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Evaluating the Impact of Small-Group Discussion on Learning in an Organizational Psychology Class Utilizing a Classroom Response System

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EVALUATING THE IMPACT OF SMALL-GROUP DISCUSSION ON LEARNING
IN AN ORGANIZATIONAL PSYCHOLOGY CLASS UTILIZING A
CLASSROOM RESPONSE SYSTEM

by

Thorhallur Orn Flosason

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Advisor: Heather M. McGee, Ph.D.

Western Michigan University
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EVALUATING THE IMPACT OF SMALL-GROUP DISCUSSION ON LEARNING IN AN ORGANIZATIONAL PSYCHOLOGY CLASS UTILIZING A CLASSROOM RESPONSE SYSTEM

Thorhallur Orn Flosason, Ph.D.

Western Michigan University, 2010

A classroom response system is a technology that allows individual students to provide answers to questions posed by the instructor during lecture using hand held remotes (clickers) that transmit a signal to the instructor's computer via a receiver and computer software (Judson & Sawada, 2002). This instructional technology is widely used in higher education and several studies have shown that it can enhance learning outcomes and its use is generally viewed favorably by students and instructors alike.

The first part of the present study used an alternating treatments design to examine whether discussing questions in small groups before responding improved accurate responding on similar questions on unit exams. A social validity questionnaire was also administered to assess students' perceptions of clickers and discussions as an instructional tool. The second part of the study used a between-subjects design to compare the exam performance of students who used clickers to answer questions during lectures to the exam performance of students who did not answer questions using clickers. The results of the first study did not show any clear advantages of small-group discussion in terms of learning outcomes. However, many students expressed perceived learning benefits of engaging in small-group discussion and almost all participants viewed using

clickers favorably. The second study showed that clicker use during lecture was associated with higher exam scores, but that relationship can be interpreted in several different ways, some of which are not tied to active responding. The implications of these findings with respect to previous research are discussed.

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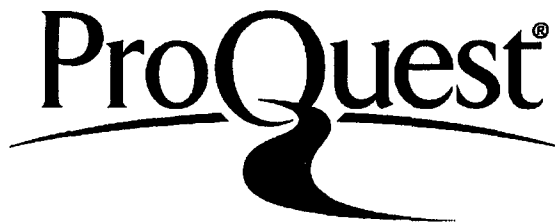
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TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	ii
LIST OF TABLES.....	vi
LIST OF FIGURES.....	vii
INTRODUCTION.....	1
Improving College Instruction.....	5
Active Responding in the College Classroom.....	6
Classroom Response Systems.....	11
Background and Description.....	11
Using Clickers in the Classroom.....	14
Research on Clickers.....	16
Small Group Discussion and Clickers.....	22
Rationale for Current Project.....	27
STUDY 1.....	29
Method.....	29
Participants and Setting.....	29
Materials.....	29
Experimental Research Design.....	33
Procedures.....	34
Interobserver Agreement.....	37

Table of Contents – Continued

Dependent Measures.....	37
Results.....	38
In-class Clicker Questions.....	38
Ratings of Clicker Use.....	44
Discussion.....	49
STUDY 2.....	52
Method.....	52
Participants and Setting.....	52
Materials.....	53
Experimental Research Design.....	53
Procedures.....	53
Interobserver Agreement.....	54
Dependent Measures.....	54
Results.....	54
Discussion.....	59
GENERAL DISCUSSION.....	60
Peer Discussion.....	61
Clickers.....	64
Limitations and Future Directions.....	66
Conclusion.....	70
REFERENCES.....	71

Table of Contents – Continued

APPENDICES.....	82
A. Anonymous Demographic Questionnaire.....	82
B. Course Syllabus – Section 1.....	84
C. Course Syllabus – Section 2.....	91
D. Sample Study Objectives.....	100
E. Sample of Clicker Questions and Isomorphic Exam Questions.....	103
F. Social Validity Questionnaire.....	107
G. Sample IOA/Grading Sheet.....	110
H. Written Comments from Students.....	112
I. Average Exam Scores from Previous Semesters.....	117
J. HSIRB Approval Letter.....	119

LIST OF TABLES

1. Mean Percentage Correct for In-Class Clicker Questions by Condition for Section1.....	38
2. Mean Percentage Correct for In-Class Clicker Questions by Condition for Section 2.....	38
3. Mean Percentage Correct for Isomorphic Exam Questions by Condition for Section 1.....	41
4. Mean Percentage Correct for Isomorphic Exam Questions by Condition for Section 2.....	41
5. Summary of Students' Demographics across the Four Sections.....	52
6. Mean Percentage Correct for Isomorphic Exam Questions for Sections 1 and 3 across Units.....	55
7. Mean Percentage Correct for Isomorphic Exam Questions for Sections 2 and 4 across Units.....	56
8. Mean Percentage Correct Overall by Condition.....	58

LIST OF FIGURES

1. Mean Percentage of Correct Responses on In-Class Clicker Questions in Section 1.....	39
2. Mean Percentage of Correct Responses on In-Class Clicker Questions in Section 2.....	40
3. Mean Percentage of Correct Responses on Isomorphic Exam Questions across Units for Section 1.....	42
4. Mean Percentage of Correct Responses on Isomorphic Exam Questions across Units for Section 2.....	42
5. Comparison of Correct Responding to Identical Question under the Discussion and No Discussion Conditions in Sections 1 and 2.....	43
6. Distribution of Student's Responses to the Statement "I liked using clickers in this class to answer questions.".....	44
7. Distribution of Students' Responses to the Statement "I think using clickers in this class helps me learn the material.".....	44
8. Distribution of Students' Responses to the Statement "I think the clicker questions asked were generally fair and tied to the course objectives.".....	45
9. Distribution of Students' Responses to the Statement "I think the clicker questions helped me do better on exams.".....	45
10. Distribution of Students' Responses to the Statement "I think the point system was fair.".....	46
11. Distribution of Students' Responses to the Question "Thinking about the two ways we used clickers this semester (discussion vs. no discussion), which method did you prefer?".....	46

