COMPUTERS IN TEACHING

Helping Students Read Reports of Empirical Research

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"Reading the Research" is a Web-based interactive learning module designed to help students learn to comprehend and critically evaluate reports of empirical research. The module can be adapted for use with any report of empirical research. Students work through the module, take self-tests for factual knowledge, and discuss critical-thinking questions in an asynchronous discussion group. We conducted a formative evaluation with upper level experimental psychology students and a summative evaluation with introductory students. Students had positive attitudes toward the module and believed it improved their learning. Increased use of the module was also correlated with better learning of the report of empirical research.

An essential goal of the undergraduate psychology curriculum is learning to read and think critically about research (Baum et al., 1993; Brewer et al., 1993; Halpern, 1998; McGovern, 1993; Miller & Gentile, 1998). Students, especially those intent on graduate studies, must gain experience reading reports of empirical research. However, they often find the style and level of writing considerably more difficult than textbooks. Many students are intimidated and overwhelmed by reports of empirical research. All too often, they simply read the arguments in the introduction and discussion sections and fail to critically evaluate the hypotheses, methods, results, or the conclusions sections. The purpose of the Reading the Research Web-based interactive module is to assist students in learning to comprehend and read critically empirical reports.

Description of Reading the Research

Reading the Research provides a summary of a research report laid out in American Psychological Association (APA) style sections.[1] The module models the format of a report, helping students become familiar with the structure and conventions specified by the APA (2001).

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[1]An example Reading the Research module is available at http://www.psych.ualberta.ca/~varn/Kenrick/Reading.htm

The first part of the module describes the genre of the report of empirical research and presents a set of questions a critical reader considers while reading a report. Guides for critically reading reports of empirical research describe a strategy of asking questions while reading different parts of the report (e.g., APA, 2001; Anisfeld, 1987; Chamberlain & Burrough, 1985; Meltzoff, 1998). We adapted questions from these guides and categorized them as factual or critical-thinking questions. The questions we used in Reading the Research appear in Table 1. Factual questions are important because they assess whether the student knows the specifics of the research well enough to evaluate it. Questions that require inferences and critical thinking are open ended to encourage students to think creatively and critically about what they are reading.

The second part of Reading the Research is a summary of the report of empirical research and is accompanied by the factual and critical-thinking questions a critical reader should consider while reading the different sections of a report of empirical research. Students work through the summary and address the questions while reading the report. This part of Reading the Research comes as a template that an instructor can customize for use with a particular report. The instructor modifies the template by editing the summary and question pages in a word processing program and then publishes it on his or her Web site.

The template has a separate Web page for each section of an APA-style report of empirical research. For each of the sections, the instructor inserts information that is specific to the empirical report that students are trying to comprehend and evaluate. An instructor can add more or less information, depending on the level of students and on the difficulty of the report. The instructor can include a summary of the key points described in the section, background information that provides the broader context of the research, methodological or ethical issues, or an elaboration of difficult concepts. Furthermore, an instructor can include links to Web resources related to the research (e.g., a page describing different types of research designs or a glossary of new terms) or to outside information available on the Web (e.g., information about the authors or the journals, links to similar research, a picture of apparatus used in the research, a news report on the research). Links enable the instructor to bring in the wealth of information available on the Web.

Table 1. Factual and Critical-Thinking Questions Included in Reading the Research

Factual Questions	Critical-Thinking Questions
Who did the research?	Where did these research questions come from?
Where was it published?	Is the research important? Why or why not?
What are the research questions?	Are the participants appropriate for the study?
Who are the participants in the study?	Is the research design appropriate for the research question(s)?
What is the research design?	Are the measures appropriate for addressing the research question(s)?
What are the measures?	What ethical considerations are important to address? Are they all addressed in the article?
What are the main results of the study?	
What conclusions do the researchers draw from the results?	Can the results be used to answer the research question(s)?
	Can the results be generalized beyond the context of the study?
	Are the conclusions important? Why or why not?

