

An Exercise to Assess Student Understanding of Bottleneck Concepts in Research

Methods

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**Empirically-Supported Teaching Strategies in this Resource**

The following exercise utilizes the following three best practices in teaching:

1. Low-Stakes Writing

The writing exercise in this exercise utilizes low-stakes writing, helping students actively apply course concepts to a specific audience in their own language and without requiring a polished lengthy paper. Benefits of such an activity include: (a) it takes little time, (b) students actively engage with class concepts, and (c) in the long run, students can improve high-stakes writing by practicing written communication and revision in a low-anxiety setting (Elbow & Sorcinelli, 2011).

1. Metacognition

Students are often “unskilled and unaware” when it comes to understanding difficult, bottleneck concepts (Kruger & Dunning, 1999, p. 1121). This gap between confidence and competence reflects students’ deficits in metacognitive skill to judge their own learning. Instructors can use this exercise first to assess whether this gap occurs, and second, to help students realize that their current learning strategies may not include the process of self-assessing how well they “own” the material. If students see the gap between confidence and competence themselves, instructors can better identify where the error in understanding occurs (remembering the original definition of a concept, understanding how to differentiate one concept from a similar one, using logic in applying a concept, etc.). Highlighting the gap between confidence and competence opens the conversation with students about employing additional metacognitive strategies such as active reading, engagement with homework without using examples, and “teaching the material” rather than “studying” it (McGuire, 2015).

1. Examination of Bloom’s Taxonomy

This assignment offers an opportunity to introduce students to Bloom’s Taxonomy and emphasize the different levels of “knowing” material. Specifically, instructors can ask students to explain and apply research methods topics, thus engaging in the “remembering,” “understanding,” and “applying” levels in the Bloom hierarchy. Introducing Bloom’s taxonomy may help instructors shift student goals from GPA to learning goals (McGuire, 2015). It also allows students to contrast the levels of Blooms’ they have used in the past with the levels they need for deeper understanding.

Elbow, P. & Sorcinelli, M. (2011). Using high-stakes and low-stakes writing to enhance learning. In W. McKeachie & M. Svinicki (Eds.), *McKeachie’s Teaching Tips*. Belmont: Wadsworth.

Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing

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McGuire, S. Y. (2015). *Teach students how to learn*. Sterling, VA: Stylus Publishing.

**Introduction**

Our exercise makes use of the notion of *Bottleneck Concepts* in psychology. After a description of bottleneck concepts, we describe our exercise, provide the materials we use, and discuss possible uses of the exercise. We designed this exercise to assess students’ understanding of, and communication about, research methods-related bottleneck concepts by asking them to define and apply research concepts in their own writing. The exercise derives from what we know about bottleneck concepts, metacognition, use of writing to assess and teach, and the importance of research methods as a foundation of psychology (APA, 2014).

Instructors can use this exercise in several ways, including to assess a) how well students can work with these concepts, and (b) how effectively their department is teaching these concepts throughout the psychology curriculum.

As part of their work on “decoding the disciplines,” Pace and Middendorf (2004) discussed what they called bottlenecks—difficulties that students have in understanding some essential components or concepts in a discipline. Gurung and Landrum (2013) built on this notion to identify challenging content in psychology. They defined *bottleneck concepts* as “deceptively difficult, perhaps due to student overconfidence” (Gurung & Landrum, 2013, p. 236).

In this exercise, we present students with a fictional news story of a (fictional) research study, which found that junior and senior students at a small private college who participated in extracurricular activities (ECAs) had higher Grade Point Averages (GPAs) than students who did not participate in these activities. After students read the article, we tell them that a state senator has proposed a law requiring all freshmen at state colleges to participate in at least three hours of ECAs per week in an effort to increase GPAs. The article and scenario contain enough information for students to determine that there are problems regarding sample generalizability, causation/correlation, confounding variables, and reliability of the research results. Students need to understand these concepts from media portrayals and understand that the research described does not warrant the proposed law.

Students then write a letter to the original researchers in which they (a) identify problems in the original study that may lead to misinterpretation, and (b) suggest study modifications that would strengthen the argument for a causal relationship between ECAs and GPA, and thus, the policy.

