Chapter 22: Using the QALMRI Method to Scaffold Reading of Primary Sources

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Abstract

One of the most important goals of any undergraduate psychology program is to develop students' ability to comprehend and critically evaluate empirical research. This chapter demonstrates the QALMRI method as an instructional strategy for teaching students how to identify, comprehend, and critically evaluate conceptually important information in an empirical article. Originally created as a framework to help students to develop scientific literacy, QALMRI is an acronym that stands for Question, Alternatives, Logic, Method, Results, and Inferences. We first provide an overview of the QALMRI method with a student-directed instruction guide; we then demonstrate a scaffolding approach for integrating the QALMRI method across different education levels. We conclude with a set of learner-centered activities designed to apply the QALMRI method with specific learning objectives.

Introduction

One of the essential goals of any undergraduate psychology program is to teach students how to critically evaluate primary research. For example, the American Psychological Association (APA) guidelines identify scientific literacy as its second major learning goal (Halonen et al., 2013). As such, it may not be surprising to find that many psychology instructors incorporate primary source readings (i.e., empirical articles) into their courses. Among liberal arts colleges, one study found that 70.8% of psychology instructors assigned primary source readings (Oldenburg, 2005). Although assignment of these readings was more prevalent for upper-level courses, primary source readings were also assigned by 46% of introductory psychology instructors.

Empirical articles are often incorporated into a curriculum as a tool to support student learning of specific learning objectives. For example, articles have been used to help students understand basic statistical and methodological principles (Christopher & Walter, 2006; Pennington, 1992; Ware & Badura, 2002), spark classroom discussions (Suter & Frank, 1986), promote critical thinking (Chamberlain & Burrough, 1985), motivate engagement (Carkenord, 1994), improve student writing (Price, 1990; Ware & Badura, 2002), and serve as assessment tools (Bachiochi et al., 2011). Yet, there has been considerably less focus on teaching students how to make sense of the scientific literature as a whole, which begs the question: how do students learn to read empirical articles in the first place?

Primary source readings, as compared to textbook chapters, may be particularly challenging for undergraduate students. Whereas textbooks are written with students in mind, empirical articles are written for other professionals and present persuasive arguments rather than facts (Gillen, 2006). Additionally, textbooks provide a great deal of guidance, explicitly pointing readers to important information using text structure and signaling techniques like headers and keywords (Kardash & Noel,

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2000; Sanchez, Lorch, & Lorch, 2001) to scaffold reading comprehension (Varnhagen & Digdon, 2002). By contrast, scientific writing contains explanatory and argumentative text structures that are inherently challenging for non-experts to understand (for a review, see Britt, Richter, & Rouet, 2014). In short, the comprehension and critical evaluation of primary sources poses a unique challenge for undergraduate students in two important ways. First, the reader must be able to find and identify important conceptual information that may or may not be explicitly stated. And second, the reader must be able to understand the logical connections between important ideas, both within the context of the individual research article and in the broader context of the scientific literature and research methodology. Here we describe the QALMRI method as a teaching device that provides students with an easy-to-remember guide for identifying, summarizing, and integrating conceptually important information in an empirical article, see Figure 1.

The QALMRI

"QALMRI" is an acronym that stands for:

Question:	(a) What was the broad question being asked by this research project?
	(b) What was the specific question being asked by this research project?
Alternatives:	(a) What was the author's hypothesis?
	(b) What were the alternative hypotheses?
Logic:	What was the logic of the hypotheses? If the author's hypothesis is true, then what should happen?
Method:	What were the methods?
Results:	What were the important results?
Inferences:	What inferences about the hypotheses and questions can be made based on the results?

Figure 1. An outline of the QALMRI method adapted from Kosslyn and Rosenberg (2003).

What is the QALMRI method?

