

From teaching to assessment: Benefits of active lecture cues

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Abstract

The current study examined the effectiveness of active lecture cues, rather than passive lecturing, on three levels of Bloom's taxonomy. Distributed rehearsal lecture cues (DRLC) query students about course material in a repetitive manner. Conversely, elaborative rehearsal lecture cues (ERLC) prompt students to personally connect with the material. It was hypothesised that students' scores would be significantly higher for constructs taught using either active lecture cue than passive lecture techniques. It was hypothesised that DRLC would be the most effective for knowledge level test items, while ERLC would be most effective for comprehension and application level test items.

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Repeated measure ANOVAs supported the hypotheses, suggesting active lecturing techniques influence the level at which students learned the information.

Keywords: Interactive teaching, Bloom's taxonomy, Active learning, Lecture style, Assessment

Many psychology instructors hope that students will take what they have learned during a course and apply it to their own lives. In fact, a task force created by the American Psychological Association (APA), created a rubric for student learning which includes the ability to apply concepts to everyday life (Halonen, et al, 2003; Tomcho et al., 2008). However, the passive-learning paradigm that currently exists in which teachers verbally present information to students who then passively receive it, may not be the most effective way for students to learn how to apply knowledge (Lord & Baviskar, 2007; Michel, Cater III, & Varela, 2009; Stewart-Wingfield & Black, 2005). Rather, it has been argued that any techniques that involve the student personally, and actively, working with the material facilitate stronger encoding, storage, and retrieval of the material than traditional passive lecture (Katayama & Robinson, 2008; Lord & Baviskar, 2007; McGlynn, 2005; 2008; Peck, Ali, Matchock, & Levine, 2006).

Anecdotally, many instructors have found success in directly showing students how to think about material on a deep level. For example, Forrest (2005) illustrated to her students that social psychology is ubiquitous by taking them to a hockey game. The students were able to actively interpret how social psychological concepts apply to their everyday surroundings and developed their own personal connections to the material, had deeper discussions about the concepts, and learned on a deeper level. Forrest suggests that this type of activity, in which students practice the skill of application, led to thinking, and subsequently learning, at higher levels. These strategies work because active, rather than passive, teaching techniques promote deeper levels of thinking, encoding, and application, which aids in memory retrieval (Tomcho et al, 2008; Lord & Baviskar, 2007; McGlynn, 2005; 2008).

Unfortunately, creating opportunities for engagement like in-class activities, demonstrations, or taking students to a hockey game is not always feasible in the traditional classroom environment. Instead, most instructors try to find other ways to

teach the material that still engage students and teach at higher levels of cognitive processing (McGlynn, 2005). The current research attempted to find a way to effectively, but also efficiently, provide a way for instructors to create active learning opportunities with little to no interruption to their current teaching style. One possible solution is that lectures include simple and brief instructor initiated cues for interaction that prompt students to provide the teacher with information rather than just listening and taking notes. These cues may provide a subtle, efficient, and practical method of increasing student engagement during lecture. However, there are few studies that have *empirically* examined the effectiveness of using these active lecturing cues within the classroom, or how they affect learning. That is, are there techniques that can be used across topics and disciplines, and are easily incorporated into an otherwise passive lecture, which are engaging enough to prepare students for various levels of assessment?

Lecture Cues

Lecture cues are an opportunity for interaction, provided by the instructor, during an otherwise passive lecture. These brief moments may be part of the instructor's typical lecturing style, or they could be deliberately enacted in the hopes of beginning a discussion or clarifying a point. Regardless, these moments result in the students' actively engaging in the material, which leads to deeper learning (Lord & Baviskar, 2007; McGlynn, 2005; 2008; Tomcho, et al., 2008). Of particular interest are two types of lecture cues which originate from the memory processes of distributed and elaborative rehearsal.

Distributed rehearsal is the process of strengthening memory through repeated presentations and practiced retrieval of information, spaced out over time (Modigliani & Hedges, 1987). This rehearsal can occur in many forms, such as repeated presentations, cyclical repetitions, or even homework or exams. Past studies have shown that this type of spacing, often referred to as the spacing effect, is robust and highly beneficial for memory, especially for vocabulary words and concepts, because it increases one's ability and speed to retrieve or recall the information explained in class (Dempster, 1988; McGlynn, 2005; Modigliani & Hedges, 1987).