We provide the instructions and the news story. We also provide follow-up questions regarding students’ confidence and competence in understanding these concepts. Students rate the difficulty of each bottleneck concept and their confidence in their own understanding of these bottleneck concepts. Cognition research shows that students’ own judgments of how easy/difficult it will be to remember concepts are only moderately accurate (Mueller, Tauber, & Dunlosky, 2013). Inaccurate judgments of learning lead to overestimations of future performance and the *competence illusion*. Students’ confidence may indeed be stronger than their competence (Castel, McCabe, & Roediger, 2007).

Finally, we include a 9-point rubric that can be used to assess students’ understanding and application of these concepts. We also suggest potential modifications to this exercise that will allow the instructor to tailor the assignment to meet their personal course or departmental goals.

**How to Use this Exercise**

We have provided materials that can be used in a variety of courses in various ways. We encourage instructors to adapt these materials for their own purposes and give some suggestions for modifying the exercise from its current form in the “Adaptations” section below.

**Courses**

* Introduction to Psychology (High School or College)
* Statistics
* Research Methods
* Upper Level Courses with at least one of these APA (2013) 2.0 goals
  + 1.1 Describe key concepts, principles, and overarching themes in psychology
  + 1.3 Describe applications of psychology
  + 2.1 Use scientific reasoning to interpret psychological phenomena
  + 4.1 Demonstrate effective writing for different purposes

**Adaptations (to instructions, news story, follow-up questions, and/or rubric)**

* Include additional concepts
  + Statistical vs practical significance (add small but significant r value to article)
  + Anecdotal vs empirical evidence (Do quotes or data have more weight?)
  + Information literacy (evaluate sources of information and article itself; discuss over-interpretation of results; evaluate how a popular press article differs from a peer-reviewed journal article)
* Add follow up questions
  + Demographics
  + Previous psychology courses taken
  + Connect this exercise to other material in the current course or the curriculum
* Evaluate writing style, grammar
* Allow students to revise their writing, to develop and better express their understanding of these concepts

**Classroom Uses (adaptions may apply)**

* Exam question
* Short paper for class
* Critical thinking exercise (for example, “compare/contrast statistical vs practical significance”)
* Discussion or debate prompt (for example, “How good does science need to be to inform public policy?”)
* Reflection prompt (for example: relationship to other concepts or courses; information literacy)
* Pre-post course assessment (for example, content knowledge and critical thinking skills)
* Suggestions for using the questionnaire
  + Correlate confidence and difficulty ratings to check for inverse relationship (higher confidence relates to lower competence, as literature suggests).
  + Compute bottleneck score for each concept by multiplying confidence and difficulty ratings.
  + Compute correlations among overall rubric score with difficulty judgments, confidence ratings, and computed bottleneck scores
  + Plot ratings of confidence and competence by performance on essay itself (actual score earned) to investigate whether a larger gap between these ratings and actual performance exists at the lower ends of scores compared to the higher ends, as literature suggests
  + Have students reflect on their own bottleneck scores, and average scores for the class

**Departmental Uses**

* Assess APA (2013) goals
* Track development of majors’ knowledge and skills
* Assess the relationship of learning to student demographics
* Curriculum development (for example, effectiveness of the transfer of learning, rigor of upper-level courses)

**Stimulus Materials**

**General Instructions**

You will read a brief news story, complete a writing task based on the article, and then answer some follow-up questions.

The news story is similar to ones published in news sources all across the country.  Your task is to:

a)   read the article carefully

b)   complete the writing assignment

c) answer the questions that follow

**News Story**

**Researchers find relationship between extracurricular activities and GPA among college students**

by Steven Santora, education reporter

(AP) College students may want to strap on their running shoes and join an intramural running club, or dust off their old clarinet and join the orchestra. A researcher at Hendrick College, a small private school in the area, has been looking at the relationship between engaging in extracurricular activities and academic success in college.

C. R. Welsh, an assistant professor at Hendrick College, randomly selected a group of 500 juniors and seniors at Hendrick, many of whom engaged in a wide range of extracurricular activities (ECAs), including sports (intramural and intercollegiate), music, theater, student government, volunteer activities in the community, honor societies, and other student clubs.

Welsh found a correlation between the number of hours of ECAs and GPA; the more hours spent the higher the GPA. The researcher described the correlation as “small but statistically significant.” Professor Welsh said, “It didn’t matter what type of ECA it was; students who regularly engaged in ECAs have higher GPAs.”

If you’re headed to campus this fall, you might want to dust off that clarinet.

