Teaching-to-Learn:
Its Effects on Conceptual Knowledge Learning in University Students

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ABSTRACT

Students report poor learning goals and study strategies. Educators may encourage better learning by requiring students to complete assessments that promote generative learning. The benefits of engaging in generative processes suggest encouraging them through teaching-to-learn assignments may be helpful. There is little research examining the benefits of teaching-to-learn conducted as part of a classroom curriculum with appropriate control conditions. The current study examines the benefits of teaching-to-learn on conceptual knowledge learning by requiring 53 students to prepare and deliver a lecture in one unit and write a paper in another unit. Students then answered questions covering their lecture and paper topics on both a unit and surprise final exam. Analyses on exams revealed students answered a greater percentage of the questions about their lecture topic correctly (84.91% and 76.23%) than their paper topic (76.98% and 67.92%) on both the unit and final exam respectively.

KEYWORDS

Elaborative Rehearsal, Learning, Learning by Teaching, Pedagogical Research, Teaching Strategies, Teaching-to-Learn

INTRODUCTION

When students decide how to study, they may choose from a variety of study strategies with varying degrees of effectiveness (Dunlosky et al., 2013; McConnell Rogers, 2020). Some strategies encourage students to use deep processing as they study the material. When processing material deeply, students use elaborative rehearsal strategies that encourage students to manipulate the material and think about the meaning of the material (Craik 2002). These strategies tend to lead to better long-term retention and greater conceptual knowledge than more shallow strategies (Bartoszewski & Gurung, 2015; Koster & Vermunt, 2020; VanZile-Tamsen & Livingston, 1999). When students use shallow strategies, like highlighting, they tend to focus on memorization rather than understanding the material. These shallow strategies require the students to minimally process the material and result in minimal gains in test performance (Dunlosky et al., 2013).

When students study material they often create a learning goal (Nelson & Narons, 1990). For example, a student's goal may be to memorize the material, or it may be to understand it. Unfortunately, often student's goals focus more on memorization, which typically results in minimal performance (Bartoszewski & Gurung, 2015; Dunlosky et al., 2013). Educators may promote better learning using assessments that encourage students to monitor their learning and focus on understanding important concepts. For example, when learners engage in assessments such as collaborative testing (LoGiudice et al., 2015), writing-to-learn (Gingerich et al., 2014), and knowledge-in-use assignments

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(Harris et al., 2019) they typically show better performance on classroom exams. Mayer's (2014) Select-Organize-Integrate model of generative learning provides a helpful guide for thinking about learning and how to develop assessments that might promote it. According to this model, the most important aspect of successful learning is how students make sense of new learning. As students engage in generative learning they must select relevant content, organize the selected material, and integrate it into existing knowledge (Fiorella & Mayer, 2016; Mayer 2014). The benefits of engaging in these generative processes suggest encouraging them through course assignments should benefit student learning and requiring students to engage in teaching-to-learn may be particularly helpful.

Typically, when students engage in teaching-to-learn practices they receive the role of teacher tasked with teaching academic content to other students. Educators have many options for incorporating teaching-to-learn into their courses, such as using peer tutors, providing peers feedback on assessments, using students as co-teachers, and requiring students to develop educational materials (Duran 2017). Previous studies support the benefits of teaching-to-learn. Students who engage in reciprocal peer tutoring perform better on exams (Dioso-Henson, 2012; Peets et al., 2009; Roscoe & Chi, 2007), participants who prepare a lecture perform better on a surprise memory test than participants who do not (Annis, 1983; Fiorella & Kuhlmann, 2020; Fiorella & Mayer, 2013; Muis et al., 2016), and participants who teach a lecture perform better on a surprise test than participants who do not (Annis, 1983; Fiorella & Mayer 2013). A recent review of 28 studies with Japanese students confirmed the benefit of teaching-to-learn and suggests students may benefit from teaching in multiple educational and cultural settings (Kobayashi, 2019b).