Important to academia, this memory process offers professors opportunities to prompt student learning via **distributed rehearsal lecture cues (DRLC)**. That is, instructors can repeatedly query students about the same material multiple times throughout the lecture or even a semester. For example, when teaching students about aggression; a professor might ask students if they can explain which part of the brain, discussed in a prior lecture, would be active when one experiences aggression. Theoretically, students would then think about the material discussed in prior lectures or look through notes in order to answer the question correctly. Thus, DRLC prompts students to repeatedly retrieve information which, much like distributed rehearsal, should strengthen their ability to recognise or recall it again later (Craik & Lockhart, 1972; McGlynn, 2005).

Elaborative rehearsal is a memory process that incurs a different type of cognitive processing. This memory process involves assigning relevant meaning to a construct, as opposed to rehearsal and memorisation of a functional or conceptual definition (Benjamin & Bjork, 2000; McGlynn, 2005). Elaborative rehearsal fosters long term memory because the larger the amount and type of connections that one has to the material, the more retrieval cues one can rely on later (Benjamin & Bjork, 2000; McGlynn, 2005).

As it relates to academia, an **elaborative rehearsal lecture cue (ERLC)** would consist of a general prompt for students to connect the material being learned with something already located in their personal long-term memory. This would be beneficial because anytime an example is presented, or students generate an example along with the definition of a construct, the opportunity for deeper learning is increased (Wollen, Quackenbush & Hamlin, 1985). Moreover, this could be especially true if the example is student originated. While it is a varied process, in that there are many ways to achieve learning, ERLC involves a general prompt to connect new information with something already located in the long-term memory (Benjamin & Bjork, 2000).

However, it is imperative to keep in mind that the cognitive processing stimulated by a lecture cue should match the cognitive processing needed for success on test items, referred to as transfer appropriate processing (Morris, Bransford, & Franks, 1977; Roediger & Karpicke, 2006). Bloom's Taxonomy of educational objectives (1956) describes the process of learning as a sequential hierarchy ranging from the most basic

level such as memorising material (remember/knowledge) to increasingly complex levels such as creating new information from the learned information (synthesis/create; Anderson & Krathwohl, 2001; Bloom Engelhart, Furst, Hill & Krathwohl, 1956; Halawi, McCarthy, & Pires, 2009; Lord & Baviskar, 2007; Noble, 2004). In the most basic level, knowledge, students are able to describe, list, or identify concepts that have been previously taught (Lord & Baviskar, 2007; Reid & McLoughlin, 2002). They may be able to recall or recognise information varying from simple facts and terminology to complete theories and explanations, as long as all that is required is simple memorisation (Granello, 2001; Lord & Baviskar, 2007). DRLC may prove useful if the instructor's goal is that the students are able to remember or recognise that two concepts, such as Leon Festinger and cognitive dissonance theory, are connected. That is, the cognitive processing stimulated by a DRLC is consistent with the type of processing necessary for knowledge level test items on quizzes and exams. Thus, students may remember the definition of a construct, but not necessarily be able to understand its meaning or apply it to a new situation (Wollen, et al., 1985).

In order to increase learning to levels of understanding or applicability of a concept, a better solution might be to utilise an ERLC, which may aid in increasing students' comprehension and application of concepts. Conceptually, Bloom's comprehension and application levels of learning describe elaborating on information given in class, or putting the concepts into action (Lord & Baviskar, 2007). At the comprehension level, students are able to reword information in a meaningful manner, suggesting that they have 'grasped' the information and have a basic understanding of the material (Granello, 2001; Lord & Baviskar, 2007; Reid & McLoughlin, 2002). At the next level of learning, application, students are able to think about phenomena in a holistic fashion and apply them to new construct (Granello, 2001; Lord & Baviskar, 2007; Reid & McLoughlin, 2002). ERLC may aid in learning at these levels because the cognitive processing involved in elaborate rehearsal is conceptually similar to the cognitive processing required for comprehension and application. ERLC allows students to practice manipulating the concept to observe its functionality, and also provides a supervised opportunity for applying a particular construct. For example, when teaching students about persuasion techniques in a psychology class, students could be prompted to describe a time when they were persuaded into buying a product they did not really desire. As students begin thinking about their own experiences, sharing them with the professor and class, and hearing other students' experiences, connections

