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Active Processing via Write-to-Learn Assignments: Learning and Retention Benefits in Introductory Psychology

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Abstract

This study evaluated brief, in-class write-to-learn assignments as a tool for promoting learning and retention in large, introductory psychology courses. A within-subjects (student) design was used with assignment of concepts to write-to-learn and copy (control) conditions counterbalanced across sections for each instructor. Students performed better on exam questions that pertained to concepts they actively wrote about than those that pertained to conceptual information they copied from an instructor's slide. On a retention test taken approximately 8.5 weeks after the course, students continued to perform better on write-to-learn concepts than on copied concepts. The findings suggest that write-to-learn assignments facilitate active processing of lecture material, which produces modest benefits for learning and retention of key, conceptual knowledge.

Keywords

write-to-learn, active processing

Many instructors adopt techniques that encourage students to actively learn rather than passively listen during lectures (Bonwell, 1996). One such technique, in-class write-to-learn assignments (WTLs), is becoming increasingly popular in large introductory psychology courses. The emphasis of WTLs is on the process of *reaching understanding through writing* and not on performing or simply communicating what has already been learned (Bean, 1996; Elbow, 1997; Emig, 1977; Wade, 1995). WTLs are undoubtedly a practical and useful approach to facilitating active engagement, including in large courses. What is less certain, however, is whether active engagement via WTLs translates into better understanding (learning) of course material as assessed via exam performance. Moreover, there are no current studies that speak to the question of whether WTLs facilitate retention of course material beyond the semester's end. The purpose of this study was to address these important questions.

A WTL may prompt students to generate an original example, evaluate a research finding, or apply a concept to a real-world situation. WTLs may be planned but can also be done spontaneously in response to a discussion point or to emphasize particularly troublesome concepts. One practical advantage of WTLs is that they are completed in just a few minutes of class time (Angelo & Cross, 1993; Lefton, 2005). A second advantage, especially when considering their use in large courses, is that they do not require a significant time commitment on the part of a grader (Nevid, Pastva, & McClelland, 2012). A few points may be awarded for participation, but WTLs do not have to be assigned a grade because the emphasis is not on performance. Thus, even in classes that include hundreds of students, WTLs offer *all* students the opportunity to actively engage with key concepts.

There is some evidence that minute papers, which require students to synthesize material by writing a response to a general question (e.g., what is the most important thing you learned in today's class?), are associated with better learning of material than simply asking students to think about the material at least when administered in smaller recitation sections that accompany a large introductory psychology course (Drabick, Weisberg, Paul, & Bubier, 2007). There is also evidence for a learning benefit related to the in-class writing of "microthemes," which prompt students to think critically about and apply lecture material and which are graded for content (Stewart, Myers, & Cully, 2010). However, this benefit has been established only in small (14–20 students) sections of psychology of women courses. Moreover, the microthemes required approximately 12 min of class time, leaving open the question of whether brief in-class WTLs would similarly yield a learning benefit.

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There are few studies to date that have examined whether there are measurable benefits of using in-class WTLs in the brief format that is frequently used in large courses such as Introductory Psychology (see Merek, Christopher, Koenig, & Reinhart, 2005, for an evaluation of out-of-class writing assignments). In one study, Butler, Phillmann, and Smart (2001) found mixed evidence for learning benefits for short, in-class WTLs—most exam questions were not responded to more accurately by students in the section who completed the writing assignment than in the section who did not. However, about 25% of the exam questions revealed a WTL benefit. More recently, Nevid, Pastva, and McClelland (2012) found improved exam performance for concepts that students wrote about during 16 in-class WTLs (which were assessed via 16 exam questions throughout the semester) compared to concepts they did not write about (i.e., 195 concepts that were unrelated to the student writings and for which there was an exam question).