THEORETICAL EXPLANATIONS

The Select-Organize-Integrate model of generative learning provides a good theoretical explanation for why incorporating teaching-to-learn into a course should promote student learning (Fiorella & Mayer, 2016). Students can use various generative techniques when studying. For example, many students report summarizing the material, which is a process that requires students to generate content (Bartoszewski & Gurung, 2015). However, a technique like summarization does not necessarily encourage students to check whether they understand the information during the learning process. Another technique, self-explaining, is generative and encourages reflection and monitoring of learning (Fiorella & Mayer, 2016). Learners can use this strategy when studying alone or with peers, and studies show this approach leads to better exam performance than less generative and reflective strategies (Dunloksy et al., 2013). Teaching-to-learn is a similar generative strategy that requires learners to explain content and should be more likely to encourage them to intentionally employ the selecting, organizing, and integrating generative processes. As learners prepare to teach others, they must select the relevant content to teach, organize the content in a meaningful way, and consider how examples and applications should integrate the content into existing knowledge. Teaching-to-learn may also differ slightly from self-explaining as a generative strategy because the learner needs to anticipate questions when preparing to teach, and recent studies suggest anticipating questions may be important in explaining the benefits of teaching-to-learn (Hoogerheide et al., 2016; Kobayashi, 2019a; Muis et al., 2016).

LABORATORY VERSUS CLASSROOM STUDIES

When examining the literature supporting the benefits of teaching-to-learn, many studies examined the benefits of teaching as a part of a laboratory study, and only a few studies required students to teach material as part of an actual course curriculum. These laboratory studies included specific controlled conditions that do not necessarily suggest they would translate to success in a classroom. In many of these studies, participants studied unfamiliar material for a brief time in a controlled setting (Hiller et al., 1973; Hoogerheide et al., 2016, Nestojko et. al, 2014). For example, in Hoogerheide et al.'s (2016) study participants watched a 13-minute video on unfamiliar material and then received 6 minutes to prepare to teach the content. Participants also typically deliver very short lectures (e.g., Fiorella & Kuhlmann, 2020; Fiorella & Mayer, 2013). Participants in Fiorella and Mayer's (2013) study received ten minutes to study unfamiliar material and then lectured to a camera for 5 minutes. These tightly controlled laboratory experiments allow researchers to examine potential cognitive processes underlying the benefit of teaching because they remove factors like knowledge of the content and motivation in class. However, these laboratory results are not necessarily guaranteed to translate to improved learning in the classroom when incorporated into the curriculum. As discussed by Daniel and Pool (2009), experimental findings highlighted in controlled laboratory settings may not produce similar results in the classroom because of the many uncontrolled factors such as students' motivation to learn, selection of study techniques, and aptitude. If educators want to consider requiring students to teach material as a tool to help them learn, we need to examine whether these laboratory studies replicate in a classroom setting.

There are a few studies that have examined teaching-to-learn as a part of a classroom curriculum; however, they tend to lack the control needed to ensure the teaching assignment and not other factors led to the increased learning. For example, in several studies, participants in the teaching group did not engage with the material in a similar method as the participants in the control group—such as comparing learning between teaching assistants and students (e.g., Fremouw, Millard, & Donahoe, 1979) or tutors and tutees (e.g., Sharpley, Irvine, & Sharpley, 1983). Although these results suggest the value of teaching-to-learn, it is less clear whether these benefits may appear when comparing students with similar roles in the course and who spend more similar amounts of time with the material. Additionally, studies examining the benefits of teaching-to-learn have relied on between-subjects designs, which makes it more difficult to control for individual differences such as knowledge of the content and motivation—both important factors in the classroom.

CURRENT STUDY

Together these studies suggest the potential benefits of requiring students to teach material as a part of a course assignment, but we need to bridge the gap between the tightly controlled laboratory and the less controlled classroom studies by requiring students to engage in teaching-to-learn techniques like those used in the laboratory but as a part of the required curriculum in their course. To accomplish this, students in psychology courses prepared and gave a brief lecture on an assigned topic and wrote a paper on another topic. Their performance was examined on multiple-choice questions assessing conceptual knowledge of the topics they taught and wrote about on a unit and final exam.

Fifty-three students in two sections of a 200-level cognitive psychology course at a private liberal arts university in the Pacific Northwest participated in the study. Thirty-five students identified as female and 18 identified as male. Thirty-six students were psychology majors who enrolled in this course as an elective they can take to fulfill the requirements of the major, and 17 students completed the course as an elective in the psychology minor. Two additional students started the course but withdrew from the course before completing the assignments and exams. Participants completed the study as part of a required course assignment and could opt out of including their scores in this study; however, all students opted to include their data. No students requested accommodations requiring changes to the structure of the assignment.

