.R. and Peat, M. (1998). *Fostering collaborative learning during student transition to tertiary education: An evaluation of academic and social benefits*. **in** Improving Student Learning, C. Rust (Ed), pp272-283. Oxford: Oxford Centre for Staff and Learning Development.

Free Software Foundation (1991). *The general public license (GPL)*. <http://www.opensource.org/licenses/gpl-license.html> (1 May 2000).

Free Software Foundation (1999). *What is the Copyleft?* <http://www.gnu.org/copyleft/copyleft.html (1 May 2000).

Gazzard, S. and Dalziel, J.R. (1998). *Comdesign Principles for "Next-Wave" Educational Tools: The development of the WebMCQ assessment system.* Proceedings of the Fifteenth Annual Conference of the Australian Society for Computers in Learning in Tertiary Education, (Ed. R. Corderoy), 289-296, Wollongong: University of Wollongong.

Grice, C. (1999). *Business software leasing growing more uniform*. <http://news.cnet.com/news/0-1004-200-1441966.html?tag=st> (1 May 2000)

IMS (2000). *IMS Specifications - Question and Test Specification - Public Draft*. <http://imsproject.org/question/index.html> (1 May 2000).

McInnis, C. James, R. and McNaught, C. (1995). *First year on campus.* Canberra: Australian Government Printing Service.

Reuters (1999). Microsoft moving towards service. <http://news.cnet.com/news/0-1003-200-852083.html?tag=st> (1 May 2000).