Best Principles in the Use of On-Line Quizzing

Thomas Brothen
University of Minnesota

David B. Daniel
University of Maine at Farmington

Diane L. Finley, Ph.D.
Prince George's Community College

With today's Internet-based courseware, instructors have been presented with many new options for quizzing students. This new array of choices can be daunting even for experienced computer users. In this section of the report, we hope to provide useful information to guide productive use of computerized quizzing in both face-to-face and asynchronous courses. Computerized quizzes can reside on an individual computer, on a local area network, or on the Internet. They are variously known as Internet quizzes, web quizzes, online quizzes, electronic quizzes, computer-based quizzes, computer quizzes, or computerized quizzes. Most quiz delivery software today is Internet based but many of the principles and recommendations discussed in this section can refer to more than one method of delivery. Throughout this section we will use the general term computerized quizzes while recognizing that most applications will be delivered via the Internet.

Why Should Instructors Use Computerized Quizzes?

In general, and especially at the introductory level, short quizzes at the start of a traditional class combined with prompt feedback have proven to be a very effective teaching strategy (Connor-Greene, 2000). Frequent quizzing reduces massed practice and procrastination (Connor-Greene; Maki & Maki, 2000), keeps students focused on what they need to do (Salomon & Gavriel, 1998), and helps them decide how their studying is proceeding (Rosenthal & McKnight, 1996). But in-class quizzes have limited utility because of the need to be short and focused (cf., Brothen, Wambach, & Hansen, 2002) and they cannot practically be given more than once without sacrificing too much class time. Further, the time it takes to generate in-class quizzes, grade them, and provide timely and effective feedback can place significant demands on the instructor.

Administering computerized quizzes outside of class via the Internet can be a tool for efficiently providing the benefits of quizzing (Brothen & Wambach, 2001, 2004; Daniel & Broida, 2004, Daniel and King, 2003). Computerized quizzes are more easily scored so they reduce grading time once created. Lectures may be more effective if students have done the reading before hand and, if students are required to complete quizzes before coming to class, they may be more likely to have read the chapters (Connor-Greene; Daniel & Broida). Students can complete computerized quizzes multiple times over the same material and this mastery approach (Bloom, 1976) may produce greater learning. Many computerized quiz programs are adaptable to a mastery learning approach and the right kind of quiz structure facilitates this (Maki & Maki, 2001). Taking multiple quizzes can increase fluency with the material (Johnson & Layng, 1992) and is ultimately related to course success (e.g., Daniel & King). Quizzes delivered asynchronously that are self-grading and give feedback to the learner also free up instructors' time to interact with students in ways that have been shown to be particularly effective in both distance courses and standard face-to-face courses (Bernard et al., 2004).

Functions of Computerized Quizzes

Computerized quizzes can be used as formative or summative assessments. If quizzes are to function in a summative way, there are several issues to consider. If used to determine grades, they must be "secure" and resistant to what the instructor might consider to be cheating. An obvious way to deliver them is in monitored computer classrooms. Another way is to conceive of them as "open book" quizzes or to set time limits for delivery off site. These and other techniques can increase instructors'

confidence that students actually know something about the material they are being tested on. An additional possibility is to integrate quizzes into a sequence of activities that increase instructor confidence that students have mastered the material. Making accessing the summative quiz contingent on achieving mastery scores on open book, formative practice exercises that have little or no point value is one way to do this. For example, students may first complete a fill in the blank exercise with key words from important sentences that good students should highlight, and then take a multiple choice practice quiz. Both would require mastery scores to go on to take the chapter quiz.

Most commonly, computerized quizzes are conceived of as a formative assessment to help students assess their current mastery of the material and guide studying. Many publisher-provided computerized quiz programs are marketed as formative assessments and actually seem to function in this manner. However, instructors must structure their courses to require students to use such tools for them to be effective. It is important to point out, however, that the mere availability of quizzes does not guarantee their effective use. Even though, when encouraged, students tend to prefer the availability of computerized quizzes and may even use them more than other available pedagogical tools (Gurung, 2003), their use does not automatically lead to improved exam scores (Brothen & Wambach, 2001, 2004). In summary, students may not even use such tools (Daniel & King, 2003) and if they do, their use does not necessarily lead to improved learning, especially using the default settings of many publisher-provided course management cartridges (Daniel & Broida, 2004).