The QALMRI method is an instructional strategy for teaching students to identify key conceptual information necessary for the comprehension and critical evaluation of empirical articles. It was originally designed as a loose framework to help students understand the meaning of the research described in an empirical article by identifying and drawing connections between the questions being asked, how the researcher tried to answer them, and the implications of the answer. The QALMRI method is particularly suited for improving student comprehension of scientific literature because it provides a template for organizing ideas relative to each other, integrating prior knowledge, and encouraging active construction of meaning (Anderson & Pearson, 1984; Kintsch, 1988; Lorch & van den Brock, 1997). Below we provide an overview of the QALMRI method adapted from Kosslyn and Rosenberg (2003). We have written specific QALMRI instructions for students, which instructors can copy as-is to create an instructional guide (see Appendix A for an example of a completed QALMRI summary).

Q stands for Question.

What was the broad question(s) being asked by this research project?

What was the specific question(s) being asked by this research project?

All research begins with a question, and trying to answer the question is the point of conducting research. The first step to understanding any empirical article is to identify the question or questions that were asked by the author (researcher), and understand why the question was important enough that we should care about the answer. In general, there are often two categories of questions being asked: broad and specific. Broad questions are typically too general to be answered by any single experiment and provide an overview of the general topic of interest (e.g., “What is the influence of playing video games on our daily behavior?”). Specific questions, on the other hand, can be addressed by a single experiment or set of experiments (e.g., “Does playing violent video games cause children to engage in more violent behavior?”). Answering one or more specific questions should be considered steps made toward addressing a broad question.

Generally, the first few paragraphs of the introduction of an empirical article should include the questions the article is addressing. The broad question can often be found in the very first paragraph of the introduction, where the author introduces the broad topic of interest that is being examined. It should be noted that sometimes the broad question is not made explicit, and may require some work on the part of the reader to draw a connection from the specific question to the broad topic. Additionally, specific questions might tap multiple broad issues making it difficult to identify a single broad question.

Hint: If you are having difficulty identifying the broad question, first identify the specific question, then try to connect that question to the broader topic. For example, the article might quickly introduce the specific question, “Does playing violent video games cause children to engage in more violent behavior?” and from this you might conclude that the broad question is about how video games impact our behavior. However, the topic could have been introduced by describing factors that can cause children to engage in violent behavior, and not by describing other ways video games have been shown to influence behavior. In this case, the larger issue might not be video games per se, but might center on aggression and childhood behavior. The specific question in this example is related to both of these broad questions, but it is important to separate the broad question as understood by the author, and other potential issues the question might relate to.

Depending on the writing style, the specific question might be found early in the introduction, shortly after the broad topic is introduced, or near the end of the introduction after the author has provided a review of previous work on the topic. The review of the previous work should also provide some context, explaining why the questions being addressed are interesting, important, and worth spending time and resources addressing.

A stands for Alternatives.

What was the author’s hypothesis?

What were the alternative hypotheses?

A good empirical article will consider at least two possible answers to the specific question(s) being asked. Each possible answer proposed in the article is called a hypothesis. The author should explain why each possible answer is plausible, usually referencing previous articles and theories. However, the author's preferred or favorite answer is called "the hypothesis," while other proposed answers are called "alternative hypotheses." It is important to note that some studies have multiple questions. Each of these questions will require its own hypothesis and alternative hypotheses. The hypotheses can usually be found in the general introduction. After describing the questions, the author should provide the hypotheses and explain why those hypotheses are plausible.

Again, it is worth reminding students that the hypotheses are the possible answers to the question. However, sometimes the alternative hypotheses are not explicitly stated, or even considered by the author. If the alternatives are not stated clearly, the student should try to figure out what they could be on your own. For example, if the study is attempting to confirm the predictions of a single theory, what might other theories predict? Could a different interpretation of the theory proposed by the author make a different prediction?

L stands for Logic.

What was the logic of the hypotheses?

If the author's hypothesis is true, then what should happen?

The goal of any research project is to carry out an experiment or set of experiments to discriminate between alternative hypotheses. The logic, therefore, is the general idea underlying how the alternatives might be distinguished, using empirical data as evidence for or against each hypothesis. Ideally, you should be able to state the logic in the form of an *if–then* statement. That is, if the author's hypothesis is correct, we would predict that manipulating a particular variable should change the participant's behavior in a specific way. If the alternative hypothesis is correct, then we would predict that manipulating a specific variable would change the participant's behavior in a different way. The logic of the study generally appears near the end of the general introduction. Often, the author will provide an overview of the research methods being applied in the study, and the predictions made in accordance with relevant hypotheses. From these predictions, you should be able to derive *if–then* logical statements.