List of Figures – Continued

12. Distribution of Students' Responses to the Statement "Extent of learning with peer discussion versus working on your own.".....	47
13. Distribution of Students' Responses to the Statement "Please rate how good your instructor was at lecturing.".....	47
14. Distribution of Students' Responses to the Statement "I would like to use clickers in my future classes.".....	48
15. Mean Percentage of Correctly Answered Exam Items by Students in Sections 1 (clickers) and Section 3 (no clickers).....	57
16. Mean Percentage of Correctly Answered Exam Items by Students in Sections 2 (clickers) and Section 4 (no clickers).....	57

INTRODUCTION

Throughout the history of higher education, lectures have been, and continue to be, the most common instructional format utilized in the college classroom (Lammers & Murphy, 2002). Lectures involve an instructor verbally communicating information that is related to course objectives to his or her students, often with the use of visual aids such as PowerPoint™ or other media. As an instructional methodology, the traditional lecture format lacks many of the components of effective instruction, such as frequent and immediate feedback on responses, self-pacing, and reinforcers for accurate responding (Fredrick & Hummel, 2004). These tenets are based on the notion that students should be active participants, making frequent responses during the instructional process instead of being simply passive receivers of instructional antecedents. John Dewey (1916/1966) stated this simply: We learn by doing. This assertion still holds true (Austin, 2000; Kellum, Carr, & Dozier, 2001; Moran & Malott, 2004; Neef, McCord, & Ferreri, 2006; Springer, Stanne, & Donovan, 1999). By actively participating during the instructional period, students are more likely to encounter conditions that shape and maintain appropriate responses relative to the subject matter, and thus expand their academic repertoire. An example of this would be answering a question during class and being provided with feedback on that response by either the instructor or other students.

While the traditional lecture format lacks many of the components of effective instruction, lectures can undoubtedly help students acquire various targeted behaviors, most likely by providing appropriate discriminative stimuli, i.e. verbal content (Skinner, 1953). Bligh (2000) concluded that lectures are as effective in transmitting information to

students as many other methods, but are “relatively ineffective to teach behavioral skills” (p. 10). Bligh continued “It takes two to communicate: a communicator and a receiver. People sometimes talk as if communication is a process of injection by the communicator. It isn’t. They talk as if information can be transferred directly from one person’s mind to another’s. It can’t. It *requires activity by the receiver*” (p. 32, emphasis added).

Learning can be defined as the acquisition of or change in behavior as a result of particular experiences (Moore, 2008). The ways educational practices and the science of education approach learning surely depend on the philosophical lens through which they are examined. Social constructivism, which seems to be a prevalent view within education (Duit & Treagust, 1998), views learning as the product of interactions in a social community; knowledge and understanding is constructed through collaboration with others. Learning is thus mediated through cognitive and metacognitive processes (Beatty, Gerace, Leonard, & Dufresne, 2006; Schraw & Moshman, 1995). A more behaviorally oriented perspective would describe learning that is under social influences as verbal behavior. In other words, knowledge *is* verbal behavior (Skinner, 1957), which can be analyzed in terms of environmental variables that control both the verbal and nonverbal behavior of the learner. In Skinner’s words, “We know algebra...in the sense of possessing various forms of behavior with respect to [it]” (1974, p. 138). By the same token, demonstrating understanding of something involves being able to respond appropriately, as defined by the verbal community, to a set of verbal and non-verbal stimuli. This view has been criticized for being simplistic and unable to explain complex behavior, but recent developments in behavior analysis have effectively addressed the issue of complex verbal behavior. These developments include stimulus equivalence

(Sidman, 2000), and more recently, Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001). In short, these approaches provide behavior analytic explanations for different types of emergent behavior, which is behavior that has not been directly learned, but has emerged as a function of other learned behavior (Sidman, 2000). Education relies, either explicitly or implicitly, on the conditions that facilitate emergent behavior that enables people to correctly apply concepts and solve problems of various types (Fields, Travis, Roy, Yadlovker, Aguiar-Rocha, & Sturmey, 2009; Fienup, Covey, & Critchfield, 2010; Hayes et al., 2001). Students learning in the college classroom are therefore making both overt and covert responses, brought about by contingencies operating in the students' verbal communities.

Even though lectures are primarily a means to deliver information, they may also serve as a motivating operation (Keller, 1968), triggering students' interest in the subject matter and increasing the probability of students' study behavior outside of the classroom. In fact, the role of lectures in Personalized System of Instruction was to motivate students, rather than to deliver content (Fox, 2004). Motivating students can, however, be a daunting task (Bligh, 2000) given the prevalence of competing contingencies in students' college environment (Michael, 1993). The course grade seems to be the most effective motivational variable, and one which college instructors can leverage to influence student's study behavior (Michael, 1993).

Most lecture classes typically allow some level of student involvement, for example by providing students with opportunities to ask questions and engage in discussions with the instructor, even collaborating in small-group discussions (Feldman & Paulsen, 1994). This can be difficult to achieve in larger classes (Nicol & Boyle, 2003)

and many students refrain from or are hesitant to ask questions in front of their peers, perhaps because of the fear of making mistakes or embarrassing themselves in front of a large audience (Caldwell, 2007; Graham, Tripp, Seawright, & Joeckel, 2007). Some instructors make an effort to involve their students during lectures but only a small fraction of them has the opportunity to ask or answer questions, which makes it difficult for the instructor to identify topics and concepts that students struggle with. In other words, the instructor does not receive adequate feedback on his or her performance (Bligh, 2000).