regarding applicability are being made. Through the use of ERLC, students can better understand and apply the material because they already have experience applying it to unique situations. Thus, the information they need to understand and/or apply the information is linked to the material itself (McGlynn, 2005).

The Current Study

Although there is a general understanding and agreement that active teaching techniques can help students learn on deeper levels, many potential active learning techniques are not feasible within the time constraints of many classrooms. Lecture cues provide an environment in which active teaching can be incorporated efficiently and practically. However, while the idea that active lecturing increases learning is not new, there are no known *empirical* examinations of the effectiveness of active lecturing cues. Thus, the current study set out to provide evidence that active lecture cues have learning benefits. Specifically, this study investigated the effectiveness of four lecture techniques (i.e. ERLC, DRLC, both cues, or neither cue). As it was argued that the cognitive processing stimulated by a lecture should match the cognitive processing needed for certain types of test items, students' learning was assessed at three of Bloom's taxonomy levels (i.e. knowledge, comprehension and application). The following four hypotheses were outlined:

- Hypothesis 1** Students' scores on pop quizzes would be higher for taught using active lecture cues than for constructs that were taught without the use of lecture cues.
- Hypothesis 2** Students' scores on knowledge level quiz items would be higher for constructs taught using DRLC alone, than ERLC alone, or no cue.
- Hypothesis 3** Students' scores on comprehension level quiz items would be higher for constructs taught using ERLC alone, than DRLC or no cue.

Hypothesis 4 Students' scores on application level quiz items would be higher for constructs taught using ERLC alone, than DRLC or no cue.

Although it was unclear how a combination of both DRLC and ERLC would affect students' scores on each of the levels of assessment, a condition designated 'both' is included in the study and in the analyses of each hypothesis. However, no specific hypothesis was made regarding the both condition.

Method

An Introduction to Social Psychology course was utilised as a means of assessing the educational effectiveness of DRLC and ERLC lecturing techniques to engage students and enhance learning. Multiple constructs were taught using one of four variations of the lecture cues: DRLC only, ERLC only, no lecture cues, or both. Student's learning was assessed through six quizzes, each of which assessed a construct on three Bloom's taxonomy levels of knowledge, comprehension, and application.

Participants

Fifty-one undergraduate students, 18 men and 33 women, participated in the current study. The participants were enrolled in an Introduction to Social Psychology course at a Midwestern university. The course is a 300-level traditional undergraduate course consisting of 50 minute classes, meeting three times a week, for 15 weeks. Student composition consisted of 11 freshmen/first year students, 31 sophomores/second year students, seven juniors/third year students, and two seniors/graduating students. For the purposes of maintaining anonymity within the data, age and ethnicity were not collected from the students. However, the class was comprised mostly of traditional aged college students (approximately 18-22 years of age) and a majority of students were Caucasian, although other ethnicities were also represented.

Lecture Cues

While each lecture technique could vary slightly with the concept being taught, a basic sentence stem was used to flag a specific technique. The DRLC stem consisted of “Does anyone remember from a prior lecture, what theory/phenomena/construct applies to this situation?” or “Can anyone tell me what this theory is called?” Then the instructor waited for students to respond. The query and interaction would continue until the correct answer was retrieved by students, or until a discussion led to the correct answer. Ultimately, the concept and its relevance to the current topic were introduced and the concept was re-explained.

The ERLC stem consisted of a prompt for students to “Tell me about a time when _____ has happened to you” in connection with a construct or phenomenon. Then the instructor waited for students to respond. A minimum of four different examples are given by students, and an active discussion regarding the appropriate or inappropriate nature of the students’ application of the concept, and how the phenomena or construct ‘worked’ in each students’ example was explicitly discussed.