M stands for Methods.

The methods are the details of what the researchers did in the study. The amount of methodological information included in an article can be overwhelming. As a reader, you should first determine what your goals are, and what level of detail you wish to learn about research methodology. We will make a distinction between having a general understanding of research design and understanding all the methodological details. Depending on your goals as a reader, a general overview may be sufficient.

A general overview of the research design. Before diving into the gritty details, you should first familiarize yourself with the general design of the study. It is important to note that there are a variety of different methods for testing a hypothesis and you should first try to identify the general method being applied. Some of the most common designs used in psychological research are experimental, quasi-experimental, and correlational. Experimental designs manipulate an independent variable to see changes in a dependent variable. For example, you could manipulate the time of day students take a test (evening vs. morning) and measure the change in test scores. Critically, in an experimental design participants are randomly assigned to one of the groups (evening or morning). On the other hand, quasi-experimental designs do not randomly assign participants to groups and instead rely on existing group memberships (e.g., musician vs. non-musician, married vs. single). For example, you could measure the difference in test scores (dependent variable) for male and female students. In this case, gender is treated as an independent variable even though we do not randomly assign participants to each condition. Finally, in correlational designs we measure variables and look for relationships between them. For example, you could measure the amount of money people make and how happy they are to examine whether there is a relationship between salary and happiness. Once you have determined the general type of research design, you should identify all the key components of the design. If the study uses an experimental or quasi-experimental design you should be able to identify the dependent variable(s) (what is being measured) and the independent variable(s). Are the independent variables within- or between-subjects? Is the independent variable manipulated (i.e., experimental) or using existing group memberships (i.e., quasi-experimental)? If it is a factorial design, you should identify the levels for each factor. It might be worthwhile to draw a table, renaming and mapping the factorial design onto the appropriate cells of the table.

A general overview of the research design is usually described at the end of the general introduction, or if there are multiple studies, in the introduction to each study. If there are any details that are unclear from the general overview, you can search them out in the Methods section.

*Methodological details***.** The methodological details found in the Methods section, provide in-depth descriptions of all the materials and procedures used throughout the study. For example, the methods section will describe who participated in the study and how they were selected. It will also describe what materials they used, how they were constructed, etc. There should be enough detail included that any researcher could replicate the study without tracking down the original authors to ask questions. The Methods section is usually broken down into the following subsections:

Participants. While reading this section, you should try to understand who participated in the study. How were they selected? Are multiple groups being compared? To what population are the researchers intending to generalize their results? Is the sample representative of that population? If a study was conducted to examine a particular population (e.g., men in their early 20's), then the participants should be as similar to that group as possible. If no particular group is specified, then the sample should be representative of the population in general. If the study uses more than one group (i.e., a between-subjects design), they should be equivalent on important demographic variables such as age, education, or gender. You should try to think of any demographic variables that are not described, or controlled for by the experimenter, that could influence the results.

*Apparatus and materials***.** The apparatus is any equipment used during data collection, whether to deliver stimuli or measure responses. The materials can include scripts, surveys, and software used for data collection, as well as any stimuli presented to participants throughout the study. The authors should describe exactly how stimuli were presented, how those stimuli were constructed or chosen, and how responses were recorded. For example, if the researcher used a computer apparatus, they should describe the software used, how long stimuli were presented on the screen, the size of the stimuli, and the types of responses recorded. You should think about how the apparatus and stimuli would have looked to the participant. Is there any aspect that would have been distracting or confusing to the participant? Is the apparatus, stimuli, response collection, etc., appropriate for the specified task?

Procedure. The procedure is the step-by-step listing in chronological order of what a participant did in the study, and if appropriate, a step-by-step listing of what a participant did for any given individual trial. You should try to picture yourself as a participant in the study. Does the task seem easy or difficult? What were the instructions given to participants? Were the instructions clear enough that participants would have understood them? Is it possible the researcher treated participants in different groups differently?