MATERIALS AND PROCEDURE

All students delivered a lecture in one unit and wrote a paper in another unit. Students self-selected which unit they lectured on and which they wrote a paper on through a sign-up sheet, which had enough spots for half of the students to complete one lecture in each unit. The paper topics matched the lecture topics for each unit, and students wrote the paper covering the topic they did not teach. Students answered multiple-choice test questions covering those topics on two unit exams and one final exam. For both assignments the Unit 1 topic was object recognition and the Unit 2 topic was theories of encoding. Twenty-six students lectured on object recognition and 27 students lectured on encoding. The students were to demonstrate conceptual knowledge and understanding of the assigned topics. This within-subject design allowed the researcher to examine test performance on questions covering topics students taught and topics they wrote about. Specifically, students who gave the lecture on Unit 1 material wrote the paper in Unit 2, and students who gave the lecture in Unit 2 wrote the paper in Unit 1.

Lecture and Paper Assignment

Students received a rubric for both the lecture and the paper that explained all requirements and encouraged students to demonstrate understanding and application of course material. For the assignments, both topics had already been taught by the instructor. The students were instructed to create novel examples and applications and to try to describe key concepts using their own words. The rubric instructed them to demonstrate an understanding of topics in hopes of encouraging better learning goals with the assignment (see Appendices A and B for the paper and teaching rubrics, respectively).

For the lecture assignment, students delivered a 10-minute lecture in Unit 1 or in Unit 2. In preparing the lecture, students selected relevant concepts, explained the relevant concepts using their own words, provided novel examples of the concepts, and discussed real-world applications of the concepts. These guidelines were selected because they align with the generative processes proposed by the Select-Organize-Integrate model (Fiorella & Mayer, 2016; Mayer 2014). Students used presentation software to deliver the lecture allowing them to try to use images to explain concepts and include key concepts on the slides. Students delivered the lectures outside of class time to two trained teaching assistants. The lectures were also filmed for grading purposes using Panopto technology that syncs the video with the presentation software. While there are many teaching-to-learn methods that could work well in the classroom, we required students to teach a brief lecture because this methodology aligns more closely with the previous laboratory studies (e.g., Fiorella & Mayer, 2013). The shorter length could also minimize student anxiety about teaching and limit the time needed outside of class to listen and grade the lectures.

Because previous research suggests that anticipating and answering questions may be needed to fully benefit from teaching information (Hoogerheide et al., 2016; Kobayashi, 2019a; Muis et al., 2016), students knew they would be asked two questions following the lecture from the teaching assistants. The teaching assistants asked all students to provide an additional example of a concept and to explain a concept in a different way. The teaching assistants were knowledgeable on the assigned topics and received a detailed assignment key to assist with grading. To grade the lectures, the instructor reviewed the rubric and key with the teaching assistants and assigned points for each element. Both teaching assistants assigned a grade for each lecture, and for any lectures that the assigned grade was more than two points apart, the instructor viewed the filmed lectures and assigned a grade. The instructor then used the average of the assigned grades.

The paper assignment required students to write a two-to-three-page paper explaining relevant cognitive psychology topics (object recognition or theories of encoding) to a hypothetical member of the community. Students selected a hypothetical member of society that they believed could benefit from learning more about these cognitive principles, and then wrote a paper with that person as the target audience. Students used language, examples, and concepts that should be understood by that audience. The same grading procedure with the teaching assistants and instructor was used for the paper assignment as the teaching assignment.

Unit and Final Exams

To measure the short-term benefit of using teaching-to-learn techniques on students' conceptual knowledge, students answered five multiple-choice questions on the Unit 1 exam that covered object recognition and four questions on the Unit 2 exam that covered theories of encoding (see Appendix C for a sample of the multiple-choice questions). All students answered identical questions regardless of which assignment they completed in each unit. Because this was an introductory cognition course, the conceptual knowledge was measured using multiple-choice exam questions fitting Bloom's Taxonomy of Educational Objectives category of understanding. It can be important in an introductory course to assess lower-level conceptual learning like knowledge and understanding before building to higher-level learning over time (Bloom et al., 1956). These test questions were a part of the unit exams that contributed to students' overall course grade. These questions represented about 15% of the multiple-choice questions on the Unit 1 and 2 exams. Because there were five questions covering object recognition and four covering theories of encoding, the raw scores were converted to percent correct for each topic and these ratio scores were used for analyses. The unit exams occurred about 1 week after the teaching and paper assignments were due.