There are other traditional means of involving students, such as exams and assignments, but the consequences for completing exams and assignments are often delayed or not useful to the learner (Dihoff, Brosvic, & Epstein, 2003; Kulik & Kulik, 1988). Students can, and often do, learn from traditional lecture classes, but there are certainly opportunities to enhance their effectiveness and efficiency. Given the contention that traditional lectures are simply the presentation of information (Bligh, 2000), college-level classes tend to be content oriented rather than outcome oriented, placing too little emphasis on what students can do after instruction, but more on what happens during instruction (Axelrod, 1976). For example, students have limited opportunities to demonstrate the skills acquired over the course of a semester when midterm and final exams are the only times during which they are required to exhibit newly acquired behaviors. Of course, there are other means by which students respond to course material, such as writing papers and completing assignments, but those activities generally occur infrequently. Efforts to introduce alternative instructional methods have often been met with resistance for a number of reasons, two of which will be briefly mentioned here.

First, the initial development of courses utilizing alternative instructional methods is very time-consuming (Pear & Crone-Todd, 1999), and second, approaches that involve self-pacing do not fit the academic calendar well which would involve various administrative challenges (Fox, 2004).

Improving College Instruction

Various approaches have been taken to make higher education more individualized as opposed to the mass delivery approach of the traditional lecture (Moran & Malott, 2004). Self-pacing and mastery learning refer to the instructional procedures in which students reach a pre-specified criterion of performance at their own pace, which takes varying abilities of students into consideration (Fox, 2004). Examples of these methods are Programmed Instruction, which has in more recent years evolved into computer-based instruction (Kulik, 1994), and the Personalized System of Instruction (PSI; Keller, 1968). These methods have been highly effective as indicated by student achievement scores (Fox, 2004; Kulik, Cohen, & Ebeling, 1980; Kulik, Kulik, & Cohen, 1979).

In Programmed Instruction, course material is broken down into small units that are gradually combined into a functional repertoire by providing prompts and consequences for responding, fading them out over time (Vargas & Vargas, 1991). Today, computers are frequently used as “teaching machines” (Skinner, 1968), an ideal delivery mechanism for delivering course content while assessing performance and tailoring progress to the individual student. This approach helped shift the focus from the teacher to the behavior of the learner.

The Personalized System of Instruction (PSI) consists of self-pacing, mastery criterion, lectures as a motivational tool, emphasis on the written word, and the use of proctors to administer and score exams as well as provide tutoring (Keller, 1968). To some extent, these methods make the typical classroom environment redundant, where all components of the instruction, including communication with instructors, can take place outside the classroom. Despite the significant impact these instructional methods have had (e.g., Kulik et al., 1980; Kulik et al., 1979), the classroom has maintained its position as the primary venue for higher education courses (Bligh, 2000).

Active Responding in the College Classroom

Acknowledging the limitations of the traditional lecture format, many educators are taking steps towards making the college classroom more interactive by implementing various forms of active responding (Austin, 2000; Bruff, 2009; Johnson, Johnson, & Smith, 1998). Active responding refers to an observable student behavior as a response to an instructional antecedent, for example a question (Kellum et al., 2001). Numerous studies have supported the contention that active responding is crucial to successful learning, some of which will be discussed below.

Collaborative Learning. There are several variations of the collaborative learning approach and different terms are generally used for these, for example cooperative learning (Slavin, 1996), interteaching (Boyce & Hineline, 2002), and reciprocal peer tutoring (Fantuzzo, Dimeff, & Fox, 1989). Hereafter, these methods will be commonly referred to as collaborative learning. Collaborative learning is an instructional format in which students work either in pairs or small groups on assignments or discuss the specific aspects of the course material (Slavin, 1996). Some have suggested that smaller groups

are more beneficial since it increases the likelihood of everybody in the group participating and more reserved students may not contribute to the conversation in larger groups (Boyce & Hinline, 2002). In other words, as group size increases, the individual's contribution to overall performance and the perceived consequences decreases, weakening the relationship between outcome or grade and individual performance. Collaborative learning can be implemented in small segments throughout a class period or take up whole class periods. For example, in interteaching (Boyce & Hinline, 2002), instructors cover main topics or difficult material at the beginning of each class with the remainder used for small group discussions.

The structure of the collaborative learning process can vary considerably. In some versions, students are required to generate questions about the subject matter on their own and discuss it with their peers with the aim of being well prepared for exams (Fantuzzo et al., 1989). In a more structured approach, the instructor provides his or her students with a set of questions or specific discussion guidelines to work through during the collaborative learning period (Boyce & Hinline, 2002). Axelrod and Greer (1994) pointed out that the behavioral processes underlying cooperative learning are not well described by the proponents of the method, but a couple of possible explanations will be included here. By participating in collaborative learning, students help shape each other's verbal repertoire by providing social consequences, for example, by praising accurate responding and correcting errors. Another plausible explanation for the effectiveness of collaborative learning is that students come better prepared to class in order to avoid the embarrassment of not being able to contribute to the conversation and provide feedback on their peers' responses, thus slowing down the session. Therefore, it may not be the

actual collaborative learning period *per se* which is effective, but the influence it has on study behavior, which in turn results in higher achievement scores. Instructors, and in some cases their assistants, are present during collaborative learning to answer questions that students may have and provide feedback on their performance, either as individuals or groups (Slavin, 1996). Students sometimes earn points for participation or correct responses during collaborative learning (Axelrod & Greer, 1994; Boyce & Hinline, 2002), but often the social consequences provided by the students' peers seem to be the only conditions that support performance in those classes.

