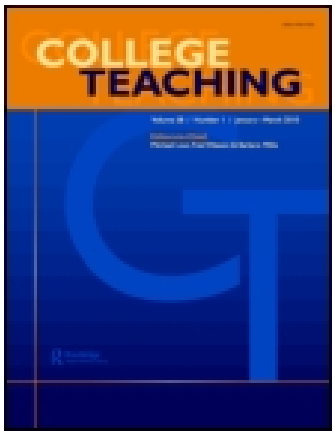

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A Note-Restructuring Intervention Increases Students' Exam Scores

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A Note-Restructuring Intervention Increases Students' Exam Scores

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It was hypothesized that students' learning would be enhanced by an intervention getting them to elaborate on and restructure the notes they had taken in lecture. Students in a research methods course were randomly assigned to weeks in which they would turn in a copy of their restructured lecture notes along with a very brief summary of the class. This intervention required students to spend *quality* time-on-task. Subsequently, results of exam questions from weeks in which students completed the intervention were compared to weeks they did not do so. The intervention improved student performance by a full class grade (11 percent, effect size $d = 1.1$) and it improved performance equally for students at the top, bottom, and middle of the class.

Keywords: note-taking, deliberate practice, active learning, comprehension, testing performance, lecture classes, educational intervention

Of all the skills acquired in a liberal arts education, perhaps one of the most basic is the ability to take in information and make it one's own, by processing it, restructuring it, and then presenting it in a form so that it can be understood by others (or by oneself at a later point). The large lecture hall is not a frequent feature of many people's lives after they leave college. However, lecture courses do provide an excellent opportunity for students to practice the basic skills that will be useful throughout their lives in making information one's own.

Many students in large lecture classes seem to have become out of practice with these skills (Arum & Roksa 2011), perhaps in part because the need for them has been greatly reduced in many college classrooms. The practice of handing out or posting online PowerPoint summaries of lectures has meant that many students no longer need to master the skills of taking notes and summarizing information for themselves (see, for example, Stefanou, Hoffman, & Vielee 2008). With PowerPoint summaries, students have the product—good notes—but skip the process—the actual taking and reconstructing of notes.

The process, however, can be quite important as note taking and re-construction can be an exercise in "active learning" that can enhance students' education (Chickering & Gamson 1987). The task of taking notes during a lecture can be quite cognitively demanding, and many students have not been taught the skills of structured note-taking (using concept maps, "structured summarization," or other devices encouraging them to organize and make connections between lecture material) (Armbruster 2008; Chew 2008 2010; Piolat et al. 2005; Rickards & McCormick 1988; Smith & Tompkins 1988). So it is likely important that students go back to their notes after class, trying to recall information to fill in holes in their notes and re-organizing material to highlight important points, identify themes, and clarify in their own minds the underlying structure of the lecture (see also Chew 2010, on the importance of studying "with retrieval and application in mind)." Lectures are necessarily linear in their progression, because they take place over time. However, the development of ideas in a lecture is not necessarily linear, and thus it makes sense to return to one's notes and organize them in a way that reflects the connections between ideas, rather than simply the chronology of presentation (Armbruster 2008; Piolat et al.

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2004). As Chew (2010) notes, "students learn more during review than they do during initial reading"; the same may be true of lectures, with the review, recall, and re-structuring being more valuable than the initial intake of information.

There is some evidence that "active learning" practices, such as the note-restructuring intervention described below will improve learning outcomes. For example, in their study of students from a range of institutions, Kuh, Pace, and Vesper (1997) found that engagement with active learning was the best predictor of educational gains. Among the active learning practices they asked about were: "made outlines from class notes or readings," "summarized major points and information in your readings or notes," and "tried to see how different facts and ideas fit together" (451). Such supportive evidence is only indirect, however, because (a) the practices above represent only 3 of the 25 practices that were aggregated into an index and (b) the educational gains were derived from subjective self-reports on the College Student Experiences Questionnaire (rather than from objective measurements) (cf. Arum & Roksa 2011).