The current study sought to examine whether brief WTLs produce a learning benefit in large introductory psychology classes, a benefit for which mixed evidence currently exists (Butler et al., 2001; Nevid et al., 2012), and evaluate whether the benefit reflects the active-learning processes that WTL assignments promote or is instead attributable to other theoretically less pertinent factors. For example, as Nevid et al. (2012) acknowledged, the WTL benefit they found might be attributable to the additional time and effort spent on the concept rather than to the writing process itself, an explanation that could similarly account for WTL or WTL-like benefits in studies that employed between-subject (student) designs (Butler et al., 2001; Drabick et al., 2007; Stewart et al., 2010). The WTL benefit in all prior studies could also be accounted for simply by in-class exposure to relevant content (i.e., content that was deemed important by the instructor and tested at a later point) during the WTL because the control conditions were not equated for exposure. Alternatively, WTL and related (e.g., use of microthemes) benefits could reflect active-learning processes such as deeper engagement with material via application of concepts or generation of conceptually relevant information, processes that have been associated with enhanced retention in laboratory settings (Craik & Lockhart, 1972; McDaniel, Waddill, & Einstein, 1988; Slamecka & Graff, 1978).

To more clearly delineate the role of active-learning processes in WTL benefits, we conducted an ecologically valid experiment with several important design features. First, we implemented a stronger control condition than used in prior studies. The control condition required that students spend an equivalent amount of time writing about the *same* concept as students in the WTL condition, but importantly the writing was in the form of copying from an instructor-provided slide and not active processing of the concept. Thus, the WTL and control conditions differed in the extent to which the writing promoted *active*-learning processes (e.g., self-generation of examples, applications, or related conceptual information) but were equated with respect to exposure to and in-class time spent with relevant conceptual content. As an example, consider the sample WTL prompts from our study shown in the Appendix. To respond to the WTL prompt, students actively generated relevant information about a concept and/or actively applied the concept by generating new examples. By contrast, to respond to the copy prompts, students simply wrote word for word the relevant conceptual information that was provided by the instructor. Second, we manipulated condition (WTL vs. Control) within subjects (students), and importantly, counterbalanced assignment of concepts to WTL or control conditions across two sections of each instructor's course (see Table 1). This ensured that each concept served in both conditions, thereby controlling for concept difficulty, concept interest, clarity/richness of lecture material pertaining to a concept, and so on, factors that were not controlled for in prior studies (Butler et al., 2001; Drabick et al., 2007; Nevid et al., 2012; Stewart et al., 2010).

This study additionally examined the novel question of whether any learning benefit produced by the WTLs would be evident beyond the semester's end (see Stewart et al., 2010, for a retention benefit related to microtheme writing, with retention defined as performance on multiple choice questions administered during Week 10, which assessed knowledge of material covered in Weeks 2 through 7 of a course).This question is practically important, given some departments' administration of comprehensive exams to graduating seniors, students' desire to perform well on the Psych GRE and retain relevant knowledge for graduate school or employment purposes, and broader concerns about the value of a college education, including its assessment (e.g., Arom & Roksa, 2011).

Method

Participants

Nine hundred twenty-four students consented to participate in the study in the fall of 2011. Participants were enrolled in six sections of Introductory Psychology at a large state university, with section sizes ranging from 95 to 171 students. The majority of students were female (60%). Most (80%) were freshmen, but each section included students of every level. All participants were nonpsychology majors; a wide variety of majors were represented.

Three instructors each taught two sections of Introductory Psychology. Two of the instructors were faculty with primary teaching responsibilities and one was a third-year doctoral student with previous teaching experience. The instructors used the same textbook, and their basic course requirements and content schedule were the same.

Design and Procedure

Twelve times during the semester, students in all six sections completed an in-class WTL assignment. The WTL assignments were designed to give students the opportunity to write about a concept in a way that would deepen their understanding of it. For example, when learning about independent and dependent variables, students were asked to write an original idea for an experiment (in a sentence or two), labeling the independent and

Table 1. Scheme Used for Counterbalancing of Concepts 1a Through 12b Within Each Instructor Across the WTL and Copied Conditions.