The most important feature necessary for quizzes as formative assessment is their ability to provide prompt and accurate feedback. By its very nature, feedback is designed to influence further learning. With that in mind, the useful structuring of feedback is no simple matter. Bangert-Drowns, Kulik, Kulik, and Morgan (1991) have shown that giving students access to practice exercise answers not contingent on their answering the questions, is worse for their learning than giving them no study aids. Thus, the typical study guide that has quiz answer keys at the back may be attractive to students but counterproductive to learning. Similarly, lenient quizzing parameters may allow students to utilize strategies that do not optimize learning (Brothen & Wambach, 2001, 2004; Daniel & Broida, 2004). Students may simply look up answers in the glossary or textbook, take the test in groups, or use other work-avoiding strategies. In addition, students who avoid mastering the text in favor of repeatedly taking quizzes and finding answers (a "quiz to learn" strategy) tend to score lower on exams than students who use quizzes as a formative assessment to guide their own learning (Brothen & Wambach, 2001)

Computerized quizzes can deal with potential student misuse if they are structured appropriately (see below). Early versions of computerized study guides featured multiple choice quizzes that allowed students to click on" a," then "b" and then "c," etc. until they got the correct answer. This guessing game likely convinced students that they either really knew the answer or had learned something about the material after stumbling upon the correct answer. The typical practice quiz delivered today via publishers' Internet sites does not improve on this very much. Such quizzes usually consist of 10 to 15 items that do not vary. Students can eventually score 100% on them without doing any studying. The "magical" moment for students of seeing a multiple choice item that could be on their exam with the correct answer highlighted is a powerful incentive. It is not easy to

convince them that the hard work of reading, studying, and restudying after receiving feedback is the better approach.

Of course, a quiz can function as both summative and formative assessments as some hybrid uses have shown. The key to quizzes functioning in this way is feedback. For example, if students get three attempts at a quiz with their best score counting towards their grade, helpful feedback and effective use of it by students to restudy can result in improved learning at the same time their learning is evaluated for assigning grades.

Practical Suggestions for Creating and Using Computerized Quizzes

Computerized quizzes offer instructors numerous options for improving and assessing learning but students can subvert the instructional purposes by using online search engines, glossaries, and other methods to get answers. We recommend the application of psychological principles to structure the learning environment. Taking a structured approach to using technology in an educational design is the most significant technology available to instructors.

Based on the research cited above and the combined experience of this task force's members, we make several suggestions for psychology instructors considering using quizzes delivered electronically, especially those delivered via course management systems over the Internet. Each of these suggestions and others can be obtained from the references cited below.

How Many Items Do I Have to Create for My Computerized Quizzes?

Correct answers on quizzes are very important to students. Hindsight bias is one operative concept here. Seeing a correctly keyed answer, no matter how obtained, is highly attractive to students. They are too often more interested in getting the correct answer than even understanding the question. Instructors should try to ensure that students engage in the appropriate behaviors to utilize the quizzes to improve concept mastery. Those behaviors are proper reading, studying, a good effort on quizzes, asking questions, etc. In order to greatly reduce the likelihood of students memorizing or sharing answers on a quiz, large pools of objective items from which quizzes are randomly chosen are crucial to good learning results. The pool should cover all the concepts from the unit being tested. This might require instructors to devote nearly all of a textbook publisher's test item bank to their computerized quizzes. It is also possible to use test banks from other textbooks as long as you verify that the concepts taught are covered in the text or in class. There are also a number of commercial computerized quizzing products that allow you to import quiz questions created in word processing software, etc. In most course management systems, it is possible to delete questions that are irrelevant or poorly constructed from an imported test-bank. Further, some instructors prefer to delete the exact questions used on exams from the quiz options although if the pool is large enough this is not absolutely necessary.

Setting the quiz delivery software to randomize question choice eliminates some concerns about cheating. A potential drawback to randomization is that students may get quizzes of unequal difficulty or an uneven sampling of concepts. Some course management systems, (e.g., WebCT) allow the instructor to create blocks of related questions from which a designated number will be randomly selected. For example, if I designate 10 questions of medium difficulty on a particular concept, I can have the program randomly choose 2 of these for each quiz.

How Much Time Should I Allow For My Quizzes?

