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Learning by Doing: An Empirical Study of Active Teaching Techniques

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Abstract

The current study sought to examine the effectiveness of four teaching techniques (lecture, demonstrations, discussions, and in-class activities) in the classroom. As each technique offers different benefits to the instructor and students, each technique was expected to aid in a different depth of learning. The current findings indicated that each teaching technique has its own unique benefits and is effective for various levels of learning. Additionally, our findings supported the notion that active techniques do aid in increasing learning. In-class activities led to higher overall scores than any other teaching method while lecture methods led to the lowest overall scores of any of the teaching methods. The implications for the classroom are discussed.

Keywords: Active learning, Bloom's taxonomy, assessment, teaching techniques.

Traditionally, college lectures consist of teachers verbally communicating information to the students, and students passively receiving and encoding it in their memories (Boyer, 1990; Michel, Cater III, & Varela, 2009; Stewart-Wingfield & Black, 2005). In a typical college classroom, this presents as a teacher lecturing at the front of the room while students feverishly take notes. However, it is probably more likely that most instructors do not solely teach in this passive fashion but also have engaging or interactive classroom moments or situations. Perhaps this is because many recent studies (e.g. Bonwell & Eison, 1991; Michel, et al., 2009) suggest that the passive method may not be the most effective way for students to learn. Rather, current research advocates for teaching techniques that encourage students to actively engage in the material because classroom engagement has been found to promote deeper levels of thinking and better facilitate encoding, storage, and retrieval than traditional lecture (McGlynn, 2005; Peck, Ali, Matchock, & Levine, 2006). Consequently, it is likely that most instructors attempt to incorporate techniques that involve the students and get students thinking about and applying the material (see Michel, et al., 2009 for a review). These techniques can range from demonstrations, to discussions, to in-class activities. Simply put, traditional ideas of lecture have developed a bad reputation, and some may be ready to banish them from their teaching repertoire.

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Active Teaching

Active, or experiential, teaching is a student-centered approach to teaching. It includes any technique that involves the students in the learning process and holds students responsible for their own learning (Bonwell & Eison, 1991; Michel, et al, 2009; Yoder & Hochevar, 2005). Instructors may have a vast arsenal of active teaching techniques at their disposal, perhaps without even being aware of them (e.g. asking questions as part of one's normal lecture style). Instructors have used elaborate demonstrations, structured activities, journaling, small group discussions, quizzes, interactive lecture cues, videos, humorous stories, taking field trips, and games, to get students involved and active in the learning process (Bonwell & Eison, 1991; Cook & Hazelwood, 2002; Ebert-May, Brewer, & Allred, 1997; Hackathorn, et al., 2010; Michel et al., 2009; Peck, et al., 2006; Sarason & Banbury, 2004).

While the literature on teaching effectiveness is vast, a large portion of the literature has been focused on the effectiveness, or perceived effectiveness, of interactive teaching strategies. These strategies can range from appropriate use of media and electronic resources (Serva & Fuller, 2004) to homework assignments (Bolin, Khramtsova, & Saarnio, 2005) and quizzes (Crone, 2001) to demonstrations (Zaitsev, 2010) and group projects (Kreiner, 2009). For example, Hackathorn and colleagues (2010) used interactive lecture cues, such as prompting students to link the material to personal stories, and found that it was an effective way of increasing students' depth of learning. Forrest (2005) took her students on a field trip to a hockey game, allowing them to see psychological principles, such as conformity and in-group bias, firsthand. Other instructors have created in-class games based on television game shows like "Jeopardy" (Binek-Rivera & Mathews, 2004) and "Who Wants to Be a Millionaire?" (Cook & Hazelwood, 2002; Saranson & Banbury, 2004) to increase student involvement and enthusiasm in the classroom.