To measure whether teaching content leads to longer retention of conceptual knowledge, these same nine questions were included as surprise final exam questions. These questions were included as optional bonus questions, and as long as students attempted to answer these questions, they received a bonus point on their final exam. The final exam was not comprehensive, so students did not expect these repeated questions from the Unit 1 and 2 exams and had no reason to study these topics covered on previous exams. The final exam occurred about 1 month after Unit 2.

Estimates of Time

Immediately before completing the unit exams, students in one course section reported how much time (in hours) they spent preparing the teaching and paper assignments. Students in both sections also reported how much time (in minutes) they spent studying the topics covered in their lecture and covered in their paper. They received a bonus point on each unit exam for providing this information.

Results

Students' raw score on the relevant multiple-choice questions on the unit and final exams was converted to a percent correct. A 2 (assignment type: lecture vs paper) by 2 (exam type: unit vs final) repeated measures ANOVA was conducted. It revealed a significant main effect of assignment type with participants answering a greater percentage of the lecture relevant questions ($M = 80.57$, $SD = 19.81$) than the paper relevant questions ($M = 72.1$, $SD = 22.32$) across both exams, $F(1,52) = 19.56$, $p = .0001$, partial eta squared = .273. There was also a significant main effect of test type with students performing better on the relevant questions on the unit exams ($M = 80.95$, $SD = 21.49$) than on the final exam ($M = 72.08$, $SD = 20.64$) across both assignment types, $F(1,52) = 9.183$, $p = .004$, partial eta squared = .150. However, as shown in Table 1, there was no significant interaction between assignment type and test type, $F(1, 52) = .001$, $p = .999$, partial eta squared = .001.

DISCUSSION

Current results suggest requiring students to teach as a part of the course curriculum may promote conceptual knowledge comprehension and retention because students had higher test performance on questions about their lecture topic than their paper topic. These results suggest previous laboratory work showing the benefits of teaching-to-learn can be replicated in the classroom (e.g., Fiorella & Mayer, 2013). This enhanced performance on the teaching questions over the paper questions continued when these same questions occurred as optional bonus questions on the final exam. Because the final exam was not cumulative, students did not expect to answer questions covering topics from the previous unit exams. This suggests the students retained the conceptual knowledge without further studying the material after the unit exam.

To better understand why participants performed better on the lecture questions than on the paper questions, it is helpful to examine how much time students reported preparing the assignments and

Table 1. Average percent correct by assignment type and exam type

Assignment Type	Exam Type	
	Unit Exam	Final Exam
	M (*SD*)	*M* (*SD*)
Lecture	84.91 (19.22)	76.23 (20.40)
Paper	76.98 (23.76)	67.92 (20.88)

Note. Students answered test questions covering topics they lectured on and wrote about. The same questions appeared on the unit and final exams.

Note: Students answered test questions covering topics they learned on and wrote about. The same questions appeared on the unit and final exams.

studying the material. The benefit of teaching may have occurred simply because students spent more time preparing their lecture than their paper assignment. However, analysis revealed students reported spending similar amounts of time (in hours) preparing the lecture assignment ($M = 3.25$, $SD = 1.22$) and the paper assignment ($M = 2.52$, $SD = 1.64$), $t(24) = 1.672$, $p = .108$, $d = .499$., 95% CI [1.688, 1.608]. This suggests the better exam performance on the lecture relevant questions may not be due solely to differences in the amount of time spent preparing the assignment. To examine whether the amount of time students spent studying could explain the results, students reported how much time (in minutes) they spent studying the lecture and paper relevant topics. Students reported spending similar amounts of time studying the topics covered in their lecture ($M = 56.17$, $SD = 77.62$) and in their paper ($M = 48.08$, $SD = 51.77$), $t(52) = .683$, $p = .498$, $d = .123$, 95% CI [15.81, 32.11]. Together these findings suggest the better performance on the lecture questions is not due to simply spending more time preparing or studying the lecture topics. Although these findings are promising, it is important to note some limitations. Only half of the participants reported how much time they spent preparing the assignment because this question was added after the first section completed the semester, which results in a lower sample size. Also, the standard deviations between the lecture and paper questions are larger for the paper topic in both analyses. Additionally, there is no way to confirm the accuracy of their estimates, and students may not accurately remember their time and effort. To try to minimize potential motivations students could have for inflating their time estimates, the students provided the estimates after already receiving their assignment grades. This could deter students from inflating their estimates in hopes of receiving a higher grade. Importantly, because this is a within-subject design with students reporting time estimates for both assignments, if the estimates are inaccurate, there is no clear reason to suspect students would be more likely to systematically provide biased estimates for one assignment over the other. However, given these constraints, these estimates should be viewed cautiously, and further research should continue exploring how different assignments may change how students study and prepare for exams.