The study described here directly addresses the issue of the causal role of a note-restructuring intervention in improving student learning. It manipulates whether students were required to re-structure their notes on a given week, and compares their performance on exam questions that came from that week vs. those that came from weeks in which they did not have a note re-structuring assignment. To be clear about the aims of the present paper: we are examining whether the note-restructuring intervention is *one* effective intervention involving active learning principles that can enhance student achievement. There are certainly other interventions that could involve active learning and deliberate practice principles; we are merely presenting this as one activity that yields particularly high "bang for the buck."

In the design below, students act as their own control, with scores during note-restructuring weeks (the "on" week) contrasted with scores from weeks in which they did not have this assignment (the "off" weeks). We do not have a control condition where students engage in some other activity during their "off" weeks that a) does not involve principles of active learning or deliberate practice but b) takes equivalent amounts of time as the restructuring assignment. This is a weakness but it is a fairly mild one, because, as research on deliberate practice has shown, "time on task" *by itself* produces very little gain (Ericsson, Krampe, & Tesch-Romer 1993; Karweit 1984; cf. Chickering and Gamson 1987). Students may be exorted to "Study more! Study harder" but without using effective techniques, this may amount to very little (beyond simple memorization) (Chew 2008 2010). In a seminal paper by Schuman and colleagues (1985), the authors attempted to "produce a positive relation between amount of study and GPA," but after a decade of "four different major investigations and several minor ones," the data left them with "a certain amount of disbelief" and the conclusion that "there is at best only a very small relation between amount of studying and grades" (pp. 945, 947). Reviewing research since that time, Plant and colleagues (2005, 97) note that researchers have "largely accepted the findings of Schuman et al. (1985)" and subsequent investigations have "consistently found a weak or unreliable relationship between" study time and GPA (cf. Rau & Durand 2000 vs. Schuman 2001). And Plant and colleagues' own study demonstrated that study time was not significantly related to college grade point average.

The intervention in the present paper is the type of task that increases *quality* study time. Structured tasks done with the explicit goal of improving performance—in the intervention below, recalling lecture material and re-organizing it to highlight theme and structure in one's notes—may not be "inherently enjoyable" (Ericsson et al. 1993). However, it is time spent in this sort of activity—rather than simple time spent on task—that leads to expertise and excellence.

METHOD

Seventy-nine students were enrolled in a social psychology research methods course with a 2 hour per week "chalk-and-talk" lecture section. Students were mostly junior and senior psychology majors at a large selective-admission state university.

Intervention

The intervention required a randomly selected 20 percent of the class to submit their note-restructuring assignments to the professor by Wednesday at noon following their Monday afternoon lecture.

At the end of each lecture, two numbers were randomly selected (using sampling without replacement). Those whose student ID numbers ended with either of the 2 digits needed to do a re-structuring assignment that week. The assignments were done for the first 5 weeks of the class, but not for the 6th week (to give all students equal time to study for the exam in week 7)[1].

The professor and students explicitly discussed the purpose for the assignments, their format, criteria for success and possible examples before students began doing the assignments. The assignments had three parts, each worth 1 percent of the student's total course grade and each was graded on a 0 (inadequate) to 1 (adequate) scale. The three parts of the assignment were:

[1]Of the 79 students, 74 completed a note-restructuring assignment during their randomly assigned week, giving a 94 percent compliance rate. To preserve the virtues of random assignment (namely, the ability to infer causality), the 5 students who did not complete the required assignment were included in the analyses presented in the text. In the second half of the course, students were given the option to replace the grade on their first note-restructuring assignment by doing a second note-restructuring assignment. Only 24 of 79 chose to do this second assignment. With 70 percent of the students not completing an assignment on the randomly selected week, an analysis of second exam questions parallel to the one reported in the text was not significant.