Reading the Research is an interactive module. Each of the summary pages has clickable icons linked to multiple-choice test questions or to online discussion groups. The template includes all the programming required to format multiple-choice questions and to provide students with performance feedback. An instructor simply types in the relevant content. Use of the online discussion groups requires a special program; we use Discus (Paulisse & Polik, 2000) or WebCT (http://www.webct.com/). Typically, the instructor begins the discussion by posting a question or comment. Students respond to the instructor's posting or to postings of other students. Online discussion groups are especially useful for attaining participation from students in large classes. Furthermore, for classes with graded participation, the online discussion may facilitate evaluation because a copy of student contributions is preserved. Moreover, online discussion enables more reflective discussion in that students have the opportunity to ponder questions and comments before responding to them (Varnhagen, Drake, & Finley, 1997). They do not have to react right away, as they often must do during an in-class discussion. In addition, all students in a large class can engage in discussion when grouped into small asynchronous discussion groups, whereas they may not be willing or able to in a large lecture hall.

Formative Evaluation in Experimental Psychology

We conducted a formative evaluation of Reading the Research in a second-year experimental psychology class. As part of a laboratory exercise, students completed a module, written to accompany an article on day care (Broberg, Wessels, Lamb, & Hwang, 1997), and then evaluated the module; we did not grade participants on their performance. The goals of this formative evaluation study were to determine students' perceptions of the usefulness of Reading the Research for learning how to read reports of empirical research and to evaluate whether students perceived that Reading the Research helped them learn about the format and content of reports of empirical research.

Method

Participants. Participants were 5 male and 11 female college students enrolled in a second-year experimental psy-

chology course. The students were somewhat experienced at using computers. When asked about their computer experience, the modal response was that they were "moderately comfortable" working on computers and had "fair" computer skills. Only 1 student reported no experience with computers. They reported moderate computer access (63% had a computer at home), but minimal Internet access (26% had access at home). As part of course requirements, students read APA-style reports and used them as reference material in papers. For most of the students, this was their first exposure to empirical reports.

Materials. The second author created a Reading the Research module with discussion questions for Broberg et al. (1997). We both developed a questionnaire designed to assess students' perceptions of the module. The questionnaire had 5-point Likert scale items to assess attitude toward the module, yes–no questions about difficulties encountered using the module, and multiple-choice items about students' preferences for activities associated with reading reports of empirical research. These questions appear in Table 2. We measured student self-ratings of computer skill through several Likert scale questions, including "How comfortable do you feel working on computers?" ranging from 1 (*not at all comfortable*) to 5 (*very comfortable*).

Procedure. Students met as a group in a computer lab for a single 2-hr session to work through the Reading the Research module. They had been instructed to read the report associated with the module (i.e., Broberg et al., 1997) before attending the lab session and to bring it to the session. Students worked through the module at their own pace, and contributed to the online discussions as part of their lab assignment. Because anyone on the Web could read the discussion, students posted their comments using first names only or a pseudonym. At the end of the lab session, students completed the questionnaire, which evaluated their use of the module.

Results and Discussion

Table 2 presents the students' modal attitudes toward the module. The students expressed positive attitudes. No student rated Reading the Research as being "not at all enjoyable." Students rated the Reading the Research module as the most helpful activity for comprehending empirical reports, compared with reading the report, discussing the report in class, or

Table 2.   Modal Responses to the Questionnaire Items

Questionnaire Item	Modal Response
What is your overall impression of Reading the Research?	Somewhat positive
How interesting did you find Reading the Research?	Interesting
How enjoyable did you find Reading the Research?	Enjoyable
How worthwhile did you find Reading the Research?	Worthwhile
Do you think this module should be a part of the class?	Yes
What did you do that helped you understand the empirical research article the most?	Using the computer module
What did you do that helped you understand the empirical research article the least?	Reading the article
Do you feel you learned something about the research?	Yes
Do you feel you learned something about the different parts of a report of empirical research?	Yes

being tested on the report. They reported that they thought they had learned something about the specific research and about APA-style reports in general. They rated reading the actual report as least helpful for comprehending it. This finding is consistent with anecdotal evidence suggesting that students find reports of empirical research dry and difficult, sometimes so much so that they are not motivated to read them thoroughly enough to be able to think critically about them (Baum et al., 1993; Brewer et al., 1993; McGovern, 1993; Meltzoff, 1998; Wade, 1997). Reading the Research seems to be one tool that instructors can use to make the empirical literature more accessible to undergraduates.