Collaborative learning has proved to be an effective teaching method; for example, achievement scores of students of all educational levels have improved as a result of these methods (Johnson et al., 1998; Saville, Zinn, Neef, Van Norman, & Ferreri, 2006; Slavin, 1996; Springer, et al., 1999). Additionally, collaborative learning is generally well liked by students (Cohen, Kulik, & Kulik, 1982; Saville, et al. 2006). However, evidence has also suggested that the learning gains attributed to collaborative learning may in fact be a function of other instructional techniques, such as detailed study objectives, and frequent exams, but are sometimes part of the collaborative learning package (Flosason, Fox, Huitema, & Koerber, 2007)

Guided Notes. Note taking is another way for students to make active responses in the classroom. Students generally perceive note taking to be important to academic achievement and research has shown that students who take notes do better on exams than those who do not (Baker & Lombardi, 1985; Kiwera, 1987; Nye, Crooks, Powley, & Tripp, 1984). However, many students are not skilled at taking notes (Kiwera, 1987), likely because they have never been taught how to and the classroom environment does

not provide sufficient contingencies to support efficient note taking (Palmatier & Bennett, 1974). One of the methods instructors have used to facilitate students' note taking behavior is to use guided notes. Guided notes are either electronic files or printed handouts, provided by the instructor prior to lectures that include the lecture notes for that session with some of the key words and phrases missing (Austin, 2000). This requires the students to pay attention to the flow and content of the lecture and either write in the missing information in their notes or type it in the electronic document. This approach ensures that students pay attention during class and write down accurate information that requires less effort than transcribing whole paragraphs, sometimes of irrelevant or misleading information. Research on the use of guided notes shows that using them can result in higher exam scores compared to typical note taking and this method is generally well liked by students (Austin, Lee, Thibeault, Carr, & Bailey, 2002; Neef et al., 2006). The effectiveness of guided notes has been attributed to the notion that active responding in class, i.e., writing, facilitates later recall via antecedent control and that students create accurate permanent products that can be used for review prior to exams (Austin, 2000).

Response Cards. Response cards are signs or small boards that students hold up in class to indicate their answer to a question posed by the instructor (Gardner, Heward, & Grossi, 1994; Kellum et al., 2001). The instructor can, for example, ask a multiple-choice question for which he offers four possible answers. Each student would then hold up a card that corresponds to the answer choice he or she thinks is the correct one. In this case, the cards would be of different colors or have different numbers or letters on them, representing the different response options. A second type of the response card is a small board on which students can write brief answers to questions (Gardner et al., 1994). Both

of these types allow the instructor to monitor student responses to the material and then tailor his or her pacing and content of the lecture, based on how students respond. If the majority of students answer a question correctly, the instructor can proceed to the next topic or question, assuming that most students can discriminate between the correct answer and the incorrect ones, thus demonstrating understanding of the material just presented. If a large portion of the class provides an incorrect answer then the instructor can review and elaborate on the content of the question and provide additional examples for clarification.

Studies conducted in the college classroom have shown that using response cards has several advantages. Students with response cards are more likely to participate during class than students without response cards (Kellum et al., 2001). Second, student achievement scores tend to be higher with response cards (Gardner et al., 1994; Kellum et al., 2001; Marmolejo, Wilder, & Bradley, 2004). Finally, students generally have a favorable attitude towards the use of response cards (Kellum et al., 2001; Marmolejo et al., 2004). Response cards do not come without disadvantages, however. First, they are ill-suited for larger classrooms where it may be difficult for the instructor to monitor and analyze the responding of a large audience. Second, some students may base their responding on how others in the classroom respond. Related to that issue, students may not be comfortable with making a public response because they fear the potential embarrassment following an incorrect response (Caldwell, 2007; Graham et al., 2007). Fourth, providing individual consequences, in the form of incentives, for responding can be challenging for the instructor. This may reduce students' efforts to "do their best" and

could maintain random responding. There is a third type of response card which does address some of these concerns. That is the topic to which we will now turn.

Classroom Response Systems

A classroom response system is a technology that allows individual students to provide answers to questions posed by the instructor during lecture using hand held remotes (clickers) that transmit a signal to the instructor's computer via a receiver and computer software (Judson & Sawada, 2002). Overall results of students' answers can then be displayed graphically on a projection screen and stored and graded individually. This technology is also referred to as audience response systems (Miller, Ashar, & Getz, 2003), electronic response systems (Judson & Sawada, 2002), immediate response systems (e.g., Yourstone, Kraye, & Albaum, 2008), voting machines (Reay, Li, & Bao, 2008), and wireless keypad response systems (Burnstein & Lederman, 2003), among others. Hereafter, these instruments will be referred to as either clickers or clicker systems.

Background and Description

The first documented use of clickers dates back to the 1960s and 1970s (Bessler & Nisbet, 1971; Brown, 1972; Froelich, 1963), but some sources trace them back to the 1940s and 1950s (Bruff, 2009, May 26). These early versions were primitive by today's standards. Each seat in the classroom was equipped with a response mechanism which was connected to the instructor's computer and provided him or her with a count of the total responses per response option. Some of the systems were able to provide individual feedback to students (Judson & Sawada, 2002).

Today, most clicker systems consist of computer software, wireless transmitters, and a receiver. There are several systems available but the majority of these systems are very similar in terms of functionality despite some minor differences (Burnstein & Lederman, 2003). The software allows instructors to create and administer questions during lectures via PowerPoint® or other similar visual presentation programs. The software also stores all responses emitted by students and displays them graphically as a part of the PowerPoint® presentation in the form of a histogram showing the distribution of answers across response options. The transmitters are small, handheld units, usually with a numeric keypad which students use to submit their answers to questions presented on the projection screen. The most common clickers today are wireless and emit radio frequency, but older versions used infrared signals. The main advantage of using radio frequency is that the transmitters do not have to be pointed directly at the receiver in order for the response to be registered, which is necessary for infrared transmitters. When a number on the keypad has been pressed a signal is transmitted to the instructor's computer, via the receiver, which captures and stores each individual response. These systems are easy to use and only require minimal technical training beyond the ability to create PowerPoint® presentations, in order for instructors to use clickers successfully in the classroom. The software usually includes grading tools, enabling the instructor to keep track of individual student responses in each class and across semesters. In order to monitor individual performance, each student is assigned a clicker, which is then registered in the software under the student's name. Once response data have been stored they can be exported into an Excel® spreadsheet, making the analysis of responses easy, provided the instructor possesses adequate Excel® skills. Instructors may also choose to

solicit student responses anonymously, which may be advantageous under certain conditions, such as when students are asked about their opinions of sensitive social or political issues, ones they may not want to become known to the instructor. The particular response system used in the current study is described in more detail below.