	Instructor 1		Instructor 2		Instructor 3	
	Section 1	Section 2	Section 1	Section 2	Section 1	Section 2
1a: IVs/DVs	WTL	Copied	Copied	WTL	WTL	Copied
1b: Pos/neg correlations	Copied	WTL	WTL	Copied	Copied	WTL
2a: Limbic areas	Copied	WTL	WTL	Copied	Copied	WTL
2b: Language areas	WTL	Copied	Copied	WTL	WTL	Copied
3a: Evolutionary Psych critique	Copied	WTL	WTL	Copied	Copied	WTL
3b: Genetic research critique	WTL	Copied	Copied	WTL	WTL	Copied
4a: Piaget's stages	WTL	Copied	Copied	WTL	WTL	Copied
4b: Parenting styles	Copied	WTL	WTL	Copied	Copied	WTL
5a: Top-down/bottom-up processes	Copied	WTL	WTL	Copied	Copied	WTL
5b: Sensory thresholds	WTL	Copied	Copied	WTL	WTL	Copied
6a: Pos/neg reinforcement	WTL	Copied	Copied	WTL	WTL	Copied
6b: Schedules of reinforcement	Copied	WTL	WTL	Copied	Copied	WTL
7a: Serial position effect	Copied	WTL	WTL	Copied	Copied	WTL
7b: Spacing effect	WTL	Copied	Copied	WTL	WTL	Copied
8a: Forgetting curve	WTL	Copied	Copied	WTL	WTL	Copied
8b: Proactive/retro. interference	Copied	WTL	WTL	Copied	Copied	WTL
9a: Rationalization	Copied	WTL	WTL	Copied	Copied	WTL
9b: Reaction formation	WTL	Copied	Copied	WTL	WTL	Copied
10a: Characteristics of disorders	WTL	Copied	Copied	WTL	WTL	Copied
10b: Attributions in depression	Copied	WTL	WTL	Copied	Copied	WTL
11a: Cognitive dissonance	Copied	WTL	WTL	Copied	Copied	WTL
11b: Persuasion	WTL	Copied	Copied	WTL	WTL	Copied
12a: Deindividuation	WTL	Copied	Copied	WTL	WTL	Copied
12b: Groupthink	Copied	WTL	WTL	Copied	Copied	WTL

Note. IVs = independent variables; DVs = dependent variables; WTL = write-to-learn assignment; Pos = positive; Neg = negative.

dependent variables. They were then asked to write a sentence that captured the distinction between independent and dependent variables. Students were given a few minutes to write.

Each instructor also gave 12 copy (control) assignments in each section over the course of the semester such that a total of 12 in-class WTLs and 12 in-class copy assignments were administered (see Appendix for sample assignments). The in-class copy assignments consisted of students copying concept information from the instructor's slides for approximately the same length of time as students were given to generate answers to WTLs. For example, for the independent and dependent variables concept, students copied the following: "An independent variable is the experimental factor that is manipulated. It is the variable whose effect is being studied. It should be defined operationally. The dependent variable may change in response to manipulation of the independent variable. It is the outcome factor, and it should also be defined operationally. For example: An experimenter demonstrates that the IQ scores of 8-year-olds are higher for children who were breast fed in infancy compared to children who were given formula. The independent variable is type of milk. The dependent variable is IQ at age 8." Critically, assignment of a particular concept to either the WTL or copy (control) condition was counterbalanced across sections for each instructor. For example, when an instructor's Section 1 class completed a WTL on independent and dependent variables, her Section 2 class copied information about that concept. Students in this instructor's Section 2 then completed a WTL on a different concept from the same module of the text (i.e., positive and negative correlations), while students in Section 1 copied the material. As shown in Table 1, this means that all concepts served in both the WTL and copy conditions. There are three advantages of this design. First, it allows for a within-subject (student) comparison of the WTL and copy conditions, thereby minimizing subject-related differences (e.g., commitment to class and studying outside of class time) that might exist if the conditions were compared between classes or groups of students. Second, instructor characteristics that could affect learning of a particular concept, such as clarity of lecture material, richness of content, and degree of engagement, are balanced across the two conditions. Third, it controls for variation in the difficulty, interest, and so on, of particular concepts because each concept appears in both the WTL and the copy conditions.