From an innovation point of view, active teaching techniques change the pace of the classroom, and are a creative way to increase students' involvement, motivation, excitement, attention, and perceived helpfulness and applicability of the class (Binek-Rivera & Mathews, 2004; Bonwell & Eison, 1991; Guthrie & Cox, 2001; Stewart-Wingfield & Black, 2005). From a cognitive perspective, experientially taught students may engage in higher-order thinking such as analysis, synthesis, and evaluation (Anderson & Krathwohl, 2001; Bloom, Engelhart, Furst, Hill & Krathwohl, 1956; Bonwell & Eison, 1991; Hackathorn, et al., 2010). They are also better able to identify the concepts in the real world, manipulate phenomena for their own purposes, think about the material in new and complex ways, comprehend phenomena conceptually, and recall, retain, and memorize the material better (Donovan, Bransford, & Pellegrino, 1999; Driscoll, 2002; Rubin & Hebert, 1998; Serva & Fuller, 2004; Whetten & Clark, 1996).

Although it seems that active teaching strategies should be adopted in every classroom, the literature is still mixed on its effectiveness (see Michel, et al., 2009 for a review). This may be because the majority of the early research studying the effectiveness of teaching techniques are either qualitative in nature (Berger, 2002), anecdotal (Forrest, 2009), used satisfaction or course evaluations (Serva & Fuller, 2004), or used student

completed, self-report measures of perceived learning (Benek-Rivera & Matthews, 2004) instead of actual cognitive outcomes. While it is important to understand how the students perceive and appreciate active teaching, a cognitive outcome offers a concrete evaluation of the degree to which students have learned a given concept (Tomcho & Foels, 2008).

Bloom's cognitive processing taxonomy is a valid, reliable, efficient, and effective means of evaluating learning (Anderson & Krathwohl, 2001; Bloom, et al., 1956; Lord & Baviskar, 2007; Noble, 2004). Specifically, the first three levels of Bloom's taxonomy (knowledge, comprehension, and application) can be used to effectively assess cognitive outcomes, because each level assesses learning at a different depth. The most basic level (i.e. knowledge) mostly assesses the students' abilities to remember material through questions that prompt students to identify, list, or describe a concept. Second level (i.e. comprehension) items prompt students to reword information in a meaningful manner to show that they understand the material. Third level (i.e. application) items instruct students to apply the material to new phenomena or constructs, which demonstrates their ability to select appropriate information from situations (Anderson & Krathwohl, 2001; Bloom et al., 1956; Granello, 2001; Lord & Baviskar, 2007).

In the past decade, a large number of studies have begun to empirically examine the cognitive effects of active teaching techniques on learning outcomes (e.g. Benek-Rivera & Matthews, 2004; Cook & Hazelwood, 2002; Ebert-May et al., 1997; Sarason & Banbury, 2004; Seipel & Tunnell, 1995; Strow & Strow, 2006; Tomcho & Foels, 2008). However, the results are mixed and often contradictory (see Michel, et al., 2009 for a review). For example, some empirical studies demonstrate that active teaching techniques are superior to lecture (Serva & Fuller, 2004; Michel, et al., 2009; Van Eynde & Spencer, 1988), while others suggest that there is no real difference (Dorestani, 2005; Miner, Das, & Gale, 1984; Stewart-Wingfield & Black, 2005). Thus, further research is warranted.

Perhaps one reason for such mixed results is that many of the empirical studies treat one class of students as an active teaching class ("active") and compare it to another class of students that emphasizes lectures ("passive"), with the two courses commonly being taught by two separate instructors (Michel, et al., 2009). While overall, this provides evidence either in favor of or against active teaching, it confounds the comparison of the effectiveness of the technique itself. For example, Michel and colleagues (2009) found students in the "active" course were better at learning and memorizing course material than students in the "passive" course. However, because the class and instructors were different, a direct comparison of active teaching and traditional lecture is difficult. The differences may be due to the teaching techniques, the students who self-selected the course or the instructor, the instructor, or some other difference between the groups. Additionally, the authors used a large variety of techniques, without clear operational definitions of where one technique ends and another begins. Michel and colleagues (2009) described their 'active' class as containing quizzes, critical thinking exercises, demonstrations, discussions, and in-class activities. However, it is unclear which particular technique was the most effective, or whether one technique accounted for the difference in the learning outcomes. In another example, Stewart, Myers, and Culley (2010) examined