Clicker systems are under constant development which has resulted in different application possibilities. TurningTechnologies™, a leader in the development and production of classroom response systems, offers, for example, applications that allow remote voting: using cell phones or computers as clickers which enables student to participate, even though they are not physically present in the classroom. Even though the focus of the current paper is on the application of clickers in higher education it is worth pointing out that clickers have also been used in primary education (Penuel, Boscardin, Masyn, & Crawford, 2007) as well as in business and industry but no studies have been conducted in those areas to date.

Four limiting factors of ordinary, paper-based response cards were described previously, all of which can be overcome by using clickers. Clickers can be used in large classrooms with several hundred students whose responses are immediately summarized and displayed to the instructor and students alike. Responses are made discretely with clickers so that peer influence is less likely to affect which response is selected. Being anonymous to other students, each and every student can respond to questions without publicly displaying or otherwise verbalizing that answer in front of his or her class (Freeman, Blayney, & Ginns, 2006; Graham et al., 2007). With clickers, consequences can also be delivered immediately, possibly motivating participation (Len, 2007) and thus increasing active responding in the classroom. Unfortunately, the comparison between

paper-based response cards and clickers has not been examined extensively, but a couple of preliminary studies suggested that the difference between the two types in terms of achievement scores is minimal (Lasry, 2008; Stowell & Nelson, 2007).

Using Clickers in the Classroom

Clickers can be used in several different ways in the college classroom. Caldwell (2007) summarized some of these, based on the existing literature. Clickers in the classroom are used to:

- Increase or manage interaction. Questions can generate discussion among peers, the outcome of which can be highlighted by having students vote.
- Assess student preparation and pre-existing skill level coming into the class. It may be beneficial for the instructor to evaluate student proficiency in the subject matter in the beginning of the semester, allowing him or her to add, reduce, or somehow modify course content.
- Find out about students' opinions, for example about the content of the course. Course evaluations are one example of this. Instructors can ask about the pace or content of lectures or other issues related to the instruction.
- Assess student understanding and misunderstanding, which determines the future direction and pacing of the lecture. This includes asking questions about home assignments.
- Administer quizzes and tests. Clickers facilitate the administration of quizzes and reduce the effort of having to grade individual exams, since the software tracks and scores individual answers of each student.

- Provide practice opportunities for students. Posing frequent opportunities to answer questions about the course material can be helpful for students, especially with conceptual and application level questions.

In addition to the possibilities identified by Caldwell, clickers have also been used to take attendance (Shapiro, 1997) and to identify students who are at risk of academic failure (Griff & Matter, 2008). Some clicker systems include game applications in which students can compete, either individually or as teams, with their names and scores displayed on the classroom screen. For example, points can be earned on how fast students select the correct answer; the faster they answer the more points they earn.

Clickers are used in several different ways in the classroom, some of which will be presented throughout this paper but the most general approach is to intersperse multiple-choice questions throughout the lecture, projected on the classroom screen (Bruff, 2009). Students are then given some time to answer the question and even discuss among themselves. Once all the students have responded, the software displays the graph which shows the distribution of responses along with a correct answer indicator, if there is a correct answer. The results then generate discussion which allows the instructor to provide a rationale for the correct answer and clarify any misunderstandings or confusion students may have. The instructor then proceeds with the lecture, based on the distribution of answers and the outcome of the discussion. For example, if a large portion of the class answered the question incorrectly, the relevant material should be reviewed with additional examples for clarification purposes before proceeding to the next topic. If, on the other hand, the majority of students answer the question correctly the instructor can proceed without additional review (Carnaghan & Webb, 2007). Tailoring the

progress of the lecture based on student in-class performance is referred to as agile teaching (Bruff, 2009) or contingent teaching (Draper & Brown, 2004), and supports effective delivery of course content. If properly used, clickers prevent instructors from moving too fast or too slow through the lecture and encourage adequate explanation of difficult content. This close connection between instructor and students ensures that a large portion of students are not left behind, not being able to apply at least some of the information presented in lecture. Students are thus able to actively participate in class, directly impacting the extent to which certain topics are covered within a lecture and, by the same token, the instructor receives real-time information on how students are responding to course material. This level of interactivity is difficult with the paper-based version of response cards, especially in larger classrooms where analyzing the distribution of responses can be a time consuming task and where students may not be willing to publicly display their answers. Also, awarding points based on responding is not a feasible option with traditional response cards.

It should be emphasized that simply incorporating technology into the classroom does not automatically enhance participation and learning (Greer & Keohane, 2004). A well structured class and sound instructional methodology is the key to effective and efficient learning (Mayer et al., 2009). Clickers can become a part of this structure, facilitating the interaction between instructors and students and increasing the probability of active responses to course material during lectures.

Research on Clickers

The use of clickers in the classroom has been explored across several disciplines within higher education such as biology (e.g., Preszler, Dawe, Shuster, & Shuster, 2007),

business (e.g., Carnaghan & Webb, 2007), chemistry (e.g., Woelk, 2008), engineering (e.g., Felce, 2007), law (e.g., Caron & Gely, 2004), mathematics (e.g., Lucas, 2009), medical education (e.g., Miller et al., 2003), physics (e.g., Len, 2007), and psychology (e.g., Stowell & Nelson, 2007). There have been several literature reviews conducted on clickers in higher education (e.g., Caldwell, 2007; Fies & Marshall, 2006; Judson & Sawada, 2002; Simpson & Oliver, 2007) and all conclude that clickers positively affect participation and learning in the college classroom when compared to control groups. However, many of the earlier studies from the 1960s and 1970s did not support the notion that using clickers in the classroom resulted in learning gains, while students themselves endorsed the use of such systems and still do (Judson & Sawada, 2002). More recent studies have demonstrated stronger effect of clickers which may be attributed to the following reasons. Over time, the technology has become more advanced, allowing instructors to provide immediate feedback and a display of answers to all students. This practice commonly generates discussion which enables students to verbally construct explanations for their answers, possibly facilitating generalization, derived responding (Hayes et al., 2001) and feedback from others. Additionally, in recent years more emphasis has been placed on question construction. Complex questions focusing on application of concepts rather than simple recall of facts seem to be the questions most commonly used in clicker classes (Beatty, et al., 2006; Bruff, 2009; Crouch & Mazur, 2001).