Some attitudes toward the module were correlated with self-reports of computer skills. Students who rated themselves as being more comfortable in using computers had a more positive overall impression of the module than did students who rated themselves as less comfortable, $r(14) = .76$, $p < .05$. However, students who rated themselves as being less comfortable using computers enjoyed the module more, $r(14) = -.49$, $p < .05$. This finding may have been a contrast effect; students with poorer computer skills may have been surprised that they could navigate the module successfully and therefore found the experience more enjoyable than anticipated. The other correlations between comfort and attitude were small and not statistically significant. These results indicate that even novice computer users have a positive attitude toward using a Web-based supplement in their learning.

This study demonstrated that students in a second-year experimental psychology course found the module useful and enjoyable. In the next study, we examined how students used the module in a course setting and how their use related to learning.

Evaluation in Introductory Psychology

We integrated Reading the Research into "intro.psych," a technologically enhanced introductory psychology course (Varnhagen, 1999; Varnhagen, Winship, & Apedoe, 2000). Students in intro.psych attend a keynote lecture on each topic in the introductory psychology curriculum and then complete Web activities designed to enhance their understanding of these different topics. An important component of the Web activities is the students' asynchronous discussion. Students participate in discussion groups of three to five students, and our course technology (Heth, 1999) allows stu-

dents to link directly to a specific thread in their discussion group (Paulisse & Polik, 2000).

Students completed two Reading the Research modules, one accompanying research on adolescent dating (Kenrick, Gabrielidis, Keefe, & Cornelius, 1996) and one on preparing for examinations (Balch, 1998). These reports of empirical research, and the accompanying Reading the Research modules, were a part of course requirements. Students were graded on their asynchronous discussion of the reports. Questions relating to comprehension of the articles and understanding of the structure of reports of empirical research appeared on the multiple-choice midterm and final examinations.

We examined students' performance measures as a function of their use of the modules as indicated by server log files. If Reading the Research and the accompanying discussion helped students learn about and critically evaluate empirical research, we would expect to see relationships between use of the module and performance based on critically examining and learning about the research from the module.

Method

Participants.   Participants were 46 male and 50 female students enrolled in intro.psych. Of these, 66 students were in their first year of university, 17 were in their second year, 7 were in their third or higher year, and 6 were unclassified students. All students participated in the evaluation as a part of course credit for research participation.

According to an online survey conducted the first week of the term, few students were novice computer or Web users: 60% rated themselves as "comfortable" or "very comfortable" with using computers, 65% rated their Web browsing skill level as "excellent" or "good," and 69% indicated they had home access to the Web. The course catalogue listed the course as having an Internet component; thus self-selection may have led to students having better-than-average computer skills and access.

Procedure.   Students completed the Reading the Research modules as a part of their regular class work. They completed the first module, accompanying Kenrick et al. (1996), approximately one third of the way through the course, and they completed the second module, accompanying Balch (1998), at the end of the term. Students were quite accustomed to using the Web components of the course by these

times. After a keynote lecture introducing the concepts, students had 1 week to complete the assigned Reading the Research module. We asked students to complete an online questionnaire similar to the one used in the formative evaluation following completion of the module. One week after doing the module, students completed either a midterm or final examination, which included seven multiple-choice questions about the associated report of empirical research.

As part of a larger research project on student learning from the Internet (Varnhagen et al., 2000), students also completed the Cornell Critical Thinking Test (CCTT; Ennis & Millman, 1985), an online questionnaire regarding their computer skills during the first week of the term, and an online questionnaire regarding their impressions of the course during the last week of the term.

Results and Discussion

Fewer than 20% of the students completed the online evaluations for the Reading the Research modules. Although we do not report the results here due to the small return rate, the students' impressions were comparable to those obtained in the formative evaluation.

We examined student computer log files to determine how students used Reading the Research. We examined how many and what pages students accessed and how many times they posted to their discussion group. Table 3 shows the statistics for number of sessions, total number of pages accessed, number of pages accessed by type of page (the introductory pages on how to read reports of empirical research, the summary pages, and the multiple-choice factual test pages), number of discussion posts, percentage mark for the discussions, and percentage score on the exam questions related to the module.

Most of the students worked with Reading the Research in more than one session. Students generally worked through the module in a linear fashion during the first or second session and then revisited selected pages, such as the introduction, results,

and discussion summary pages, in additional sessions. A few students appear to have bypassed the summary pages altogether, jumping straight to the graded discussions.