the effectiveness of active teaching through a specific technique of in-class writing assignments. However, the authors noted that in conjunction with the in-class writing assignments discussion was often used. Thus, there is no way to truly discern which was the effective technique, the writing assignments or the discussion.

The Current Study

In order to add to the literature on the effectiveness of active teaching techniques, the current study empirically examined several commonly used active teaching techniques. The current study used the same classroom and instructor to compare various techniques, while also distinguishing between techniques. Four separate teaching techniques (i.e. lectures, demonstrations, discussion, and in-class activities) were used to teach various constructs throughout an entire semester of a social psychology course.

Lecture. Lecturing, sometimes referred to as the "information dump" is a commonly used approach that involves presenting specific information for the majority of class time, allowing little opportunity for student interaction and expects students to have mastered the information by the time of the exam (Stewart-Wingfield, & Black, 2005; Whetten & Clark, 1996). Generally, lectures consist of instructors introducing constructs and their definitions, examples of how phenomena work, and other supporting information. This approach is beneficial because it is a convenient and efficient way to introduce a vast amount of information, especially in large classes where activities may be impractical (Michel et al., 2009; Miner, et al., 1984; Whetten & Clark, 1996; Van Eynde & Spencer, 1988). Consequently, lecturing has developed a reputation of being mundane, disengaging, or monotonous, (Dorestani, 2005; Miner, et al., 1984; Stewart-Wingfield & Black, 2005). Some instructors worry that students retain less of the information, and many instructors find themselves dealing with students who pay less attention, play games or send messages on their laptops, or even sleep in class (Michel, et al., 2009; Van Eynde & Spencer, 1988).

Demonstrations. Demonstrations involve activities that occur in the classroom as a means of demonstrating how a phenomena 'works' (Dunn, 2008). This technique is slightly more active than lecture because the students are able to get involved and see first-hand how the construct or phenomena presents itself in the real world. Additionally, demonstrations can break up the pace of the classroom while also providing an enjoyable experience for the students (Forsyth, 2003). However, generally, demonstrations only engage a few of the students in the classroom, have guidelines and parameters dictating the path of the learning process, and usually lead to a very specific, often predetermined, outcome. For example, in one demonstration, three students are asked to come to the front of the room and identify the flavors of jellybeans to demonstrate the domination of the olfactory bulb on taste. As part of the demonstration, one student is instructed to eat a jellybean normally, one student is instructed to shut his or her eyes while eating the jellybean and the third student is instructed to shut his or her eyes while also plugging his or her nose while eating the jellybean. As the third person is often unable to identify even the strongest flavored jellybeans, this demonstration is an excellent, usually infallible, and sometimes humorous way to illustrate the importance that smell has on our ability to

taste. However, this demonstration does not allow all students to experience the phenomena. Thus, the uninvolved students are still just passively receiving information.

Discussion. Discussion, a hybrid form of teaching because students give and receive information, is often considered the prototypic method and core component of active teaching and learning (McKeachie, 2002; Stewart, et al., 2010; Whetten & Clark, 1996). A classroom discussion is an active teaching technique because it enables students to explore issues of interest, opinions, and ideas. However, it also leads to deeper levels of learning because in order to build on each other's ideas, the students must first listen and understand the contributions of others students in order to respond or add to it (Hadjioannou, 2007). Additionally, past studies have shown that during discussion students are attentive, active, more engaged, and motivated (see Bligh 2000 for a review; Ryan & Patrick, 2001).