1) Notes: Students had to submit a typed copy of their re-structured and re-organized notes from the lecture. Notes were graded by the professor in terms of their accuracy, comprehensiveness, clarity, and coherence. The most common point deductions were because students' notes omitted important sections of the lecture, were unclear in their meaning, or were sloppily organized.
2) The "foot": Students were required to summarize the main point of the lecture in 30 words or less. The "foot" is an allusion to the story told about the famous rabbi Hillel. According to the story, when asked by a skeptic to summarize all of Judaism while standing on one foot, Hillel answered, "That which is hateful to you do not do to others. All the rest is commentary. Now go and learn" (Torah.org 2012). Similarly, students were asked to summarize the main point of the lecture simply and briefly, "as if" explaining it on one foot.
3) The "socks": Students were required to select one detail from the class and describe it in approximately 150 words, relating it to an important point from the lecture. The notion was that students need to be able to understand the complexity of the details as well as the big picture and be able to go back and forth between them. The "socks" is an allusion to the story told about the famous UCLA basketball coach John Wooden. As summarized in a recent article by Gawande (2011): "The UCLA basketball coach John Wooden, at the first squad meeting each season, even had his players practice putting their socks on. He demonstrated just how to do it: he carefully rolled each sock over his toes, up his foot, around the heel, and pulled it up snug, then went back to his toes and smoothed out the material along the sock's length, making sure there were no wrinkles or creases. He had two purposes in doing this. First, wrinkles cause blisters. Blisters cost games. Second, he wanted his players to learn how crucial seemingly trivial details could be. 'Details create success' was the creed of a coach who won 10 NCAA men's basketball championships."

Dependent Variable

The midterm exam consisted of 55 multiple choice questions, (38 based on material from lecture and 17 based on material from assigned readings; correlation between the lecture and nonlecture part of the exam was .47, $p < .001$; overall alpha for exam = .77). Most of the lecture questions required students to apply their knowledge and make inferences (rather than, say, define a term or recall a particular fact). For each lecture question, the instructor determined which week's material the question was primarily derived from. We could thus calculate for each student the percent correct for questions based on material from (a) the week the student was randomly assigned to complete a re-structuring assignment and (b) the weeks the student was not randomly assigned to complete such an assignment.

RESULTS AND DISCUSSION

The hypothesis was that students would score higher on weeks in which they were randomly assigned to complete a note re-structuring assignment (as opposed to weeks in which they were not). Because the dependent variable involved the proportion of correct answers, we transformed the variable using an arcsine transformation (Draper & Smith 1981; Cohen et al. 2003 on variance stabilizing transformations). The difference in proportion correct (transformed) in the week a given student did the note-restructuring assignment vs. the proportion correct (transformed) in weeks they did not do an assignment was significant, $t(78) = 4.87$, $p < .000006$, effect size $d = 1.10$.

For ease of comprehension and understanding the magnitude of the differences, we present the raw untransformed proportions in Table 1.[2] As may be seen, students averaged 72 percent correct (SD = 25) on questions from the week they completed a note-restructuring assignment, whereas they averaged 61 percent correct (SD = 14) for other weeks. Thus, the benefit of the note-restructuring intervention—indexed as the score for questions derived from the week students did the assignment minus the score for questions derived from weeks they did not—was 11 percent in raw percentages. In terms of an effect size, the d of 1.10 would conventionally be considered large according to J. Cohen (1988).[3]

The data were also examined to see whether the benefits of the note-restructuring intervention differentially improved

[2]The effect remains significant if the untransformed raw proportion is used in the analyses, $t(78) = 3.79$, $p < .0003$. It also matters little whether or not one includes the results of week 6, in which no student had to complete a note-restructuring assignment. If one includes week 6, the t-statistic comparing the assignment week to the nonassignment weeks goes from $t(78) = 4.87$ to $t(78) = 4.83$. The difference between the week students completed the assignment and week 6 was also significant, $t(78) = 4.08$, $p = .001$.

[3]It is possible that the effect of the intervention is driven by those who completed the assignment at the beginning of the course "sloughing off" during later weeks when they would not be called on to submit their reconstructed notes. The students who did the assignment in the first few weeks did benefit more from the intervention than students in later weeks (by week, the size of the benefit was 13%, 35%, 24%, −17%, and 3% for weeks 1 to 5, respectively). However, the effect does *not* seem to be driven by the early students sloughing off in later weeks. The raw percent correct for weeks when the student was "off" did not vary much by when the student did the note-restructuring assignment ("off" week scores were 56%, 65%, 62%, 66%, and 59% for students who did their assignments in weeks 1 through 5, respectively). For reasons that are unknown to us, the assignment was just more helpful for those randomly assigned to weeks 2, 3, 1, and 5 (in that order), and it actually may have had a negative effect for those in week 4. Our suspicion, however, is that this is simply chance variation. The data do suggest that the effect of the intervention is *not* due to early students deciding to "slough off" later on in the course.