**Writing Task:**

     After you read this article you find out that, based in large part on the research done by Dr. Welsh, State Senator Smith is proposing a new state law **requiring** all freshmen at state-funded universities to engage in extracurricular activities (ECAs) for at least three hours a week. Senator Smith stated, "This research is really important. If GPA and ECAs are related, we can bump up students' GPAs by having them do extra-curricular activities. We want to have students in our state do well, and anything that will increase GPA is a great thing.”

**This task has two parts:**

**Part A:**

You notice that the research study discussed in the article does not provide enough evidence for the senator’s proposed law. Your task is to refute (argue against) the Senator’s argument for his proposed law, addressing the following aspects of Dr. Welsh’s research:

* Correlational research
* Class level(s) of the sample
* School(s) used in the sample
* Role of other (extraneous or confounding) variables
* Replication

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**Part B:**

Show how Dr. Welsh could do some additional research to provide more useful information that could possibly strengthen the Senator’s argument. Your suggestions should address the following aspects:

* Experimental research
* Class level(s) of the sample
* School(s) used in the sample
* Role of other (extraneous or confounding) variables
* Replication

**Follow-up Questionnaire**

1. How hard was it for you to do the writing assignment?
   1. Very Hard
   2. Pretty Hard
   3. Neither Hard nor Easy
   4. Pretty Easy
   5. Very Easy
2. How difficult for you is it to understand the concept of “**Correlational Research**”?
   1. Easy
   2. Medium
   3. Hard
3. How difficult for you is it to understand the concept of “**Experimental Research**”?
   1. Easy
   2. Medium
   3. Hard
4. How difficult for you is it to understand the concept of “**Representative Sample**”?
   1. Easy
   2. Medium
   3. Hard
5. How difficult for you is it to understand the concept of “**Generalizability**”?
   1. Easy
   2. Medium
   3. Hard
6. How difficult for you is it to understand the concept of “**Extraneous or Confounding Variables**”?
   1. Easy
   2. Medium
   3. Hard
7. How difficult for you is it to understand the concept of “**Replication**”?
   1. Easy
   2. Medium
   3. Hard
8. How confident are you that you understand the concept of “**Correlational Research**”?
   1. Not at all
   2. Moderate
   3. Very much so
9. How confident are you that you understand the concept of “**Experimental Research**”?
   1. Not at all
   2. Moderate
   3. Very much so
10. How confident are you that you understand the concept of “**Representative Sample**”?
    1. Not at all
    2. Moderate
    3. Very much so
11. How confident are you that you understand the concept of “**Generalizability**”?
    1. Not at all
    2. Moderate
    3. Very much so
12. How confident are you that you understand the concept of “**Extraneous or Confounding Variables**”?
    1. Not at all
    2. Moderate
    3. Very much so
13. How confident are you that you understand the concept of “**Replication**”?
    1. Not at all
    2. Moderate
    3. Very much so
14. How much exposure have you had to these concepts in psychology courses *outside of statistics and research methods courses?*
    1. None at all
    2. Very little
    3. A moderate amount
    4. A lot
    5. Not applicable: Haven’t taken any other psychology courses

**Rubric**

**(9 point scale)**

**General Considerations**

* The five issues to be scored are
  + Correlational research
  + Class level
  + Type of college
  + Other variables
  + Need for replication
* Each issue, except for replication, can receive one point for identifying the problem and one point for suggesting a modification.
* A point for a modification does not automatically score as a problem point.
* For any point to score, statements must refer to the STUDY (the original research), not only to the news story or future policy/law.
* For any point to score, a statement must refer to specific information about the study described in the news story. For example, students can’t just use phrases like “correlation does not mean causation” without reference to the study variables.
* For modification points: Language needs to be clear that a statement addresses a FUTURE study, rather than referring to previously collected data. For example, “sample should be,” or “researchers should also measure work hours” indicates a modification for a future study.
* No double dipping! You cannot use the same statement or phrase to score 2 points (for example, both problem and modification) unless the second half of the statement is used to show the problem in need of a modification presented in the first part of the statement.
  + For example, “You should measure motivation, because motivation may increase ECA participation and lead to a high GPA; that’s why they were related in the first place,” scores for modification and problem for “other variables.”