In-class activities. Arguably, the most active teaching technique is the in-class activity (Whetten & Clark, 1996). In-class activities are usually a technique that involves all of the students in the class, either working in groups or alone, to solve a problem or puzzle. The benefit of an in-class activity is the same as demonstrations, in that it increases attention and students are able to see a phenomena unfold, but are also able to personally manipulate and practice using that phenomena in a first-hand environment (Forsyth, 2003). This is advantageous because students may not truly understand a concept until they have manipulated it for themselves (Whetten & Clark, 1996). Examples of in-class activities can range from playing games as exam reviews (Cook & Hazelwood, 2002; Saranson & Banbury, 2004) to in-class journaling (Bolin, Khramtsova, & Saarnio, 2005).

In the current study, student learning was assessed by administering quizzes and exams that assessed concepts on three levels of Bloom's taxonomy (i.e. knowledge, comprehension, and application). This methodology allowed the researchers to examine the effectiveness of each individual technique on three depths of learning while also examining the overall effectiveness of the techniques in a comparative fashion. There were five main expectations for the current study.

Hypothesis 1. As lecture (LECT) is considered the least effective in helping students learn material (Michel, et al., 2009; Van Eynde & Spencer, 1988), it was expected that for constructs taught using lecture, students might be able to retain or recognize vocabulary words, but may not understand the intricacies or applicability for most phenomena. Thus, it was hypothesized that students would score a higher percentage of correct answers on knowledge level questions than comprehension or application, when constructs were taught using LECT.

Hypothesis 2. Although there is evidence that demonstration (DEMOs) increase attention and enjoyment (Forsyth, 2003) as they only allow for minimal interaction as they often only employ a few students from the classroom, it was expected that students may be able to understand the concepts, but may not necessarily have increased memory for vocabulary or an increased ability to apply the concept for themselves. Thus, it was hypothe-

sized that for constructs taught using DEMO, students would score a higher percentage of correct answers on comprehension level questions than knowledge or application.

Hypothesis 3. As discussion (DISC) has the potential to involve all students in the activity and that students understand what has been said, in order to contribute (Hadjioannou, 2007), a logical inference is that discussion is probably more effective for comprehension level learning. Thus, it was hypothesized that for constructs taught using DISC students would score a higher percentage of correct answers on comprehension level questions, than knowledge or application.

Hypothesis 4. An in-class activity (ICA) allows each student to actually manipulate and practice applying the information for his or her self (Forsyth, 2003; Whetten & Clark, 1996). However, in order to correctly apply the information, one must also understand the material (Bloom, et al., 1956). Thus, it was hypothesized that for constructs taught using ICA, students would score a higher percentage of correct answers on both comprehension and application level questions than knowledge questions.

Hypothesis 5. Based on past studies and arguments (McGlynn, 2005; Peck, Ali, Matchock, & Levine, 2006), the authors expected that as the technique became increasingly active, so would the scores on test items. Thus, it was expected that students' overall scores would be significantly higher for constructs taught using ICA than LECT methods.

Method

During a social psychology course, various constructs were taught using one of the aforementioned techniques: LECT, DEMO, DISC, or ICA. Student's learning was subsequently assessed through six quizzes and four exams, which tested the constructs on three of Bloom's cognitive levels: knowledge, comprehension, and application.

Participants

Participants, enrolled in the course during the spring semester at a Midwestern university agreed to participate in a study assessing various teaching strategies. The student body (n = 51) composition consisted of 18 men and 33 women, with an average GPA of 3.31 (SD = .66). However, two students were dropped from analyses due to incomplete records. The class mean age was 19.36, SD = .76. The majority of students were Caucasian (58%), although other ethnicities were also represented: African-American (2%), Hispanic (8%), Asian (8%), Bi-Racial (4%) and other (4%). Additionally, almost half of students were psychology majors (46%), or double majoring in psychology (28%).