TABLE 1
Percent Correct From Various Sections of the Exam

	Mean	SD
Questions based on the week students completed a note re-structuring assignment	72	25
Questions based on the 4 weeks students did not complete a note re-structuring assignment (but others did)	61	14
Questions based on week 6 (when no one completed a note re-structuring assignment)	64	17

the performance of students who would otherwise generally do well vs. students who would otherwise generally do poorly on the exam. However, the benefit of the note-restructuring intervention was uncorrelated ($r = .11$, $p = .33$) with students' performance on the part of the exam that was based on the readings (and not on lecture). There was neither a linear association between the benefit of the intervention and exam score on the readings (as indicated in the previous sentence) nor was there any quadratic association ($b = .01$, $t = .37$, $p = .71$, for reading score-squared when both the (centered) reading score and the (centered) reading score-squared were entered into a regression model). (Centering the reading score at zero and squaring it allows one to test whether the effect for the middle of the distribution was systematically different from the effect for people at the high and low ends). Thus, the intervention seemed to equally benefit students along the entire range (top, middle, and bottom) of the class.

Future Research

The note-restructuring assignments did succeed in significantly improving students' learning—a gain equivalent to 1.1 standard deviations or a full grade. Questions remain as to the relative effectiveness of the present note-restructuring assignment in comparison to other possible assignments and whether the intervention might work in other courses. We address these points in turn.

As noted above, students acted as their own controls and there was no control condition in which students were given an alternative assignment that consumed the same amount of time as the note-restructuring assignment. One question is what should this time-consuming assignment in the control condition be? We know from a) research on the surprisingly inconsistent and small effect of study time and b) research on deliberate practice that an assignment requiring students to simply do more of what they already do ("Study more! Study harder" (Chew 2008; Hayek & Kuh 2002)) is unlikely to have big effects—at least for the sort of learning required at the college level. By itself, "time on task" counts for very little—it's time on the *right kind of tasks* that counts. The present paper describes one example of the right kind of task that seems to provide particularly high "bang for the buck." It will be useful, however, to compare its effectiveness against other sorts of tasks and assignments that use principles of deliberate practice (Plant et al. 2005) to improve student performance. The benefits of note-reconstruction assignments should be judged against the benefits of other sorts of assignments that employ successful principles of learning.

A related question is whether the present intervention would "scale up." Or more correctly, whether it would "scale out" and work in other types of classes. It seems reasonable to hypothesize that the intervention will most help in classes where the lecture material is relatively loosely structured—either (a) because the professor is intentionally using such a structure to illustrate creative ways of approaching a problem, using examples and telling stories to make the material more memorable, wanting students to walk through the process of thinking about hard problems and discovering answers, eliciting genuine spontaneous student participation (which cannot be entirely predicted and can only be imperfectly guided) or (b) because the professor is unintentionally using a loose structure because he or she is simply disorganized (see Chew 2008; Smith & Tompkins 1988, p. 53; Sweller, van Merrienboer & Paas 1998). Future research will need to test hypotheses about the types of classes this intervention works better for, and it would not be surprising if the effectiveness of the intervention depends on the teacher's personal lecturing style, the kinds of material being presented, the type of learning demanded, and of course, the students one is presenting to (Ericsson, Krampe, and Tesch-Romer 1993; Stefanou, Hoffman, & Vielee 2008).

Further work is required. However, the present article aimed to provide an example of how an intervention designed to get students to reorganize and restructure their notes can improve student performance. Posting our notes online or putting up PowerPoint slides that can be copied down verbatim is not a particularly good way to improve student performance (for data and a review, see, for example, Apperson, Laws, & Scepansky 2006; Bowman 2009; Buchko, Buchko, & Meyer 2012; Hashemzadeh & Wilson 2007; Susskind 2005, 2008; Savoy, Proctor, and Salvendy 2009). When we do give students our notes in part or in full (Stefanou et al. 2008), students like it (Savoy, Proctor, and Salvendy 2009); and the end product—the notes—are certainly better. However, in an attempt to give the students the good "product," we may sometimes forget that it is the process, the engagement with the material—the cognitive exercise involved in recollecting, summarizing, reorganizing and restructuring—that actually matters the most.

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