Many of the studies conducted with clickers focus more on process measures such as engagement, likability, and self-reported benefits (e.g., Draper & Brown, 2004; Dufresne, Gerace, Leonard, Mestre, & Wenk, 1996; Duncan, 2005; Miller et al., 2003;

Stowell & Nelson, 2007) rather than objective learning outcomes, such as exam scores. For example, in a recent literature review (Fies & Marshall, 2006) only 4 of 14 studies included in the review (Bullock, LaBella, Clingan, Ding, Stewart, & Thibado, 2002; Fies, 2005; Paschal, 2002; Reay, Bao, Pengfei, Warnakulasooriya, & Baugh, 2005) utilized test scores as outcome measures while 10 of the 14 studies relied on some type of surveys and questionnaires. These studies will not be described here since the following overview provides more recent information. The literature has grown steadily since the Fies and Marshall (2006) review and a few peer-reviewed studies on examining objective learning outcomes have been published to date, some of which are discussed below.

Preszler et al. (2007) examined the effects of clickers on student attitudes and performance. Students in six biology courses, upper- and lower-level, participated in the study, which used clicker questions to test for understanding of concepts. Only questions that few students answered correctly were discussed in class. Points were earned for correct responses and incorrect responses (80% of what could be earned for correct responses) but none for unanswered questions. The number of clicker questions varied between lectures in order to evaluate the effects of frequency of clicker questions on exam performance. Frequency levels were set at low (0-2) medium (3-4) and high (5-6) clicker lectures. Results showed that students across all classes performed better on exams following high clicker question lectures than medium clicker question lectures and medium clicker lectures also reliably resulted in higher achievements scores than low clicker lectures, $F(1,635) = 14.92, p < 0.001$.

Carnaghan and Webb (2007) conducted a study in four sections of an introductory management accounting class to evaluate whether students ($N = 186$) learned more with

clickers than without them. Two of the sections used clickers for the first half of the semester while the other two sections did not have clickers. For the second half of the semester clickers were removed from the first two sections and transferred to the other two sections. The same course material was used across all four sections. Four to six multiple-choice questions were interspersed throughout 80 minute class periods. Students in both conditions were encouraged to discuss the questions before responding. Students in the clicker sections used their clickers to respond, but the instructor asked for a volunteer in each of the non-clicker sections to answer the question. More students were polled if the volunteer answered incorrectly. Regardless of course section (clicker or non-clicker), the correct answer was then displayed on the classroom screen. The conditions were thus identical with the exception of the response mechanism, including the histogram displayed and the discussion that often ensued. In addition to surveys measuring satisfaction and engagement, Carnaghan and Webb used scores from midterm and final exams to evaluate learning effects. Three categories of exam questions were defined: items related to in-class questions, all multiple-choice items, and items that were not related to any of the in-class multiple-choice questions. Performance gains only occurred for items related to in-class questions; there was no significant difference found for either all multiple-choice questions or items not related to in-class questions. Analysis of data revealed that the majority of students had a favorable reaction to clickers and both high and low ability students benefitted from using clickers with an average improvement of about two percentage points. A somewhat surprising result from this study was that clicker use seemed to suppress oral participation, as measured by the number of questions asked by students in class. A possible explanation for this is that students may feel

reluctant to ask questions when the histogram shows that most of their peers answered correctly. This would not be the case with a non-clicker condition in which students do not know how the overall class responded.

Crossgrove and Curran (2008) used clickers in a biology class for non-majors and a genetics class for biology majors to evaluate the effects of clicker use on different student populations and to assess whether clickers had any effect on retention of course material. Comparing classes taught with clickers with classes taught without clickers during the first year of the study, there was no statistically significant difference found in overall exam scores. However, the second year of the study, when the instructors were more experienced clicker users, students performed significantly better on exam items that were based on clicker questions compared to non-clicker items. Furthermore, clickers improved long-term retention of materials for students in the non-major biology class but not for students in the genetics class. A limitation of this finding is that only a small fraction of students participated in the retention assessment. Again, students in this study highly valued the use of clickers. The authors cite two confounding factors for limited learning gains in this study. First, adapting new technology into the classroom proved to be difficult, and second, active learning strategies were already being incorporated into the classroom, which could be responsible for overall student improvement.

In a well designed study, Mayer et al. (2009) evaluated whether clickers positively affect learning, using 358 educational psychology students as participants. One group received instruction using clickers; the second group was asked questions during class but without clickers. The third group was a control group that did not get questions

or clickers. The material covered across the three conditions was identical and student demographics across conditions were very similar. The authors analyzed exam scores on midterm and final exams to compare the three conditions; each exam consisted of 45 multiple-choice questions. Thirty of these questions were similar to questions asked in class, aimed at measuring the same concepts or theories without being presented in the same manner. The clicker group used 5-10 minutes of each lecture to discuss and answer 2-4 clicker questions. After each question, a brief discussion followed which included the rationale for the correct answer. Students earned 2 points for correct responses and 1 point for incorrect responses. The no-clicker group answered 2-4 multiple-choice questions on a piece of paper at the end of each class period and handed them in. Then the instructor asked students to indicate their answers by raising their hands, provided them with the correct answer and asked a student to provide the reasoning behind that answer. This took place right before students left. These students also earned 2 points for correct answers and 1 point for incorrect answers based on their written answers. Students in the control group were able to ask questions during lecture but they were not exposed to any multiple-choice questions. Students in the clicker group significantly outperformed students in both the other groups, with an improvement of about 1/3 of the former group versus the other two. Mean total score on exams for the clicker group was 75.1, and 72.3 and 72.3 for the non-clicker and control groups, respectively. Unlike the studies by Carnaghan and Webb (2007) and Crossgrove and Curran (2008), students from the clicker group scored higher on dissimilar items, that is, questions that they had not received during class in a different version. A possible explanation for the difference between the clicker and non-clicker groups is that clicker questions can be administered

efficiently, while paper-based questions took time and were disruptive to the lecture. Also, points earned for paper-based questions were not immediately available to students via the course website as were points for the clicker group.