R stands for Results

What were the outcomes? The outcome of the study will be detailed in the Results section. First, you should try to gain an understanding of how participants generally performed in the task. The results of the study are often summarized using descriptive measures of central tendency (means, medians, or modes) and variability (e.g., standard deviation). These descriptive measures are usually displayed in a table or figure that provides you with an easy-to-understand summary of the results.

Second, how do you know the differences you see in the descriptive measures are reliable and should be taken seriously? We rely on inferential statistics to help us make judgments about our data. In the results section, the author will report the statistical tests (e.g., t-test, ANOVA) that they used to analyze their data and the resulting p-values. The p-value of a statistical test represents the probability you would have observed the reported difference in the sample, by chance alone assuming there are no true differences in the population (for more information, see Gigerenzer, 2004). The p-value is always a number between 0 and 1, and the commonly accepted standard is 0.05. If the p-value is less than 0.05, (say, 0.049) the result is said to be "significant," and we can be reasonably certain that the difference found in the sample, represents an actual difference in the population. Other common p-values include 0.01 and 0.001, each of which increases the probability that your results were not due to chance and represent an actual difference in the population.

Sometimes, the results section can be difficult to navigate. There can be numerous statistical tests with many different results. You should try to identify the important results. Which statistical tests directly relate to the questions asked? In other words, the hypotheses made predictions about the changes we would expect to observe in our dependent variable for each of the groups or conditions. For example, there might be predicted differences between specific groups or, in the case of correlational designs, predicted associations. Try to find the statistical tests that test those specific predictions.

I stands for Inferences.

The results section details the results of the author's measurements, and statistical inferences about whether differences between those measurements should be considered reliable. But what does it all mean? The real payoffs of conducting an empirical study are the inferences one can draw from the results that bear on the questions asked and help identify which of the possible answers (i.e., hypotheses) are most likely to be true. Given the results, what did the authors conclude? The Discussion section will contain the inferences (note that the use of the word *inference* is separate from *inferential statistics*) the authors made about their results. Ideally, if the logic and methodology are sound, the results should be more consistent with only one of the hypotheses, allowing the authors to eliminate one or more alternatives. At this point, you should be able to work backwards through the first half of our QALMRI answering all the questions the authors originally set up. For example:

(Logic) How do the results line up with the logical if–then statements?

(Alternatives) Given the results, which hypothesis does the logic implicate?

(Questions) What does that hypothesis say about the specific and broad questions?

As a goal, you should try to summarize the author's conclusions in a short paragraph, as they relate to the logic, alternatives, and questions.

Once you gain an understanding of the inferences the authors have made regarding the results, you should try to think critically about their conclusions and about broader implications. Do the statistical tests support the author's conclusions? Were any of the alternatives not convincingly ruled out? Why? Were there any limitations or confounding variables that could alter their interpretation of the results? For example, if the study uses existing group memberships (e.g., musician vs. non-musician), are there any other differences between the groups that could also explain the results? What specific and broad questions did this particular study fail to address? Do the results of this study create new specific questions that might help us understand the broader question?

Introducing QALMRI in the classroom: A scaffolding approach

QALMRI is a tool that helps students identify, organize, and summarize important information found in an empirical article. To use the tool, however, students need help learning how to use it appropriately. Here we provide a scaffolding approach for introducing the QALMRI technique in courses at different levels. We have adopted the taxonomical progression proposed by Bloom (Anderson, Krathwohl, & Bloom, 2001). Our first two stages of learning focus on remembering and understanding methods of the QALMRI itself, while the final two focus on applying the method, which then can be used to analyze and evaluate primary source material.