Time limits discourage using the unread textbook as a primary reference. More specifically, they are necessary to keep students from taking inordinate amounts of time searching the textbook to get the correct answers for one quiz of 10 items and thus convincing themselves they know the chapter or section of material. Combining time limits with increased question difficulty is another effective strategy. The time-worn metric of one minute for each item in a multiple-choice test is clearly too long. We recommend 30-40 seconds per question, at most, depending upon item difficulty. As an alternative to discouraging the use of the text on quizzes, instructors might make the quizzes difficult enough that answering the questions correctly, even with the textbook, is indicative of effective student learning.

Of course, disability issues are a concern. Because a common accommodation for students with disabilities is time and a half on tests, instructors should decide upon the metric they will employ so they have a rational for adjusting it for some students. Instructors should also recognize that some ISPs may timeout students who take too long online. Some rules addressing this possibility need to be considered when setting up online quizzing.

Should My Quizzes Count Toward Students' Grades? If so, How Much?

Requiring students to achieve a minimum score to receive points (e.g., scores of less than 6 out of 10 count as 0) also increases students' sense that the stakes are high enough that they should be prepared for the quiz. Making the quizzes count for a relatively small part of the grade and having high value other forms of assessment such as term papers or a monitored final exam are other possibilities.

What Do I Want My Quizzes to Accomplish? Feedback and Practice Quizzing

As discussed above, computerized quizzes provide an excellent opportunity for students to receive formative evaluation of their learning progress. Thomas and Rohwer (1986) in their executive monitoring model for studying, suggest that students appraise their need for further study, deploy strategies to meet those needs, and assess their learning progress. Instructors who provide practice quizzes give students a tool to improve their learning in this way. In addition, the availability (and maybe the initial requirement) of practice quizzes allows the student to become familiar with the format of the quizzes you are employing. Many students have not used computerized quizzes and will not do so effectively if they seem difficult or time-consuming to use, even though they might prove to be useful. We also recommend that you provide some guidelines for how students can utilize quiz results to guide studying.

As discussed above, we feel that instructors need to do some thinking about whether they want to use quizzes in a formative way, summative way, or both. If used as a formative assessment, "practice" quizzes must provide feedback. The best feedback gets students into the textbook, lecture notes, etc. Giving students the right answer is not optimal. Simply reproducing the question with the student's answer marked right/wrong and instructions for students to go find the right one is better (and probably realistic for large item pools). To benefit most, students should be doing the work of learning. More informative feedback telling students they got an item about a particular concept wrong and a page number where this concept is explained is a good and feasible technique. Summative uses can also be effective teaching tools if students get more than one attempt. Of course, feedback is necessary in these hybrid situations as well. It is

important to note that students often see the task differently and interact with the quizzes accordingly. For example, some students will take practice quizzes on a chapter 30 times if it is just practice. But if the quiz is worth points, students may use as many minutes as they have available and may employ techniques that compromise learning to optimize their scores. In any case, focusing on the quiz as a learning tool only will not be very effective for students if they do not also return to the text or notes to master the content before the next quiz.

How Many Attempts Should Students Get?

Multiple tries on quizzes are important if the quizzes are to serve as a formative assessment to guide learning. For quizzes that count towards grades, the best score out of several attempts is a way of getting students to keep trying for mastery and to ameliorate the effects of a "bad draw" in the random selection of items. To reduce the chances of a "good draw" of all easy items, instructors should avoid including too many easy items in the pool. Some computer-based instructional systems are designed to structure quizzes by difficulty of items, etc. (e.g., Maki & Maki, 2001) but most are not. A high percentage of very difficult items in the pool is justified if one assumes that students will essentially make the quizzes open book.

Costs of Using Computerized Quizzing

Depending upon a number of variables, the considerable benefits of computerized quizzing may be balanced by the potential costs to be incurred. While these costs will vary depending on your particular circumstance and resources, the most common considerations are listed below.

Instructor Time

The highest cost to the average instructor will be time. It takes time to develop the quizzes and time to work with students who have difficulty interacting with the programs. Further, as mentioned above, most publishers do not deliver the quizzes in a format proven to positively impact learning, so adequate time must be devoted to properly structuring the quiz parameters. We believe that the greatest investment of time is in the very beginning. Once the quizzes are created and structured properly, most course management systems allow them to be administered fairly effortlessly so they can be used in subsequent terms.