Small Group Discussion and Clickers

Clickers are utilized in several different ways in the classroom and many excellent examples are provided by Bruff (2009), some of which emphasize the benefits of having students discuss questions in small groups before or after they submit their answers. The majority of studies reviewed so far have included some type of peer interaction or class-wide discussion and some have claimed that the success of clickers depends primarily on social interactions in the classroom (e.g., Trees & Jackson, 2007). Among these peer discussion methods are class-wide discussion (Dufresne et al., 1996) and Peer Instruction (Crouch & Mazur, 2001).

Class-wide discussion. Dufresne et al. (1996) employed a “class-wide discussion” format in conjunction with clickers in mathematics and science classes with undergraduate students. As in any other clicker class, students were presented with questions throughout lectures, but before they answered, they engaged in 3-5 minute discussions with their peers in which they provided an argument for their response option, asked questions, or added information. After the small-group discussion, students submitted their answers using clickers. Once all students had submitted their answers, a histogram of their answers was presented on the classroom screen. Without giving away the correct answer, the instructor then facilitated a class-wide discussion during which students provided explanations for their answers. Before proceeding to the next topic, the instructor provided the correct answer along with an explanation for it. No performance

related data are available on this particular approach, but verbal reports by both students and instructors indicated that class-wide instruction contributed considerably to understanding course material (Dufresne et al., 1996).

Peer Instruction. Peer Instruction (PI), developed by Eric Mazur at Harvard University (Bruff, 2009), requires students to apply concepts and explain them to their fellow students during small group discussions. The way PI sessions are conducted varies between instructors, but Nicol and Boyle (2003) provided a description of a typical PI class. First, the instructor presents a clicker question to the students. These questions are closely aligned with test items on midterm and final exams. Students then think individually about the question and submit their individual answers. Next, all students are provided with a histogram of the overall responses of the class. After students have viewed the results of their votes, peer discussion begins. Students are asked to provide a logical reasoning to their peers as to why their answer is the correct one. This period allows them to uncover difficult aspects of the course material which requires them to apply the core concepts. After a brief discussion (two to four minutes), the same question is presented and students are asked to answer again. After the second vote, the new histogram is viewed while the instructor provides a rationale for the correct answer. These questions are generally not graded (Crouch & Mazur, 2001) but students can earn points for consistent participation over the course of the semester.

Crouch and Mazur (2001) analyzed data from ten years of teaching with PI in an introductory physics course for non-majors at Harvard University. Gains in conceptual mastery, as measured on the Force Concept Mastery (FCM) was much greater when PI

was in effect ($g = 0.48$) than when traditional lectures were administered ($g = 0.23$).

Gains were calculated as follows:

$$g = \frac{\text{score at the end of semester} - \text{pre-semester score}}{100\% - \text{pre-semester score}}$$

Students also performed better on quantitative problem-solving, as measured on the Mechanics Baseline Test (MBT), after a semester of PI than after a semester of traditional lectures. Peer Instruction students from the spring semester of 2000 did much better on a final exam than did traditionally taught students from the spring semester of 1999, with an effect size of 0.57.

There are serious limitations to these findings. First, out of the nine school years included in the study, the comparison includes only two years when lectures were delivered in a traditional way (1990 and 1999) with PI being taught for the remaining seven (1991, 1994, 1995, 1996, 1997, 1998, and 2000). Data from 1992 were not available. It is interesting to note that the gain between the two years taught *traditionally* is nearly twofold. Thus, there seems to be a gradual increase in gains over time, irrespective of teaching method. Second, for the MBT, no data are available for 1999, which leaves the comparison ratio at one traditional lecture to seven PI lectures. Third, different instructors taught the class in 1999 (traditional lecture) and 2000 (PI), respectively. The difference in achievement scores could thus be attributed to a more effective instructor, not the difference between the lecture format and PI. A fourth limitation is that a condition that controls for clicker responses is lacking. That is, students may be performing better either because they engage in PI during class or because they respond individually to questions related to important course topics. It could

also be a combination of both factors. Simply comparing PI with traditional lectures does not provide the component analysis necessary to answer these questions. However, Crouch and Mazur (2001) found that when students voted again after peer discussion, more students typically changed their answers from incorrect to correct (32%) than from correct to incorrect (6%). That could have resulted from gains in understanding during discussion or simply because a more knowledgeable student provided the correct answer to a less knowledgeable student. One could also question the external validity of these findings since this study evaluated data from one type of class (physics) and all the participants came from the same university.

Recently, Smith et al. (2009) tried to distinguish between these two possible explanations, gains in understanding during discussion versus knowledgeable students providing information to others. In a study conducted in an undergraduate introductory genetics course, five questions, on average, were asked in each 50 minute lecture. Students were asked to engage in peer discussions before answering each question. Equal amounts of points were earned for both correct and incorrect answers. Over the course of the semester, a second set of 16 questions was created - so-called isomorphic questions. These questions were similar to the original questions, requiring the application of the same principles, but were presented in a different manner, i.e. with a different “cover story” (p. 123). An example of this could be a question that requires students to recognize extinction as the behavioral process. One “cover story” could include a description of a pigeon’s decreased responding in an operant chamber as a result of certain conditions and the isomorphic “cover story” could include a description of a child whose temper tantrum ceased to occur over time as a result of an extinction procedure. The concept in question

is the same, but it is presented in different ways. This arrangement was supposed to demonstrate that performance on the isomorphic question was not simply based on a recall of the original question since they were presented in a dissimilar fashion. When each of these questions was presented, students first answered individually. They were then given the opportunity to engage in a discussion with their peers. Following that discussion, all students voted again, individually. Students finally responded individually to the isomorphic question. No histograms were displayed until after students had voted on the isomorphic question. This eliminated the influence of the overall responding to the first question on the isomorphic question.