The WTL assignments (in total) counted for 1% of the student's grade. Instructors wrote their own exams as usual, but all instructors' exams included one standardized multiple-choice question (written by the first author) for each WTL concept as well as each copy concept. These questions appeared on the unit exams that followed the WTL or copy activity in class, as they normally would (less than 4 weeks after presentation of the material in class), thus allowing comparison of exam question performance for WTL and copied concepts. The dependent measure was exam performance for the WTL and copied concepts aggregated across all semester exams.

During the final week, instructors notified students that they would be contacted via e-mail in approximately 6 weeks about taking a follow-up test. To examine retention of the effects of WTLs versus copied concepts, students were given the opportunity to answer 24 multiple-choice questions on the 12 concepts for which they had completed WTLs and the 12 concepts for which they had simply copied information from slides in their fall course. Students accessed the retention test via a link that instructors distributed to students. Upon logging on to Qualtrics to complete the test, students indicated consent to participate in the retention test and were asked not to consult their notes or text and to complete the test independently. Although we cannot be certain that students adhered to these instructions, fall semester grades had already been assigned and the retention test did not contribute to any subsequent assessment of a student's performance. Students were permitted to log on and take the test at any point during a 12-day period, and a reminder was sent 3 days before the survey closed. Students took the retention test approximately 8 to 9 weeks (depending on the precise date of a student's final exam and when they elected to take the retention test within the 12-day interval) following completion of the Introductory Psychology course. As an incentive for participation, students were entered in a raffle to win an iPad and an iPod. Five hundred fifty-three (60%) students completed the retention test.

Results

Data from 87 participants were excluded because these participants did not complete one or more exams. Data from an additional 21 participants were excluded because they skipped exam questions pertaining to the WTL or copied concepts or did not clearly bubble an answer to these questions. Data from 816 participants remained.

Learning Assessment (Exam Performance During Semester)

A dependent *t*-test indicated a learning benefit associated with the WTL assignments, $t(815) = -6.50$, $p < .001$. Exam performance (mean proportion correct) was significantly higher in the WTL condition ($M = .72$, $SD = .17$) as compared to the copy (control) condition ($M = .68$, $SD = .16$).[1] The effect size was in the small range, Cohen's $d = .24$.

In a subsequent exploratory analysis, we examined the relationship between the degree of benefit associated with WTLs (relative to the copy condition) and initial exam performance. One might predict that students who fair best on the initial exam, which could be a proxy for commitment to success in the course, would be those who achieve the greatest WTL benefit. Alternatively, perhaps the more able students (those fairing best on the initial exam) routinely engage in active processing of all concepts, regardless of the instructor-assigned tasks; if so, WTL benefits might be more prominent for the less able students. However, neither of these possibilities emerged: There was no relationship between initial exam performance and WTL benefit when examined via correlation, $r(814) = .01$, $p = .76$, or when examined via a grade (A, B, C, D, and F) $\times$ condition (WTL vs. copy) analysis of variance, $F(1, 811) = .26$, $p = .91$ for the interaction term.