**CORRELATIONAL RESEARCH**

**Point for problem**: must put **into context** (reference to study and variables) that correlation does not establish causation; this is not an issue of there being a linear vs. curvilinear relationship

* Score: “A correlation does not say ECAs CAUSE GPA to rise.”
* Score: “They didn’t have a control group **who doesn’t do ECAs**.”
* Do Not Score: “Variables are related, but you’re not sure there isn’t another variable driving them both” because there is no context
* Do Not Score: “It could be that too many or too few ECAs can get in the way of your GPA.”
* Do Not Score: “Can’t make policy based on correlational research,” because it is too vague of writing
* Do Not Score: “There is no control group for this study,” without more explanation.

**Point for modification**:

Do an experiment; use random assignment; control for other variables (without specifying other variables); using pre-post design is acceptable

* Score: “Measure student GPAs before and after they participate in ECAs.”
* Score: “They should use a control group that doesn’t do ECAs.”

**CLASS LEVEL**

Student needs to note that the research was done only on upperclassmen whereas the policy refers to requiring freshman to participate in ECAs.

**Point for problem**: researchers only studied juniors/seniors; “need to include all grade levels”;

e.g., “the study was based off of Juniors and Seniors and not freshman…”

**Point for modification**: legislation is directed toward freshman so include freshman in sample

* Score: “The sample should be freshman through seniors.” “Should’ indicates new sample.
* Do Not Score: “The sample should have been freshmen through seniors,” because statement refers back to original study (a point for problem but not for modification)
* Do Not Score: “Use freshmen,” if they haven’t made it clear that the class level in the study was a problem.

**TYPE OF COLLEGE**

**Point for problem**: Can point out that doing the study at a “small” OR a “private” school was a problem; can’t just “report” that study was done “at a small private school” without saying why that is a concern

* Score: “The sample was from a small private school and doesn’t generalize to state- funded schools.”
* Do Not Score: “The study was done in a small private school,” with nothing else
* Do Not Score: “Repeat study at other types of universities,” because that’s a modification and doesn’t explain problem.

**Point for modification**: also sample people from large, public universities

* Score: Repeat the study at non-private colleges such or technical schools.”
* Do not Score: “replicated and research on the ‘targeted audience’ before action is taken.” If ‘targeted audience’ is NOT directly linked back to problems (such as class levels or schools) even if mentioned right before. To score, following sentence must have a “Therefore,” or some wording to indicate they are referring back to these specific things.

**OTHER VARIABLES**

**Point for problem:** understand other variables that could pull for correlation OR that are relevant to using the study as basis for policy. Must **SPECIFY at least 1 other variable; cannot specify the type of ECA** (because the article says type of ECA didn’t matter)

E.g.: FT/PT work; SES; family income; gender; age; major; “academic motivation,” # of hours in ECA, voluntary vs. required participation, ethnicity, “demographics,” etc.

* Score: “Correlation could be due to other variables besides ECAs themselves, such as workload, course load, etc.”
* Score: “other demographics of your sample.”
* Do not score “Correlation could be due to ‘other variables’ beside ECAs themselves.” (nothing specific)

**Point for modification**: measure or control for these variables in the study; random assignment in an experiment (random assignment controls for other variables)

* Score: “I would suggest you record how many hours they put into (ECA) and their GPA after so many months.”
* Score: “A more in-depth research of the students’ background is needed because many factors contribute to higher GPAs, including SES.”
* Do not score: “Other things need to be measured in a new study,” because “other things” is not specific
* Do Not score: “Modify study based on problems I’ve addressed.”

**NEED FOR REPLICATION: One point only – either problem or “modification”**

**Point for need to replicate**:

* Score: “It’s only 1 study” or “It’s only 1 study (or school), you should repeat it;” “to see stability of results”; shows the importance of repeating a study for consistency of findings
* Score: If other researchers were to do the same study at a different campus, would they get the same results?”
* Score: “The study should be done again with a new group of students.”
* Score: “Do the study in more schools.”
* Score: Do modified study several times to ensure reliable results (can get point for replicating a modified study—modify study, then do that one a few times)
* Score: “Repeat on other campus cultures”
* Score: “Do more correlational research to provide more evidence.”
* Do Not Score: “This wouldn’t be the hardest study to replicate.” (just using word)
* Do Not Score: The use of “replicate” for “modification,” for example, “Replicate the study at randomly selected state-funded universities,” because this is a modification
* Do Not Score: “I think the study should be ‘replicated’ and researched on the targeted audience before action is taken,” because this is a modification

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