For the combination of both DRLC and ERLC, both stems would be used for a specified construct, one time only, spread out over a lecture or even multiple class periods. When neither cue was used, students were not prompted with either stem and were instead lectured in a traditional, passive, manner. For example, the definition and examples of a construct were given, and the phenomenon was explained without instructor initiated interaction.

Procedure

First, students were informed that a study assessing the effectiveness of various strategies was being conducted throughout the semester and that their participation would include completing six pop quizzes. While students’ performances on the quizzes did not count as a grade in the class, each student received one extra credit point upon completion of each quiz. Over half of the students ($n = 29$; 57%) completed all six quizzes. The remainder of the students completed five ($n = 15$), four ($n = 2$), three ($n = 1$), or two quizzes ($n = 2$). Two students did not complete any quizzes, and thus were not included in the analyses. During the preparation of lectures, the instructor

chose four constructs, then, a lecture technique—DRLC only, ERLC only, neither, or both—was randomly assigned to each of the chosen constructs. The lecture technique associated with each construct, while recorded in the lecture materials, was not revealed to any of the remaining researchers.

A researcher, who was blind to the hypotheses of the study, acted as a teaching assistant for the semester. The teaching assistant was trained by the course instructor regarding lecture cues. The assistant attended every class period and took notes on how the material was presented, which included coding the technique (i.e. DRLC, ERLC, neither, or both) in which the construct was presented to the class. Analysis was only conducted for constructs that were coded as being taught through the use of a lecture cue.

Next, two additional researchers (blind to the hypotheses and techniques being used) created quizzes. These researchers were knowledgeable in Bloom's Taxonomy and were experienced with creating quiz questions, which helped to ensure that quizzes accurately assessed the appropriate level of Bloom's Taxonomy. For each of the four constructs assessed per quiz, there were three questions that measured learning, one question for each of the three levels of Bloom's taxonomy (i.e. knowledge, comprehension, and application). This resulted in 12 questions per quiz. Finally, two additional researchers, who were also blind to the hypotheses, techniques, and type of assessment, graded each of the quizzes. For each item, answers were either marked as completely right or completely wrong. Blank answers were graded as incorrect.

Results

A repeated measures ANOVA was conducted to test for significant differences between students score at each level of Bloom's, for each of the lecture techniques. That is, students' scores, or percentage of correct answers on quiz items, was used as the dependent variable and lecture technique, was the independent variable. Additionally, pairwise planned comparisons, controlling for a family-wise Type I error through Bonferroni, were used in each analysis to examine comparisons between lecture techniques. This allowed us to see exactly where the significant differences lie, while also controlling our chances of making an error. See Table 1 for a summary of the

scores for each level of Bloom's taxonomy, as well as overall test scores, for each lecture technique.

Table 1. Summary of Students' Scores on each of the Bloom's Taxonomy Levels for each Lecture Technique.

	Knowledge	Comprehension	Application	Overall
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
None (Passive)	.60 (.15)	.59 (.22)	.64(.22)	.59 (.21)
DRLC	.70 (.13)	.73 (.18)	.62 (.19)	.74 (.21)
ERLC	.73 (.15)	.63 (.22)	.74 (.14)	.93 (.16)
DRLC & ERLC (Both)	.67 (.17)	.65 (.22)	.78 (.18)	.59 (.29)

DRLC – distributed rehearsal lecture cues

ERLC - elaborative rehearsal lecture cue

The first hypothesis proposed that overall students' scores on the quizzes would be significantly higher for constructs taught using active lecture cues rather than constructs taught without the use of lecture cues (neither condition). Results indicated that there was a statistically significant difference in overall students' scores by lecture technique, $F_{(3, 141)} = 11.86$, $p < .000$, $\eta^2_p = .20$. Pairwise comparisons indicated that students' scores for constructs taught without the use of lecture cues was statistically significantly lower than scores taught using DRLC ($p < .000$, $d = .60$), ERLC ($p < .000$, $d = .87$) and both cues ($p = .005$, $d = .41$). Thus, hypothesis 1 was supported.