Retention Assessment

In the analysis of retention data, we included only those participants who completed the retention test and whose data were included in the learning assessment. Although the WTL benefit (relative to the copy condition) was smaller on the retention assessment (WTL: $M = .50$, $SD = .19$; copy: $M = .48$, $SD = .19$) than on the learning assessment, the benefit was statistically significant, $t(506) = -2.38$, $p = .018$ (Cohen's $d = .11$).[2]

Discussion

This study provided evidence that WTLs produce a modest (4%) learning benefit in a large introductory psychology class. Performance on exams administered during the semester was significantly higher for WTL concepts than copied concepts. This finding is consistent with the findings of Nevid et al. (2012) as well as the select, positive evidence for a learning benefit shown by Butler et al. (2001). However, these studies were limited in drawing conclusions about the role of active-learning processes stimulated by writing in producing the WTL benefit due to (a) possible confounds such as exposure to and time spent writing about relevant conceptual content and (b) differences in concept difficulty and/or differences in students' interest in written about versus not written about concepts. Our study included several notable design features that ruled out alternative explanations of the WTL benefits, allowing us to conclude that the learning benefit for WTL concepts was related to the active-learning processes (e.g., generation and application) that they promoted and not other factors. First, improving upon prior studies, we equated exposure to, and in-class time spent with, relevant content across the WTL and control (copy) conditions. Second, we used a within-subject comparison of the WTL and copy conditions and counterbalanced assignment of concepts to the WTL and copy conditions within instructor (i.e., across sections for each instructor). In addition to those explanations described earlier, these features rule out various alternative explanations of the WTL benefit including the clarity and richness of lecture material pertaining to WTL versus copied concepts, and between-group (student) differences in motivation, time spent studying, and so on.

This study also demonstrated a small (2%) retention benefit of WTLs for the retention of information learned during the introductory psychology class $\sim$8.5 weeks after the course ended (cf. Stewart et al., 2010). For concepts studied toward the beginning of the semester, there could have been up to 5 months between the WTL and the retention test. That a very simple strategy provided a small boost to retention of course material is a novel and important finding. Future research might examine whether the size of the WTL benefit on the retention test would be increased if the sample consisted of psychology majors, who may be more motivated to retain conceptual knowledge from an introductory psychology course.

Neither the learning nor the retention benefit associated with WTLs was large in an absolute sense. According to Cohen (1988), the effect sizes were in the small range. These benefits may, however, be meaningful given that a 4% learning benefit translates to approximately one half of a letter grade improvement, and a 2% retention benefit reflects approximately one fifth of a letter grade. Whether the benefits observed here provide strong support for the adoption of WTLs is less certain. Some instructors might consider adoption of an active-learning technique from the perspective of a cost–benefit analysis, including a comparison of the current technique to other empirically supported active processing techniques. The benefits of the current technique were not large but then neither were the costs (e.g., in-class and out-of-class time for the WTL assignments). Daniel and Broida (2004) found that some approaches to web-based quizzing, like that of in-class quizzing, yielded benefits to exam performance relative to a control condition (see also McDaniel, Wildman, & Anderson, 2012). To the extent that one has access to a web-based quizzing program that handles administration and scoring, costs are comparably low. At the same time, Daniel and Broida observed benefits that were statistically larger than those found in this study, which might be viewed as evidence in support of the adoption of quizzing instead of WTLs. However, the control condition they used was a no-exposure (quizzing) control unlike the control condition in this study, which exposed students to the relevant concepts from the WTL assignments. Accordingly, direct comparison of the magnitude of the active-learning benefits (above and beyond exposure alone) between these studies is not decisive.

Still, instructors may wonder why the WTL benefits were not larger in the current study, given the potency of active-learning processes such as deep processing and generation in laboratory contexts (e.g., Craik & Lockhart, 1972; McDaniel et al., 1988; Slamecka & Graff, 1978). We note that the classroom setting is substantially different from the laboratory, wherein the experimenter often uses arbitrary materials (e.g., word pairs) to which participants have limited and controlled exposure (i.e., the only difference between generate and control conditions is the fact that answers were generated in one condition and were not in the other condition). By contrast, in a psychology course, exposure to the target material in both the experimental (i.e., WTL) and control (i.e., copy) conditions is repeated, spaced, and elaborated (through assigned reading, lectures, and students' study activities); further, the target material can be meaningfully processed and likely related to prior knowledge. These factors would plausibly attenuate the magnitude of the active-learning effects found in the more impoverished laboratory experiment. Indeed, as some researchers have noted (Daniel & Poole, 2009), these complexities of the classroom context suggest caution in extrapolating from laboratory findings to the classroom. Thus, demonstrating a WTL benefit in an ecologically valid context is important, with the size of the benefit perhaps not so surprising. Converging with our finding, a recent meta-analysis on write-to-learn interventions in school settings similarly found a small, but positive effect (Bangert-Drowns, Hurley, & Wilkinson, 2004).