Because students reported similar time preparing both assignments and studying both topics, we can cautiously assume the benefits of teaching-to-learn are not simply a result of spending more time on those topics. Instead, these findings suggest something about the psychological processes used when preparing the lecture, delivering a lecture, and anticipating and answering questions during the lecture lead to greater conceptual knowledge and understanding. When viewing learning as a generative process through the Select-Organize-Integrate model, these findings support previous research suggesting teaching-to-learn is a generative process that can result in better learning (Fiorella & Mayer, 2013, 2016). As students developed the lecture, they needed to select important content, organize the material in a meaningful way, and integrate examples and applications into existing knowledge. This is consistent with other research showing the benefits of generating material on retention (e.g., Slamecka & Graf, 1978; Metcalfe & Kornell, 2007). Additionally, preparing a lecture and anticipating questions may shape the learning goal students set to focus on understanding (e.g., Nelson & Narens, 1990), which could encourage more elaborative learning strategies (e.g., Dunlosky et al., 2013). The continued improvement on the final exam aligns with previous research showing the use of elaborative learning techniques leads to better retention than does the use of more shallow techniques (e.g., Dunlosky et al., 2013).

LIMITATIONS

Although these results suggest requiring students to teach promotes learning, the specific method used in this study may not reflect other types of teaching-to-learn. The students delivered brief lectures because this reflected the methodology used in the laboratory studies. However, such a short lecture does minimize the amount of content students can teach. Further, because all students lectured on the same broad topic in each unit, it was a better use of class time to require students to deliver the lectures to teaching assistants outside of class. Because of this approach, students likely engaged with the material and audience very differently than when using other teaching-to-learn techniques such as peer reciprocal tutoring or collaborative learning. To encourage students to approach the lecture as a teaching-to-learn opportunity and not solely as an oral presentation, the assignment guidelines asked students to select the important content to teach, anticipate questions, create novel examples, and use their own words. However, this approach was still a different teaching-to-learn experience than those occurring with their peers in the classroom. Additionally, in the current study, students taught and wrote about topics already taught by the instructor. Although students were instructed to create novel examples and applications, the benefits of teaching material may change when teaching novel material because when teaching new material, the student may need to exert more effort in the select stage of generative learning than when teaching material already taught by the instructor.

Although examining the benefits of teaching as a part of an actual course assignment is an important part of pedagogical scholarship, this study does have less control than some of the previous work conducted in laboratories (e.g., Fiorella & Mayer 2013; Hoogerheide et al., 2016;). The current study also did not try to discern which aspect of teaching-to-learn (i.e., preparing the lecture, delivering it, or anticipating questions) leads to better learning as have some of the laboratory studies (e.g., Fiorella & Mayer, 2013; Hoogerheide et al., 2016), nor did it try to specifically test whether the Select-Organize-Integrate model of generative learning is the best explanation for the benefits of teaching-to-learn. Instead, this study examined whether the overall findings in the laboratory studies would extend to a better controlled classroom setting. Despite these limitations, the findings from this study suggest that requiring students to teach material can be one tool used to improve student learning of material.

FUTURE DIRECTIONS

Because results from the current study demonstrate using the controlled teaching-to-learn techniques from laboratory studies can translate into better test performance in an actual course, future research needs to further explore how to balance methodological control with teaching-to-learn techniques that involve more interaction among peers. For example, an important step could be for students to lecture in the classroom to peers who need to learn that content for the exam. If the students are teaching new content to peers who need to learn the material, this may require them to be more mindful when selecting material to teach, considering how to organize it, and reflecting on how to help their peers integrate new concepts into existing knowledge. The current study focuses on the benefit of teaching for the student giving the lecture, but as instructors, we should also be interested in any potential impact from the peers receiving the lecture. For example, previous research shows medical students perceived high levels of their own learning when rating peer instructors in an anatomy course (Agius et al., 2018), and students who attended peer teaching sessions performed better on exams (Viana et al., 2019). Additionally, the current study assessed the benefits of teaching on conceptual knowledge fitting Bloom's taxonomy of understanding. Because educators hope to promote both lower and higher-level learning as students progress through the curriculum, future studies should examine teaching-to-learn on higher-level learning. As educators consider how to incorporate teaching-to-learn activities in the classroom, they should assess the benefit of teaching-to-learn by using a within-subject design like that used in the current study. For example, a popular corporative learning approach, jigsaw, requires students to take different roles and teach different content to their small group peers (Yoshida, 2018). Typically, students are tested on both what they taught their peers and what those peers taught them. Educators should examine whether students answered more test questions correctly on the questions they taught compared to the questions they did not teach. Educators can then use this information to adjust how they integrate teaching-to-learn techniques in their own courses.