Procedure

Over the duration of the semester, constructs were taught by the instructor in ways that were complementary to the construct. In other words, if the instructor was unaware of a way to teach a construct through an in-class activity, it was not forced. For example, obedience was taught through a small demonstration, as opposed to the other methods, be-

cause it fit easily within the parameters of the classroom. A teaching assistant, who was blind to the hypotheses, was trained prior to the beginning of the semester to identify and code multiple teaching techniques. The constructs that were included in the analysis were based on the assistant's notes. Then, two additional researchers, also blind to the hypotheses, created six quizzes, to be administered approximately every three weeks. Quizzes consisted of true/false, multiple choice, and short answer questions. For each construct on a quiz, three questions assessed learning: one question for each of the three levels of Bloom's taxonomy (i.e. knowledge, comprehension, and application). Students were awarded one extra credit point for completing each quiz. In addition to the quizzes, four exams were created by the instructor and given to all of the students as part of their class grade. Finally, two additional researchers, who were also blind to the hypotheses, graded the quizzes. The exams were graded by the instructor.

Measures

For each quiz item, answers were either marked as completely correct or completely incorrect. Blank answers were graded as incorrect. No portions of credit were assigned. While the quizzes assessed learning on more constructs than just those posed in this current study, only quiz items pertaining to the current study were used in the analyses.

Exam grades were given as part of the normal class requirements. For multiple choice and fill-in-the-blank items, answers were graded as either completely correct or completely incorrect. For short answer and essay items, partial credit could be assigned. Blank answers were graded as incorrect.

Results

To examine the effectiveness of each teaching technique on each of the levels of assessment, four repeated measures ANOVAs were conducted examining differences between the three levels of Bloom's taxonomy on items within the same teaching technique. A Bonferroni correction was applied to the probability at which the tests were accepted ($p < .017$). For each hypothesis, pairwise comparisons were analyzed for differences in the percentage of correct responses on test items.

The first hypothesis stated that LECT would be most effective for knowledge level assessments. A Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2 = 9.66$, $p = .008$) therefore degrees of freedom was corrected using the Huynh-Feldt estimates of sphericity (epsilon = .871). The results indicate that there was a significant difference in the percentage of correct responses by assessment level ($F_{(1.74, 83.53)} = 22.94$, $p = .000$). The percentage of correct scores on knowledge level assessments was significantly lower than both comprehension ($p = .000$) and application ($p = .000$). Thus, the first hypothesis was not supported. Refer to Table 1 (listed directly after the results of the fourth hypothesis) for a list of means and standard deviations for each technique on each level of Bloom's taxonomy.

The second hypothesis stated that DEMO would be most effective for application level assessments. A Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2 = 14.81$, $p = .001$) therefore degrees of freedom was corrected using the Huynh-Feldt estimates of sphericity (epsilon = .809). The results indicate that there was a significant difference in the percentage of correct responses by assessment level ($F_{(1.62, 77.70)} = 4.64$, $p = .018$). Scores on application level assessments was significantly higher than knowledge ($p = .000$), but only marginally higher than comprehension ($p = .062$). Thus, the second hypothesis was only partially supported (see Table 1).

The third hypothesis stated that DISC would be most effective for comprehension level assessments. A Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2 = 19.58$, $p = .000$) therefore degrees of freedom was corrected using the Greenhouse-Geisser estimates of sphericity (epsilon = .746). These results show that there was a significant difference in the percentage of correct responses by assessment level ($F_{(1.49, 71.61)} = 28.60$, $p = .000$). Scores on comprehension level assessments were significantly lower than both knowledge ($p = .000$) and application ($p = .000$). Thus, the third hypothesis was not supported (see Table 1).