Novice: QALMRI summaries

Most introductory psychology students have no experience with primary research and enter post-secondary programs unprepared to read, comprehend, and interpret scientific literature (Larson, Britt & Kurby, 2009; Larson, Britt, & Larson, 2004; Norris & Phillips, 1994; Norris, Phillips, & Korpan, 2003). Requiring students, who have no foundation for understanding, to read full empirical articles will probably be an ineffective and inappropriate teaching strategy. Yet, we do want to give students experience engaging with primary sources, and use the scientific literature as a tool to teach students about psychology in general. However, the QALMRI method is also a tool, and before students can use it effectively, we must introduce the method and teach students how to use it appropriately. To accomplish this, we suggest that instructors provide students with completed QALMRI summaries (like the one in Appendix A) without requiring the students to read the articles or even complete the questions themselves. By providing completed summaries, students can focus on understanding the method and connecting the content of the summaries to introductory psychological concepts. Using completed summaries is also the easiest way to incorporate the QALMRI method into existing courses as instructors can use QALMRI summaries as a way to support existing learning objectives. For example, and to name but a few, QALMRI summaries can be used to connect psychological concepts to research, highlight important findings, demonstrate research methodologies, demonstrate data collection and analysis techniques, and connect psychological concepts to real-world problems. Importantly, this stage does not require students to complete the QALMRI or read the original article, thereby scaffolding the procedure for students, while giving them a framework to use themselves as they increase their skill level at reading primary literature.

Beginner: Adapting primary sources to include QALMRI summaries

Once students have a basic framework for evaluating primary sources, the next step is to expose them to the actual articles. However, the format of primary sources is inherently difficult for non-experts because they do not contain the guiding structure and signaling techniques built into textbook writing (Britt et al., 2014). One method that works well with the QALMRI approach is known as the adapted primary literature strategy (Yarden, Norris, & Phillips, 2015; see also Phillips & Norris, 2009). The adapted primary literature strategy is to rewrite primary source text by adapting and augmenting the article to include guiding structures, highlighting, and additional background necessary for non-experts to understand the article.

Although Yarden and colleagues (2015) advocate for rewriting entire articles, we suggest a simpler approach: keep the original text intact, but insert textboxes in critical parts of the article to highlight the QALMRI information. For example, immediately after the paragraph that contains the relevant information regarding the hypothesis, insert a textbox for the Alternatives section. At the early stage of learning, the instructor should include the answers to the QALMRI questions and, if necessary, an explanation as to how you arrived at that answer. The focus of this stage is to give students experience reading primary source articles while demonstrating how to locate and summarize key conceptual information. By providing the original text integrated with the completed QALMRI summaries, students can focus on connecting the summaries to the text while reinforcing their understanding of the QALMRI framework.

When constructing the adapted article, the instructor can include other information necessary for a non-expert reader to understand the article. For example, the instructor can provide definitions of technical terms, an explanation of jargon, or additional background information. The location of the inserted textboxes, however, is critical as a signal to the reader that they have just read the information being summarized.

Intermediate: Applying the QALMRI method to adapted articles

The intermediate stage is where the student progresses from learning and remembering the QALMRI to formally applying it. An introduction to applying the QALMRI method can be accomplished using the adapted primary literature strategy described above, but with the students (rather than the instructor) completing the QALMRI summaries themselves. That is, the instructor will provide the adapted article that contains the text boxes for each of the QALMRI sections in their relevant locations. However, the QALMRI will not be completed by the instructor and it will be up to the student to apply their knowledge and complete the QALMRI.

This approach allows the student to practice the application of the QALMRI, but retains the scaffolding of the adapted primary strategy. For example, the locations of the text boxes signal where the student should be looking for the necessary information (immediately prior to the textbox) and the instructor can include supplemental information in the relevant locations of the text to augment their understanding of the article content.

Advanced: Applying the QALMRI method to non-adapted articles

At this stage, students have learned the QALMRI framework for summarizing primary source material and have experience applying it to adapted primary articles. Now they should be ready to remove the guiding structures and supplemental information of the adapted primary literature strategy and begin practicing the QALMRI on non-adapted articles.