The second hypothesis, which proposed that students' scores on knowledge level assessments, would be higher for constructs taught using DRLC, was also supported. The results indicate that a statistically significant difference existed in the percentage of correct responses by condition, $F_{(3, 144)} = 5.39$, $p = .002$, $\eta^2_p = .08$. Post-hoc comparisons indicated that quiz performance was higher for knowledge of constructs taught using DRLC, but was not significantly different for constructs taught with both cues ($p > .05$). However, DRLC yielded statistically significantly better performance than ERLC ($p = .009$, $d = .52$) or neither technique ($p = .004$, $d = .54$).

The third hypothesis, which proposed that students' scores on comprehension level assessments would be higher for constructs taught using ERLC, was also supported. A Mauchly's test indicated that the assumption of sphericity had been violated (*chi-*

square= 16.02, $p = .007$), therefore degrees of freedom was corrected using the Huynh-Feldt estimates of sphericity (epsilon = .887). The results indicate that there was a statistical significant difference in the percentage of correct responses by condition, $F_{(2.512, 120.594)} = 9.97, p < .000, \eta^2_p = .17$. Post hoc comparisons indicated that correct scores on constructs taught using neither cue or DRLC were not different from one another ($ps > .05$). Additionally, scores on constructs taught using ERLC and both cues were not different from one another ($p > .05$). However, the percentage of correct responses on constructs taught using ERLC was statistically significantly higher than DRLC ($p = .001, d = .44$) and neither cue ($p = .017, d = .68$). Finally, correct responses on constructs taught using both types of lecture cues was statistically significantly higher than DRLC ($p < .000, d = .73$) and neither cue ($p = .027, d = .45$).

The fourth hypothesis, which proposed that students' scores on application level assessments would be higher for constructs taught using ERLC, was also supported. Results indicated that a statistically significant difference existed in the percentage of correct responses by condition, $F_{(3,144)} = 17.32, p < .000, \eta^2_p = .27$. Post hoc pairwise comparisons indicated that correct scores on constructs taught using ERLC were statistically significantly higher than DRLC ($p = .029, d = .43$), neither cue ($p < .000, d = .77$) or both cues ($p < .000, d = .96$). Additionally, scores for both cues were statistically significantly lower than DRLC ($p = .001, d = .58$).

Discussion

The current study examined the cognitive effects of the use of active lecture cues on learning. As expected, students' scores were higher on test items that queried constructs taught using active lecture cues than constructs taught without active lecture cues, regardless of the level of assessment. This suggests that using lecture cues leads to higher memory for information than passive lecture.

The current study also assessed the effects of the lecture cues on each of three levels of Bloom's taxonomy. The results indicate that students' scores on knowledge level items were higher when the construct was taught with distributed rehearsal lecture cues (DRLC). Conversely, students' scores on comprehension and application level test items were higher when the construct was taught with elaborative rehearsal lecture

cues (ERLC). This provides evidence that certain lecture techniques are better suited for specific levels of Bloom's taxonomy, because the cognitive processing on the test item is similar to that of the encoding process during learning. That is, DRLC is beneficial for Bloom's knowledge level test items, and ERLC is well suited to Bloom's understanding and application level test items. Thus, if an instructor wants students to remember, list, or identify specific information (e.g. dates, theories, or famous psychologists) it may be productive to teach using distributed rehearsal lecture cues. Conversely, for material that may need to be understood or applied in the real world, professors may find it helpful to utilise elaborative rehearsal techniques to aid their students' understanding and application of the material. Asking students to provide their own examples of the social phenomena in action allows students to make multiple connections to the material. Furthermore, as the student increases the amount and type of real world connections to the material, the easier it is for him/her to understand the material and use it in a situation that is similar in nature, or at least to recognise and understand the concept when it occurs in real life.

One explanation for some of the positive effects of active lecture cues may be explained through testing effects, which have been shown to be a powerful and effective means of improving retention (see Roediger & Karpicke, 2006 for a review). Roediger and Karpicke (2006) explain that testing students produces positive effects because the tests offer practice retrieving previously learned information, guide students' attention to material that is important, and provides an opportunity for feedback regarding accuracy and understanding. Active lecture cues may work in similar ways and consequently yield similar results because, in effect, students are being tested on material every time a lecture cue is used.