The fourth hypothesis stated that ICA would be most effective for comprehension and application level assessments. A Mauchly's test indicated that the assumption of sphericity had not been violated ($\chi^2 = .56$, p = .758). Results indicate that there was a significant difference in the percentage of correct responses by assessment level ($F_{(2, 98)} = 11.11$, $p = .000$). Scores on comprehension ($p = .000$) and application ($p = .007$) were both significantly higher than knowledge level scores. Thus, the fourth hypothesis was supported.

Table 1. Means and Standard Deviations of Scores for each Teaching Technique

	Knowledge		Comprehension		Application	
	M	SD	M	SD	M	SD
Lecture	.760**	.169	.878	.109	.919	.100
Demonstrations	.678	.212	.698	.285	.808[1]	.157
Discussions	.820	.180	.621**	.267	.856	.098
In-Class Activity	.789**	.163	.872	.142	.900	.088

*** = Was different from remaining Bloom's levels (p < .001).*
[1]=W as different from Knowledge (p <.001), and marginally significant from Comprehension (p = .06).

The fifth and final hypothesis stated that as the technique became increasingly active, so would the scores on test items. Thus, it was expected that students' overall scores would be significantly higher for constructs taught using ICA than LECT methods. To analyze this, a repeated measure ANOVA was conducted using the teaching technique as the independent variable and the overall percentage of correct scores as the dependent variable.

Again, a Bonferroni correction was applied to the probability at which the post hoc comparisons were accepted ($p < .013$). A Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2 = 33.28$, $p = .000$) therefore degrees of freedom was corrected using the Greenhouse-Geisser estimates of sphericity (epsilon = .684). These results indicate that there was a significant difference in the percentage of correct responses by assessment level ($F_{(1.96, 88.29)} = 29.60$, $p = .000$). Scores for constructs taught using LECT ($M = .64$, $SD = .22$) was significantly lower than DEMO ($M = .79$, $SD = .14$, $p = .001$), DISC ($M = .82$, $SD = .11$, $p = .000$), and ICA ($M = .89$, $SD = .06$, $p = .000$). Moreover, scores on constructs taught using ICA were significantly higher than scores from LECT ($p = .000$), DEMO ($p = .000$), and DISC ($p = .005$). Thus, this hypothesis was supported. See Figure 1 for an illustration of scores for overall learning in each technique.

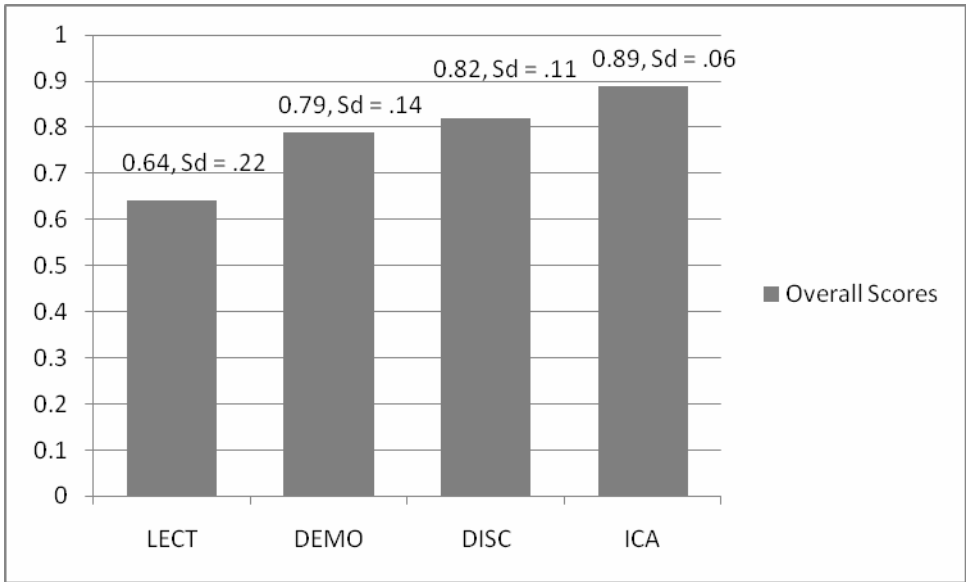

Figure 1. Means and Standard Deviations for Overall Scores of each Technique

Discussion

The current study sought to examine the effectiveness of four teaching techniques (i.e. lecture, demonstrations, discussions, and in-class activities) in the classroom. As each technique offers different benefits, the effectiveness of each technique was expected to vary by depth of learning on Bloom's taxonomy (i.e. knowledge, comprehension, and application). The current findings indicate that each teaching technique has its own unique benefits and is effective for various types of learning.