Using QALMRI as a student-centered teaching device

QALMRI is a flexible tool that can be used in a wide variety of ways. However, as with any educational tool, to be effective it should be used in a manner that connects to specific learning goals and engages students in active-learning strategies that will facilitate the development and organization of content knowledge and critical thinking (Kolb, 1984; Weimer, 2002). To that end, we will conclude this chapter with some examples of learner-centered activities that leverage evidence-based, effective education principles like active learning, practice, and collaboration (Chickering & Gamson, 1987), and describe how the QALMRI method and primary source reading can be incorporated into these activities. Sources are cited where applicable, however, we also provide some novel learner-centered activities in which case no source is cited.

Think / Write / Pair / Share

Source: Kaddoura, 2013

Learning-outcomes: comprehension, critical thinking

Purpose: This activity allows the instructor to start a broader discussion of the topic, to check for current understanding of the material, and challenge students to think critically.

Implementation: Taking only about 5-15 minutes from the total class time, this activity in combination with QALMRI is an excellent method to engage the whole class, while still giving students the opportunity to reflect individually.

The implementation of the activity is as follows: after a review and discussion of a study using the QALMRI method, the instructor asks students to write down their own thoughts concerning one particular aspect of QALMRI. For example, you could direct students to think about the relationship between the specific and the broad question (e.g., What aspect of the broad question is not addressed by the study? Do the results of this study create any new specific questions?). Students should pair up with a classmate and share their ideas with each other. The teacher then brings students back into a full class discussion by calling on students to share their own or their partner's answers.

Article abstract and/or introduction

Source: Bean, 1996

Learning-outcomes: comprehension, writing

Purpose: This activity challenges students to make connections between the QALMRI sections, reframing, and rewriting the QALMRI summary in a formal abstract or introduction format.

Implementation: The instructor selects a relevant article from the current topic being studied and provides a completed QALMRI summary to the students. From the QALMRI summary, students spend 10-15 minutes rewriting the QALMRI in the form of an abstract, summarizing the study in their own words. Alternatively, for a take-home written assignment, you can instruct the students to write an introduction for the study, requiring additional sources to help motivate the study using background literature.

One-minute paper

Source: Angelo & Cross, 1993

Learning-outcomes: comprehension

Purpose: The main purpose of this activity is to quickly assess student's current knowledge of the topic of interest.

Implementation: This activity provides a structured way to elicit student participation during in-class discussions. The instructor directs the class to write down as much as they know about a particular section of QALMRI for several minutes. This allows students to formalize some thoughts on a particular issue. The instructor can either collect the written responses to assess student knowledge on the topic, or simply use the activity to spur class discussion. By allowing students time to gather their thoughts and write a response that ensures that everyone participates and allows the instructor, armed with the knowledge that every student has a response, to cold-call students for a response. This activity is often best implemented either before the start of the class to allow students time to think about the topic prior to the lesson, or after the lesson, as a reflection on what they have learned.

Reverse engineering

Learning-outcomes: comprehension, application, critical thinking, experimental design

Purpose: This activity challenges students to think critically about experimental design, and to practice data analysis and data interpretation.

Implementation: First, the entire class participates in an experiment, unaware of the purpose. The instructor acts as the researcher, conducts the experimental procedure and collects the class data. Then students break into groups and are tasked with identifying the important aspects of the experimental design (e.g., what were the independent/dependent variables?) and deciding, as a group, what questions the experimenter was asking, and identifying possible hypotheses.

In reverse engineering, and similar to the think/write/pair/share activity, the entire class then reconvenes to share their ideas and ultimately reach consensus on what questions were being asked and what the hypotheses were. Then the class data are analyzed, the results determined, ending with the class discussing the implications of the findings in relation to the hypotheses and questions. The data analysis can be completed by students in small groups or as a class led by the instructor.

Failure analysis

Source: Baker College, 2009

Learning-outcomes: critical thinking, experimental design

Purpose: Challenge students to think critically about how a study is motivated and constructed by identifying failures in experimental design.

Implementation: The instructor presents students with a completed QALMRI summary of an experiment. The chosen experiment could be from a published study (e.g. Flegal, Kit, Orpana, and Graubard, 2013; Wakefield et al., 1998) or the instructors can design their own study. However, the study chosen should be flawed in some critical way. For example, the study may have failed to account for a specific confounding variable, have poorly constructed logical if–then statements, or have used an inappropriate statistical analyses. The instructor can break students up into small groups who are tasked with identifying one or more critical flaws in the study and proposing a solution.