Another possible explanation for the positive effects, especially as it relates to ERLC, may be explained through a recent examination of the effectiveness of dyadic collaboration (Denessen, Veenman, Dobbelsteen & Van Schilt, 2008). Denessen et al. (2008) found that providing elaboration, and using that as an opportunity to teach one's peers is helpful, especially if the student is a higher-level learning student. Additionally, with scaffolding and relevant feedback from the instructor, each student, even the lower-level learners, can strengthen their ability to elaborate and enhance their cognitive growth.

One interesting finding in the current study relates specifically to students' higher levels of learning. Results indicated that in addition to the ERLC-alone techniques, a combination of both ERLC and DRLC techniques were highly effective for comprehension level assessments. This suggests that for students to better understand the material one might want to consider not only providing the students with multiple opportunities to remember the construct, but also multiple opportunities to create personal links to the material. Using the material in these ways allows the instructor to capitalise on the positive practice effects that active lecture cues produce. However, this same result was not found for the application level assessments. In fact, using a combination of techniques actually produced a statistically significantly lower set of scores than using DRLC or ERLC alone. Simply put, on application level questions, the students performed worse when they were offered both techniques. It is unclear at this time, why this effect was found. Perhaps, it would be more helpful on application level assessments if students were offered multiple opportunities to elaborate on the phenomena. That is, instead of using ERLC then DRLC to teach specific constructs, one could use ERLC multiple times throughout a lecture, multiple classes, or even a semester. Though, the actual combination type (whether ERLC first, then DRLC or vice versa) was not analysed in the current study, future studies should examine the intricacies of using a combination of both active lecture cues for application level items, as these results were unexpected and intriguing.

While steps were taken to provide some control in this study, there were some limitations. For example, while the lecture techniques were randomly assigned to each of the chosen constructs, the constructs themselves were not randomly chosen. Constructs were chosen because they offered the feasibility of being taught using any of the four techniques. While the instructor did attempt to choose constructs that varied in difficulty, it is possible that bias was used in choosing the constructs in the first place. For example, the instructor may have inadvertently chosen 'easier to grasp' concepts, such as self-esteem, rather than more complicated psychological concepts, such as aversive racism. Future studies may want to examine the usefulness of these techniques with purposefully difficult concepts, in order to more thoroughly evaluate their effectiveness.

Additionally, the study sample originates from a private university in the Midwest. The student population of the University, tend to be primarily white, female, and of middle to

upper class socio-economic status. Thus, the external validity of these procedures should be tested in other demographic populations. For example, are these techniques equally effective for non-traditional undergraduates as they are for traditional undergraduates? Since the majority of non-traditional undergraduates tend to be higher in age than traditional undergraduates, ERLC may actually be more effective than DRLC because the students' life experience allows them to make more personal connections to the material, than traditional undergraduates. Moreover, since some non-traditional classes only occur once a week or online, there exists less opportunities to use DRLC outside of a single lecture. Thus, DRLC may be more effective and practical in a traditional classroom, rather than a non-traditional classroom. Future studies should examine the differences in educational effectiveness of certain techniques for each of those subpopulations.

Conclusions

The results of the current study provide evidence in favour of the assumptions that many professors make regarding teaching at higher levels of thinking. Not only are active lecture cues feasible within the time constraints of the traditional college classroom, but they are also effective for teaching at higher levels. They allow instructors to quickly and efficiently 'check in' with students periodically throughout a lecture session, but also provide students with repeated impromptu testing which is better for memory. Additionally, our findings lend themselves well to the notion that student assessment should align with the instructor's teaching techniques. For example, if students have not practiced applying a concept to the real world prior to an exam, they may perform poorly on an exam question that asks them to apply that concept. Since knowledge level learning was best achieved through DRLC, and comprehension and application was best achieved through ERLC, these results suggest that instructors should utilise strategies, namely the appropriate lecture cue, that are cognitively appropriate for the level that they want their students to learn and the level in which they will be assessing.

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