CONCLUSION

Because students often report using poor study strategies that focus on memorization, educators can promote more learning through assignments that teach students how to engage with material. One tool educators can use is developing assignments that help students learn how to select, organize, and integrate their learning. Incorporating teaching-to-learn techniques into the classroom is one approach for helping students shift their learning from memorization to a more generative approach. As a promising instructional technique for conceptual knowledge comprehension and retention, future research could examine its use for higher levels of learning.

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APPENDIX A.

Paper Rubric

Unit 1 Paper Rubric

General Overview

The department is starting a publicly-accessible website that explains and frames psychological research and knowledge in ways that would be usable to community service agencies, individuals in the human service industries, and people in the community. This website would provide thoughtful and practical information about current research and innovative insights in the human sciences relevant to diverse areas including education, mental and physical health, child development and parents. You will write an article geared to a member of the Spokane community explaining "Theories of Object Recognition". Any outstanding assignments may be selected to be published on our website. This highlights the need for accuracy, clarity, creativity, and writing in an engaging style. If your article is selected for publication, we will most likely go through a lengthy revision process. This is a great opportunity for you to share the importance of psychology, how psychology research can be applied to everyday life, and to engage through technology the greater Spokane community.

Specific Details

Select a member of the community. This may be a teacher, parent, therapist, air force instructor, or any other person and highlight importance concepts in "theories of object recognition" that may be relevant to their life or career. Take a specific task(s) that person may do, and explain how theories of recognition can be useful to that person. You need to select the important concepts, define the concepts in your own words, provide examples of the concepts, and apply the concepts to real life (in a way that is relevant to this person). These concepts cannot simply be ideas mentioned during class or the textbook. You need to show your own ability to apply and integrate the material covered in this topic. As an example, a video game developer could use the 3 theories of object recognition to better make video games.

Unit 2 Paper Rubric

General Overview

The department is starting a publicly -accessible website that explains and frames psychological research and knowledge in ways that would be usable to community service agencies, individuals in the human service industries, and people in the community. This website would provide thoughtful and practical information about current research and innovative insights in the human sciences relevant to diverse areas including education, mental and physical health, child development and parents. You will write an article geared to a member of the Spokane community explaining "Theories of Encoding". Any outstanding assignments may be selected to be published on our website. This highlights the need for accuracy, clarity, creativity, and writing in an engaging style. If your article is selected for publication, we will most likely go through a lengthy revision process. This is a great opportunity for you to share the importance of psychology, how psychology research can be applied to everyday life, and to engage through technology the greater Spokane community.

Specific Details

Select a member of the community. This may be a teacher, parent, therapist, air force instructor, or any other person and highlight importance concepts in how to better get memories in to long-term memory that may be relevant to their life or career. Take a specific task(s) that person may do, and explain how these concepts can be useful to that person. You need to select the important concepts, define the concepts in your own words, provide examples of the concepts, and apply the concepts to real life (in a way that is relevant to this person). These concepts cannot simply be ideas mentioned during class or the textbook. You need to show your own ability to apply and integrate the material covered in this topic. You should mention at least 3 theories of encoding from short term into long-term memory, and you should focus on the most helpful theories. As an example, a teacher could use the theories of encoding into long-term memory to better teach students how to study.

Grading Criteria for Unit 1 and Unit 2

Your paper should effectively cover the components of the paper. You could cover the 3 theories, create own examples (at least 1 per theory), creates own application (at least 1 per theory) that is different from examples, uses language lay person understands, reads like website not school paper, & the topic you select is practical and helpful to your target audience

1. Your discussion of the components demonstrates you read the textbook and thought about the assignment.
2. You provide good specific concepts from class.
3. Your content for the website is based on class information (lecture and textbook).
4. You did not simply repeat examples from the textbook or class.
   An A paper must also demonstrate:
5. The article makes the best use of class information.
6. Your examples are unique and helpful
7. You provide a thoughtful discussion and refection the concepts.
8. You demonstrate a superior knowledge of cognitive psychology
9. You demonstrate a superior ability to integrate, apply, and explain the course content in your discussion.