The construction of the flawed study can target various aspects of the QALMRI depending on the learning goals. For example, the failure in design could result from failing to address the questions asked (Questions), failures in logic (Logic), omitting important alternative hypotheses (Alternatives), methodological errors (Methods), incorrect use of statistical tests (Results), or unsubstantiated conclusions (Inferences). As an assessment, groups can either write down their analysis following the QALMRI guidelines or present their findings to the class.

Guided-discovery learning

Source: Apple & Krumsieg, 2000

Learning-outcomes: critical thinking

Purpose: An active-learning activity that puts the responsibility of discovering new course content on the student.

Implementation: The instructor gives the students a specific research question related to the current class topic. Students (either individually or as a group) are tasked with conducting a literature search to find an empirical article that addresses the question and tests a hypothesis. The QALMRI provides the set of guided questions that students need to answer from the chosen article. Each of the groups could then present their article and QALMRI summaries to the class, which is followed up with an in-class discussion about the various answers proposed.

Peer-review

Learning-outcomes: critical thinking, writing

Purpose: This activity aims to improve students' reading comprehension, writing skills, and develop effective collaboration practices.

Implementation: Peer-review is an invaluable technique that allows students to think critically about others' writing and incorporate constructive feedback into their own writing. QALMRI provides a nice rubric for students to review empirical, APA style research reports written by their peers and, in turn, receive constructive feedback on their own research reports. Students are instructed to exchange drafts of their research reports and try to complete the QALMRI, making note of information that is unclear or missing, and providing feedback about how the clarity of the reported information could be improved.

After students complete their peer-review, they should meet with their partner(s), exchange completed QALMRIs, and discuss the feedback. For the student receiving feedback via QALMRI, this activity provides an opportunity to see how a reader interpreted their writing and ideas. The rubric serves to identify areas where the reader misinterpreted the writing, and it provides specific suggestions for improving the report. For example, the reviewer might state the specific and broad questions they thought the writer was asking. Were those questions the ones that were intended?

Question-of-the-day / Challenging misconceptions

Learning-outcomes: critical thinking

Purpose: The purpose of this exercise is to formalize an argument about commonly held misconceptions and challenge those arguments using primary sources and the QALMRI method.

Implementation: This in-class activity can serve as a starting point on the current class topic encouraging students to think critically about a topical issue. At the beginning of class, the instructor gives the class a "question-of-the-day" and instructs the students to spend 5-10 minutes writing an answer and justifying why they believe their answer to be correct. These questions need not be controversial. For example, the question could be "What is the best way to remember a new piece of information?"

Students are then given an article that addresses the issue, organized into small groups, and instructed to work through the QALMRI method to summarize the study. Or if time is limited, the instructor can present the study using the QALMRI format. The class can then discuss the strength of evidence for the study's conclusion, and whether they should update their own beliefs. Of course, if the topic is sensitive, students do not have to share their responses to complete this activity. The activity can be constructed as a personal reflection rather than public discussion of personal beliefs. For common myths and misconceptions to draw from as inspiration for this activity, see Lilienfeld, Lynn, Ruscio, and Beyerstein (2011) or Furnham and Hughes (2014).