Our first hypothesis, that lecture would be most effective on knowledge level questions was not supported. In fact, the lecture method was actually least effective as correct scores on knowledge level assessments were significantly lower than both comprehension and application. Perhaps this is because knowledge level assessments are often based on

rote memorization, such as knowing which definition describes a particular construct. Lecture, while it may contain explanations viable for comprehension level learning, and examples that are important for application skills, does not necessarily lend itself to increased memorization. In fact, some of the complaints about lecture are that students often seem bored, sleeping, or multi-tasking (Michel, et al., 2009; Van Eynde & Spencer, 1988). However, it should be noted that our analysis was specifically looking at differences between the three levels of Bloom's taxonomy and did not compare lecturing to a control group, or not being introduced to the concept at all. The percentage of correct responses (76%) on knowledge level questions was still rather high. Thus, one could conclude that lecture is actually incredibly effective for all three levels of learning and perhaps these findings provides evidence contrary to the reputation that lecture has earned.

Our second hypothesis, that demonstrations in class would be most effective for comprehension, was also not supported. Instead, our findings indicate that demonstrations were no more effective for comprehension items than they were for knowledge level items. However, demonstrations were most effective for application level test items. This was somewhat surprising, as it was argued that while demonstrations increase attention and enjoyment, they only allow a few students from the classroom to actually manipulate and apply the information, leaving the rest of the students unengaged. However, it would appear that just watching others apply the information to a new situation is enough to learn the application oneself.

The findings from our third hypothesis, which stated that discussions would lead to higher answers on comprehension level questions, were possibly the most surprising. Our findings suggest that scores on comprehension were lower than both knowledge and application level items. While, Hadjioannou (2007) argued that students must first understand what another student has said in order to contribute to the discussion, this was not supported in our sample. In many cases, discussion could include thoughtful and thought provoking comments. However, they also include wrong thoughts, misleading information, and even mythology and urban legends. While the instructor takes this opportunity to correct and inform the students, perhaps the fact that the information has already been said is enough to 'throw off' some students, as it pertains to understanding. Recent research suggests that just seeing a wrong answer can interfere with one's ability to learn the correct answer (Fazio, Agerwal, Marsh, & Roediger III, 2010; Roediger III and Marsh, 2005). Perhaps, in the case of comprehension, discussions including impromptu student explanations may actually be more hurtful than helpful. However, we did not examine this possibility. Future studies may want to empirically examine the effectiveness of varying types of discussions, specifically looking at examples when incorrect information is included in the discussion.

While, it was contrary to what was hypothesized, it should be noted that for the constructs taught using discussion, the percentage of correct responses on application and knowledge level items was above a more than satisfactory 80%. This lends evidence to the notion that allowing students to interact via discussions is an effective teaching technique. Perhaps as they repeatedly hear vocabulary words throughout the discussion, it

lends itself to increased memory. And, as students voice various personal stories involving the phenomena, others are able to learn how the phenomenon applies to multiple situations. But, once again, this was not empirically examined in the current study.

Our results did support our fourth hypothesis, which stated that in-class activities would increase scores on both comprehension and application level test items. However, it should be noted that while comprehension and application level test items were significantly higher than knowledge level items, the average score on knowledge level items was 79%. Arguably, this lends more evidence to the claims that in-class activities (ICA) are the most effective of all the techniques because they allow students to actually manipulate and practice applying the information for their selves (Forsyth, 2003; Whetten & Clark, 1996).