Lack of Technology and Support

A course management system provides the necessary interface and delivery method for the quizzes outlined in this document. However, not every campus provides a course management system and even those that do may not have staff properly trained in the intricacies of these programs. For most introductory level textbooks, publishers gladly provide access to such systems with support via a toll-free number. It is important to note that, although publishers provide access to such systems, they seldom structure their offerings in a pedagogically sound manner. Most likely, you will have to negotiate for the availability of the entire test-bank within the system and appropriately structure the quizzes yourself.

Student Start-Up

Students unfamiliar with such systems often need to be taught strategies to navigate through them. It is encouraging that, most often, college-level students of all ages and levels of familiarity with computers quickly develop the skills to interact with the quizzes. We recommend a hand-out and devoting some class-time to the basics. If

possible, it may be beneficial to bring your students to a computer classroom to allow them each to go through the motions in a supportive environment. Whichever strategy you employ to help students familiarize themselves with the procedures, setting aside extra office-hours to help students interact with the system for the first few quizzes is a very good idea. But, be prepared for exceptions throughout the semester. It is common for students having technical difficulties accessing the quizzes to contact the instructor. If the issue cannot be diagnosed online or on the phone, it might be a good idea to ask students to try taking the quiz at a computer in the classroom or in your office.

Conclusion

With the above suggestions in mind, the first thing psychology instructors might consider before relying on any pedagogical device is if what they are planning to do is based on sound educational practice applied to their particular situation. The best way to proceed in the use of computerized quizzing, then, is to first clarify your personal teaching objectives. Clear objectives help guide you in constructing good quizzes and procedures that follow sound guidelines. This will set the stage for you to evaluate the effect of those quizzes in the context of your own class.

References

Bangert-Drowns, R., Kulik, C., Kulik, J., & Morgan, M. (1991). The instructional effect of feedback in test-like events. *Review of Educational Research, 61*, 213-238.

Bernard, R. M., Abrami, P. C., Lou, Y., Borokhovski, E., Wade, A. Wozney, L. et al. (2004). How does distance education compare to classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research.*

Bloom, B. (1976). *Human characteristics and school learning*. New York: McGraw-Hill.

Brothen, T., & Wambach, C. (2001). Effective student use of computer-based quizzes. *Teaching of Psychology, 28,* 292-294.

Brothen, T., & Wambach, C. (2004). The value of time limits on Internet quizzes. *Teaching of Psychology, 31,* 62-64.

Brothen, T., Wambach, C., & Hansen, G. (2002). Accommodating students with disabilities: PSI as an example of universal instructional design. *Teaching of Psychology, 29,* 239-240.

Connor-Greene, P. A. (2000). Assessing and promoting student learning: Blurring the line between teaching and testing. *Teaching of Psychology, 27,* 84-88.

Daniel, D. B., & Broida, J. P. (2004). Using web-based quizzing to improve exam performance: Lessons learned. *Teaching of Psychology.*

Daniel, D. B., & King, J. (2003, January). *What Works in General Psychology? The differential effects of study guides, web-based activities and web-based quizzing on exam scores.* Poster presented to the meeting of the National Institute of the Teaching of Psychology, St. Petersburg Beach, FL.

Gurung, R. A. R. (2003). Pedagogical aids and student performance. *Teaching of Psychology, 30,* 92-95.

Gurung, R A. R., & Daniel, D. B. (2005). Evidence-based pedagogy. *Best Practices for Teaching Introductory Psychology.* Lawrence Erlbaum & Associates Press, Mahwah, NJ.

Johnson, K. & Layng, J. (1992). Breaking the structuralist barrier: Literacy and numeracy with fluency. *American Psychologist, 47*, 1475-1490.

Maki, W. S., & Maki, R. H. (2001). Mastery quizzes on the Web: Results from a Web-based introductory psychology course. *Behavior Research Methods, Instruments, & Computers, 33,* 212-216.

Maki, W. S., & Maki, R. H. (2000). Evaluation of a Web-based introductory psychology course: II. Contingency management to increase use of on-line study aids. *Behavior Research Methods, Instruments, & Computers*, *32*, 240-245.

Rosenthal, G. T., & McKnight, R. (1996). What do introductory psychology students know about their examinations, and when do they know it? *Journal of Instructional Psychology, 23*, 137-144.

Salomon, G., & Almog, T. (1998). Educational psychology and technology: A matter of reciprocal relations. *Teachers College Record*, *100*, 222-242.

Thomas, J. W. & Rohwer, W. D. (1986). Academic studying: The role of learning strategies. *Educational Psychologist, 21,* 19-41.