APPENDIX B.

Teaching Rubric

General Overview

When I work with students to help them study more effectively, I typically tell them to study the material as if they were teaching it. In fact, many students report when they are studying, they pretend to teach others the material. Growing research suggests teaching material may promote learning. For these reasons, you will each prepare an online lecture in which you teach an assigned concept and answer questions. Half of the class will teach a set of concepts from Unit 1 and the other half will teach a set of concepts from Unit 2. You will be graded on your knowledge of the content, ability to explain the concepts, content you choose to teach, ability to answer questions, and presentation skills. You will sign up for either Unit 1 Lecture or Unit 2 Lecture. If you teach the Unit 1 lecture you will complete the Unit 2 psychology website article assignment, and if you teach the Unit 2 lecture, you will complete the Unit 1 psychology website article.

Specific Details

The Unit 1 Lecture Topic covers Theories of Object Recognition under the topic of Bottom up Processing. Unit 2 Lecture Topic covers Theories of Encoding (At least 3 of the best methods of encoding from Long Term into Short Term Memory NOT from retrieval lecture).

Prepare a 10-minute lecture teaching the important concepts and theories for Object Recognition (unit 1) or Theories of Encoding unit 2). Your lecture needs to include important concepts and theories, your own good example (1 per theory) good examples, a real life application (1 per theory that is different from your example), and illustrate the importance of the concepts. The lecture needs to be well organized and should make use of a presentation tool like PowerPoint or Prezi. The teaching assistants will ask you two questions after the lecture.

You will record your video using Panopto and answer the questions using blackboard. More details about these specifics coming shortly.

You will be graded on the following:

(1) your ability to select the important topics to include in a 10 minute lecture
(2) your ability to spend the appropriate amount of time on each topic
(3) your understanding of the concepts and theories
(4) the accuracy and clarity of the definition, examples, applications, illustration of importance
(5) effectiveness of the presentation tool (e.g., appropriate use of images and use of text)
(6) presentation ability (well-rehearsed, not overly relying on notes, appears to be explaining content as opposed to repeating memorized speech)
(7) using your time well while still keeping lecture within the time limit (spend more time on important topics)
(8) Your ability to answer questions effectively, correctly, and clearly

APPENDIX C.

Sample Test Questions

Unit 1 Object Recognition

1. Stacey improves her facial recognition by focusing on distinctive chins or noses. This technique reflects the concepts of which theory of recognition?
    a. Top Down Processing
    b. Template Theory
    c. Feature Analysis Theory
    d. Recognition by Components Theory
2. Stan takes longer to decide whether one letter is different from a second letter when those two letters share a large number of critical features. This seems to support which theory of object recognition?
    a. Recognition by components theory
    b. Template theory
    c. Feature analysis theory
    d. Top Down Processing
3. Beth is in drawing 101. She finds it boring because they keep focusing on drawing basic shapes like cylinders and cones, because her teacher says most complex 3-D objects are comprised of these shapes. Her teacher is most likely using which theory of object recognition?
    a. Recognition by Components Theory
    b. Template Theory
    c. Feature Analysis Theory
    d. Both B and C

Unit 2 Theories of Encoding

1. Thinking of how hungry you are when you heard the word "lunch" is an example of which theory of encoding?
   a. self-relevance
   b. testing effect
   c. desirable difficulty
   d. levels of processing
2. Haddie has a big test coming up, and she expects it to be an essay test. She studies by thinking about big ideas and theories. However, when the test comes it is a multiple-choice test where she must recognize an exact definition. Which theory of encoding explains why Haddie may be upset at the change in exam format?
   a. self-relevance
   b. self-generation
   c. transfer appropriate processing
   d. levels of processing
3. Which of the following examples demonstrates encoding specificity?
   a. The experiment where participants had better memory of train when it was paired with the "weak" cue black than when it was paired with the "strong" cue whistle.
   b. Jelly would make the best retrieval cue for someone who recently ate a peanut butter and banana sandwich.
   c. Students who study on land do better than students who study under water.
   d. All of the above