We analyzed differences between each of the measures shown in Table 3 with two-tailed paired t tests. Few differences were obtained, indicating consistency in use of the module and performance on the assessments for the two reports. Students accessed more of the summary Web pages when working through the Kenrick et al. (1996) module than they did while working through the Balch (1998) module, $t(93) = 1.98$, $p = .051$, $\omega^2 = .03$. This difference is not surprising because some of the Web pages—those that describe the genre of empirical reports—are the same in different modules. Once students have accessed them from the first module, they may not have a need to revisit them in subsequent modules. Students also accessed more of the multiple-choice test pages for the Kenrick et al. module than for the Balch module, $t(93) = 3.70$, $p < .01$, $\omega^2 = .05$, for the analysis of weighted means. This difference is particularly interesting because the multiple-choice midterm exam questions came directly from the module; possibly students did not realize this fact and decided they did not need to check their factual knowledge for the Balch article. Finally, students performed better on the multiple-choice exam questions related to the Balch article than they did on the exam questions related to the Kenrick et al. article, $t(92) = -3.06$, $p < .01$, $\omega^2 = .07$. The remaining comparisons were not statistically significant.

We used two-tailed correlational analyses to examine the relation between use of the different components of Reading the Research and learning, as measured by exam performance. These correlations appear in Table 4. Only number of discussion posts made correlated with exam performance for the Kenrick et al. (1996) module, but all components of the module correlated with performance for the Balch (1998) module. Given that we found few mean differences in students' use of the modules from the first reading to the second, these differences in correlations may indicate that the students became better able to use Reading the Research in their learning on their second set of experiences with the module.

We also analyzed correlations between other variables and learning. Critical-thinking ability, as measured by the CCTT administered at the beginning of the term, was not correlated with exam performance. In addition, preference for Internet-based courses versus traditional lecture-based courses did not correlate with performance. This preference variable consisted of the student's response to the question, "What do you think of the way this course was taught [with the Internet component] compared to a more traditional class lecture format?" Student responses to this variable were bimodal: 46% responded that they either somewhat or much preferred the Internet, 52% responded that they somewhat or much preferred a traditional format, and 3% responded that they had no preference. The small and nonsignificant correlation between preference and learning indicates that students can learn from technology-based courses even if they do not particularly like the instructional format.

We used stepwise multiple regression analyses to determine which components of the Reading the Research modules contributed significant independent variance to learning. The predictor variables included the number of

Table 3. Means and Standard Deviations for Sessions Completed, Pages Accessed, and Exam Performance

Variable	Kenrick, Gabrielidis, Keefe, and Cornelius (1996) Module		Balch (1998) Module	
	M	SD	M	SD
Sessions	5.1	5.7	4.9	5.6
Total pages accessed[a]	24.6	19.9	17.5	19.8
How-to-read pages	4.8	4.3	4.4	6.0
Summary pages	12.3	11.1	10.5	11.5
Multiple-choice pages	6.9	7.4	2.5	4.1
Discussion posts	3.0	2.7	3.8	3.3
Discussion grade[b]	67.7	29.2	64.7	36.5
Examination grade[b]	52.2	19.2	60.3	18.9

[a]Based on 24 total Web pages in the Kenrick et al. module and 18 total Web pages in the Balch module. There were 2 how-to-read pages for each module, 7 summary pages for each module, and 15 multiple-choice pages for Kenrick et al. and 9 multiple-choice pages for Balch. [b]Given in percentages.

Table 4. Correlations With Exam Performance and Sessions Completed, Pages Accessed, Discussion Posts, Critical Thinking, and Course Preference

Variable	Kenrick, Gabrielidis, Keefe, and Cornelius (1996) Module	Balch (1998) Module
Sessions	−.07	.20
Total pages accessed	.15	.29*
How-to-read pages	.16	.22*
Summary pages	.12	.29*
Multiple-choice pages	.13	.25*
Discussion posts	.28*	.28*
Discussion mark	.08	.20
CCTT score	.17	.28
Course preference	.11	.18

Note. CCTT = Cornell Critical Thinking Test.
*$p < .05$.

how-to-read pages accessed, the number of summary pages accessed, the number of multiple-choice test pages accessed, and the number of discussion posts made. The predicted variable was examination performance. Consistent with the correlational analyses, number of discussion posts was the only significant predictor of exam performance for the Kenrick et al. (1996) module, accounting for 7% of the variance, $F(1, 93) = 7.88$, $p < .01$, $\omega^2 = .07$. Although all components of the Reading the Research module correlated significantly with exam performance for the Balch (1998) article, only accessing the summary pages contributed a significant amount of independent variance (7%) to the exam score, $F(1, 92) = 8.21$, $p < .01$, $\omega^2 = .07$.