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Appendix A

Example of a completed QALMRI summary

Ecological validity of the testing effect: The use of daily quizzes in introductory Psychology (Batsell, Perry, Hanley, and Hostetter, 2017) Full article: http://journals.sagepub.com/doi/full/10.1177/0098628316677492	
The "testing effect" refers to the finding that people better remember information after being tested on that material, as compared to only studying. Testing has also been shown to enhance memory for study material that did not appear on the initial test (referred to as retrieval-induced facilitation), demonstrating more general benefits of testing as a way to enhance memory and learning. Although there is much evidence to demonstrate the testing effect in the laboratory, there is little evidence of the testing effect in real-life, classroom settings. The current study examines the testing effect in a naturalistic setting by comparing memory performance for Introductory Psychology material in one class that studied the material and received brief daily quizzes to another that studied the material but did not receive daily quizzes.	
Question: What was the broad question being asked by this research project? What was the specific question being asked by this research project?	What kinds of teaching techniques will improve student learning in a classroom? Will daily quizzes enhance retention of assigned study material?
Alternatives: What was the author's hypothesis? What were the alternative hypotheses?	H1: Daily quizzes will improve memory for study material whether the material had appeared in a quiz or not. H2: Daily quizzes will only improve memory for study material that appeared in the quizzes. H3: Daily quizzes will not improve memory for study material
Logic: What was the logic of the hypotheses? If the author's hypothesis is true, what should happen?	*If H1, then* a quizzed group will perform better than a study-only group on a memory test for all the studied material. *If H2, then* a quizzed group will perform better than a study-only group on a memory test, but only for the material that appeared on the tests.

	If H3, then a quizzed group will not perform better than a study-only group on a memory test for the studied material.
Methods: What were the methods?	**General overview:** The study used a 2x3 factorial design (quasi-experimental). Students enrolled in two Intro Psychology courses took part in the study. The participants were all assigned textbook readings which consisted of material not taught during the lectures. One class received daily quizzes (21 total), while the other did not. Memory was tested three times throughout the term using 15 multiple-choice questions. Test questions were either identical to the quiz questions (identical), similar in content to the quiz questions (similar), or questions that did not appear in the quizzes (new). **Independent Variable A:** Class (study-only and quiz) ● One class received daily quizzes while the other did not. ● This variable is between-subjects and quasi-experimental (students were not randomly assigned to classes). **Independent Variable B:** Question-Type (identical, similar and new) ● Memory test questions were either identical to those used in the quizzes (identical), similar in content to those used in the quizzes (similar), or did not appear in the quizzes (new). ● This variable is within-subjects and experimental (questions were randomly assigned to each condition). **Dependent Variable:** Accuracy averaged across three memory tests.
Results: What were the important results?	There were two results of importance: 1. The Class x Question-Type ANOVA and follow-up *t*-tests show that the quiz group outperformed the study-only group on all three question types. However, this difference was greatest for identical questions (21.8%), then similar questions (17.6%), and smallest for new questions (12.7%). 2. ANOVAs with follow-up *t*-tests were also run separately on the quiz and study-only groups. The results for the study group showed no differences in performance across the identical (58.4%), similar (62.8%), and new (60.4%) question types. The results for the quiz group however, showed that performance

	for the identical (80.2%) and similar (80.4%) questions was significantly better than performance for the new questions (73.1%).
Inferences: What inferences about the hypotheses and questions can be made based on the results?	**Summary:** The results of the experiment show enhanced retention of studied material when participants were quizzed daily regardless of whether the study material was actually presented during the quizzes or not. The authors conclude that they successfully replicated the testing effect, previously shown in laboratory settings, in a naturalistic classroom setting. Furthermore, they conclude that the testing benefit generalizes non-quizzed material and therefore instructors do not need to quiz all of the study material to gain the testing effect benefit. These results are consistent with the original hypothesis (H1), and suggest that periodic quizzes can enhance the retention of assigned material (specific question) and testing could be used as an effective teaching technique to improve student learning in a classroom setting (big question). **Thinking critically:** The authors ran multiple statistical tests on the same set of data without controlling for Type I error inflation. This potentially could impact the interpretation of their results. For example, the interaction between Class and Question Type resulted in a “significant” *p*-value of .047. From this result, the authors suggested that the testing effect varied across question types. Applying any error correction for the number of statistical tests would render that result non-significant. The use of two different classes, across two different semesters, with different instructors could potentially produce other confounds. As the authors note, they cannot rule out the possibility that some characteristics of the class or the instructor motivated students more in the quiz class than the study class, which lead to better performance. Additionally, students were not randomly assigned to each of the classes. Therefore, some characteristic of the course (e.g., time of day, time of year, instructor) might cause certain types of students to self-select for one class over the other, which could lead to differences in performance.