A major strength of this study was its ecological validity. From an experimental standpoint, however, choosing to prioritize ecological validity meant that certain limitations were present. One limitation is that attendance was not taken, as is the normal procedure in these large classes. In theory, students could have missed more days on which material was copied than WTL days. However, it is reasonable to expect that absences would be relatively balanced across the two conditions in the very large sample used in this study. A second limitation is that the WTLs and copy assignments were not assigned a letter grade, which is a common practice when WTLs are used in classroom contexts (Nevid et al., 2012). Consequently, it is possible that students may not have always fully completed the assignments or may not have accurately done so. Of course, concerns about accuracy pertain only to the WTL condition, as it can be assumed that all students are capable of accurately copying information from slides. It is possible that exposure to relevant content may have actually favored the copy condition because students in the WTL condition did not necessarily generate fully accurate responses. Accordingly, the size of the WTL benefit is more impressive in light of this potential limitation to the WTL implementation. And, as noted earlier, the current implementation may be attractive to instructors because it places little demands on their time (both in and out of class).

In sum, this study provided novel and important evidence demonstrating small learning and retention benefits of WTLs in a large Introductory Psychology class. An exciting direction for future studies is to evaluate whether the bundling of WTL assignments with other empirically supported active-learning strategies (e.g., retrieval practice; Lyle & Crawford, 2011) would amplify these benefits. Such studies will be important in determining whether a multipronged approach more effectively promotes active learning and the durable retention of conceptual knowledge.

Appendix

Concept 8a: Forgetting Curve

WTL: Even after encoding information well, it is sometimes still forgotten. 1. Draw the forgetting curve. 2. Explain (in writing) your drawing to someone who has never heard of it. Why does it have this particular shape?

Copy: "The Forgetting Curve: Ebbinghaus found that most of the nonsense syllables he learned were forgotten fairly rapidly. However, the small percentage of words he didn't forget rapidly was retained for quite a long time."

Concept 8b: Proactive/Retroactive Interference

WTL: Sometimes memory retrieval is interrupted because we learn other material that is similar. Provide (write out) a general definition and an original example for both of these concepts: 1. Proactive Interference, 2. Retroactive Interference.

Copy: "Proactive Interference: Retrieval of newer knowledge is interrupted by something we had learned previously. Retroactive Interference: Retrieval of older knowledge is interrupted by something we have learned more recently."

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Notes

1. Instructor 3's course sections were relatively mismatched in size (147 vs. 81 students with usable data) compared to the other two instructor's sections (138 vs. 155; 146 vs. 149). This means that particular concepts were represented in the write-to-learn assignment (WTL) condition disproportionately more frequently than the copy condition, and for other concepts, the reverse was true. This could be problematic if there were large differences in concept difficulty, interest, and so on. Importantly, if one limits the analysis to Instructor 1 and 2's sections, thereby providing a more closely matched comparison of observations within the counterbalanced WTL and copy conditions, the advantage for the WTL ($M = .71$, $SD = .17$) condition over the copy condition ($M = .66$, $SD = .17$) is still highly significant, $t(586) = -6.54$, $p < .001$.
2. Because the retention test was administered online, the amount of time participants took to complete the test varied considerably from 1 min to 1389 min. The mean was 26 min (approximately 1 min per question) and the median was 11 min. Limiting the analysis to those who took at least 5 minutes and no greater than 60 minutes, or no greater than 30 minutes, did not change the magnitude, direction, or significance of the WTL retention benefit.

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