General Discussion

Experimental psychology students reported that they believed Reading the Research enhanced their comprehension of a report of empirical research. Introductory psychology students, many of whom had never been exposed to the genre of a scientific report, were able to use the module to aid their learning. Exam performance and relations between use of the module and examination performance increased from their first to their second set of experiences with Reading the Research.

Many students heartily embrace new forms of instructional technology, only to abandon them after the novelty wears off (Clark, 1983). Although two sets of exposures to Reading the Research can hardly be considered overexposure, these results demonstrate that students did use the module in their learning after the initial novelty had worn off.

Providing students with a Web-based summary of a report of empirical research and interactive opportunities such as self-tests and asynchronous discussion thus appears to help students learn both about the difficult genre of the report of empirical research and about the research contained within such a report. Based on the results of our evaluation with introductory psychology students, asynchronous discussion seems to be a particularly important component. This finding adds to previous work (e.g., Varnhagen et al., 1997) demonstrating that Web-based discussion enhances critical-thinking, reading, and writing skills.

We developed Reading the Research as a flexible module to supplement any report of empirical research and by students of differing levels of skill in reading psychological literature. Reading the Research has the potential to assist undergraduate students in acquiring essential critical reading skills and motivate them to read other reports of empirical research.

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Evaluation of *The Psychology Place*: A Web-Based Instructional Tool for Psychology Courses

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This study examined the effectiveness of the commercial Web site, The Psychology Place (http://psychologyplace.com) in helping students learn course material in an introductory psychology course. This site consists of linked pages that contain tutorials, readings, and links to relevant sites. All participants in this study attended conventional course lecture. In addition, half of the participants completed assignments from this Web site. Students who completed assignments from The Psychology Place and attended lecture demonstrated better understanding and retention of course material than students who had only attended lecture. This finding is noteworthy for instructors because incorporating this site into a course was minimally time consuming.

Creating a course Web site is a commonly used method of incorporating technology into teaching. A course Web site allows students to benefit from a diverse array of computer-assisted instructional tools. Students can remotely access lecture notes and additional reading material, take quizzes that are immediately graded, watch video clips, and work on tutorial exercises designed to promote their understanding of course material. Because of the great versatility of this medium, Kieley (1996) suggested that all instructional technology be Web based.

Several authors have cited evidence of the effectiveness of instructional technology. A meta-analysis of 51 instructional programs found that secondary school students' final exam scores increased by .32 standard deviations when the program included instructional technology (Kulik, Bangert, & Williams, 1983). College students enrolled in a general psychology course who used a computerized tutorial had higher test scores than students who did not use this technology (Chaparro & Halcomb, 1990; Worthington, Welsh, Archer, Mindes, & Forsyth, 1996). Undergraduate and graduate students scored higher on exams in a statistics course if it included computerized tutorials (Marcoulides, 1990; McNulty, Halama, Dauzvardis, & Espiritu, 2000). Additionally, students enjoy using instructional technology (Forsyth & Archer, 1997; Hornby & Anderson, 1988; Sherman, 1998), and students need experience using computers because computer literacy is a requirement for success in today's working world (Anderson & Hornby, 1996).

Although Web-based instructional technology is a versatile teaching tool, creating a series of Web pages for a course can be a time-consuming project (Plous, 2000; Slattery, 1998). A time-efficient alternative to creating your own course Web site is *The Psychology Place* (http://psychologyplace.com). This is an educational Web site maintained by Peregrine Publishers that consists of a series of linked pages containing a collection of tutorials, readings, and links to sites that cover content on all the major fields of psychology. Available for each topic are at least two tutorial-style learning activities and at least three readings sum-