Finally, our findings supported the notion that active techniques do aid in increasing learning as in-class activities led to higher overall scores while lecture led to the lowest overall scores. However, this does not mean that one should blindly use active techniques in lieu of other methods. We often think of lecture and active teaching techniques as competing forces. This dichotomous thinking of good and bad techniques can be counterproductive. Even in the current study, no one method emerged as the 'easy button' of teaching or learning. Scores on quizzes and exams were fairly high, even when using lecture. It is unfortunate that lecture has earned such a bad reputation. While there may be some exceptions, the current research suggests that, in general, any technique that an instructor uses can be effective, if it is used competently, appropriately, and enthusiastically.

On the other hand, if your course is focused on decision making, rather than recalling facts, then active techniques probably should be a necessary component of your teaching repertoire (Serva & Fuller, 1998). As our findings suggest, active techniques affect learning on deeper levels. Additionally, active teaching can be an added bonus for teachers who are managing students with diverse learning styles. This is because instructors who vary their presentation methods create extra learning opportunities for students with different learning styles (Cook & Hazelwood, 2002). However, instructors should also realize that active teaching takes time away from full content coverage. Therefore, instructors should carefully evaluate whether using active techniques is worth sacrificing class time that could be used to cover other important information (Yoder & Hochevar, 2005).

Although, the current study is an important contribution to the literature in higher education there are limitations to the current study. One limitation to this study is that the students self-selected into the class. As this is an upper level psychology course, a large portion of the students (46%) were psychology majors, and were likely inherently interested in the material covered, and had received prior exposure to many of the topics in their introduction classes. Furthermore, the instructor tends to be liked among her students and many (42%) had taken a class with her previously. Perhaps many of the students were more alert, comfortable, and acclimated to the various teaching techniques being applied. Thus, the high scores could be explained through mere exposure or prior practice with both the phenomena and the format of the class. Since students self-selected

into the course, they could have chosen this instructor specifically because she uses many active techniques. If a student knows that they learn best when these techniques are used, and then subsequently chose to take a class from this instructor, the results could have been influenced in such a way that supports the hypotheses. However, this seems to be unlikely, considering that not all hypotheses were supported. Future studies should utilize these same methods with other instructors, as a means of replication.

Another limitation is the potential for experimenter bias. The data was collected in a classroom, and we attempted to control as many variables as possible without sacrificing the natural art of good teaching, but experimenter bias may have occurred as the experimenter was also the teacher. For example, constructs that lent themselves to being taught through in-class activities were used, and constructs for which the instructor had no knowledge of any interactive strategy were chosen for lecture. This could have led to more complicated or uninteresting constructs being taught through lecture, which could also have led to lower test grades. While efforts were made to minimize potential experimenter effects (e.g. coding constructs retroactively using TA's notes, having multiple blind quiz makers and quiz graders), it is highly possible that some effects were left uncontrolled. Future studies should be aware of their occurrence and attempt to avoid error in the data.

Teaching is a complex endeavor. Combined factors, such as student motivation and the instructor's rapport with the students, have the potential to influence how effective any technique is (Tomcho & Foels, 2008). Thus, any data taken from a classroom is inherently contaminated and may not provide a perfect picture of effectiveness. Regardless, based on the current study, active teaching techniques do enhance learning as quiz and exam scores were higher when students were allowed to interact with the material. While, results indicated that lecturing was the least effective technique, it should be noted that students still scored relatively high after lecturing alone, which indicates that learning was still occurring. Perhaps, most techniques are effective on some level, and the real decision should be on a construct by construct, and class session by class session basis. In the end, instructors must decide for themselves, and be confident in their decisions, regarding what techniques to use, what material to use it with, and how often to use them. That is probably the real underlying solution to the effectiveness of any teaching technique.

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