The results showed that significantly more students answered the isomorphic question correctly compared to the two times the original question was asked. Also, of students who answered the initial question incorrectly the first time, but correctly the second time, 77% answered the isomorphic question correctly. These data strongly suggest that students who did not respond correctly to begin with acquired the verbal repertoire necessary for correct responding during discussions with their peers. In addition, the overwhelming majority of students who answered the initial question correctly also answered the isomorphic question correctly, demonstrating understanding of the concept initially. The authors convincingly demonstrated the effects of peer instruction, but the question remains whether the instructor can generate the same effect by providing his or her own explanations rather than having students spend time discussing it among themselves. It is also possible that gains in correct responding between the first question and the isomorphic question occur simply because students have had more time to think about the concept in question and thus problem solve

more effectively. Having a control condition exposed to exactly the same procedures, except for the peer discussion would help identify possible confounds.

It is unclear which of the two discussion formats is more conducive to learning, class-wide discussion or peer instruction. However, Nicol and Boyle (2003) compared students' perceptions of the two methods, particularly their understanding and motivation. Both methods were considered helpful since students were actively involved in class, they got more time to think and immediate feedback was motivating. The overall results indicated that PI was considered more beneficial to students, especially since class-wide discussion caused some confusion by presenting multiple viewpoints and answers before the correct answer was presented. However, outcome measures that supported this claim were not provided.

Instructors sometimes actively participate in the discussion, but usually after peer instruction has ended and students have voted. It is not necessary for instructors to discuss the rationale for each clicker question; explaining answers to questions that less than 70% of the students answer correctly seems to be a common criterion (e.g., Carnaghan & Webb, 2007).

Rationale for the Current Project

When designing their courses, it is important for instructors to have empirically constructed guidelines of how efficient and effective their teaching strategies are and which ones they should use and which ones should they exclude. Several studies found support for using clickers with peer discussion in the college classroom as summarized above. However, none of the existing studies explicitly isolated the effects of discussion from the effects of using clickers to answer questions in class. Since the success of

clickers seems to depend on social factors in the classroom (Trees & Jackson, 2007) it is important to evaluate if and how much these social factors contribute to learning. It is possible that utilization of clickers themselves, without small group discussion, is primarily responsible for learning gains through the presentation of frequent practice opportunities and exposure to questions related to exam items, immediate feedback and a contingent point system. Peer discussion can take up a considerable amount of class time, so knowing whether this time does add value in terms of learning is an important, practical question.

Two studies are presented here. The first study attempted to examine the effectiveness of small group discussion when used in conjunction with a classroom response system, measured by in class responses and exam scores. This condition was compared to lectures in which clickers were used but without the discussion component. In addition, student preference for either of the two approaches and their perceptions of these instructional methods was evaluated via a social validity questionnaire.

The second study compared the exam performance of students who used clickers to answer questions during class to the exam performance of students in different sections of the same class who did not have access to clickers. Even though previous studies have addressed this question, relatively few included objective outcome measures, most of which only measured performance once over a course of a semester (e.g., Carnaghan & Webb, 2007; Crossgrove & Curran, 2008; Mayer et al., 2009). Both studies presented here include frequent measures of learning across full semesters whereas previous studies have mostly relied on midterm and final exams.

STUDY 1

Method

Participants and Setting

Ninety-five undergraduate students enrolled in two fall sections of an Organizational Psychology for non-majors class participated in the study, 58 students in Section 1 and 27 students in Section 2. Each section was taught by a different instructor. The instructor for Section 1 was teaching this class for the fourth time and the instructor for Section 2 was teaching it for the first time. Section 1 met on Monday and Wednesday nights and Section 2 met on Tuesday and Thursday mornings. Each class period was 75 minutes long and exams were administered every third class period, on average. Lectures were conducted in typical college classrooms equipped with either a whiteboard or a blackboard, a projector, and seating capacity for between 40 and 60 students, depending on the section. During the first week of class a demographic questionnaire was administered in both sections in order to collect data on various student variables, such as cumulative GPA, area of major, undergraduate status, number of credit hours being taken during the semester and prior experience with using clickers in the classroom (see Appendix A). This allows for comparison of student demographics across the two sections. A summary of these demographics can be found in Study 2, along with the demographic information of participants in Study 2.

Materials

The primary focus of the course was performance management techniques and how they are used to improve organizational performance. An overview of Behavioral

Systems Analysis was also provided. The class consisted of 8 units, each unit covering a particular topic (see course syllabi for Sections 1 and 2 in Appendices B and C).

Textbooks, course packs and study objectives. The primary text for this course was *Performance Management: Changing behavior that changes organizational effectiveness* (Daniels & Daniels, 2004). Additional reading materials and study objectives were included in course packs. Reading materials and study objectives varied slightly across sections, most notably with respect to sequencing of topics. For example, while the Performance Matrix was introduced in Unit 2 in Section 1, it was presented in Unit 3 in Section 2. Study objectives consisted of questions regarding the most crucial topics in each unit and typically included the location in the text where the answer could be found, indicated by the page number and paragraph in parentheses. An example of study objectives for the first part (one lecture) of one unit can be found in Appendix D.

Lecture slides. Each instructor used his or her own lecture slides, all of which were available to students in an electronic format via the course website. Lecture slides for both sections primarily included content and explanations related to study objectives. Multiple-choice questions for each lecture were interspersed throughout lecture slides (see below).

Multiple-choice questions. A total of 57 multiple-choice questions related to course objectives were presented during lectures in Sections 1 and 59 for Section 2, on average four per class period, eight per unit. Initially, four questions were created for each lecture, but due to time constraints in some of the lectures it was not possible to present them all. Therefore, a total of three questions were removed from Section 1 and one question from Section 2. Isomorphic versions for all of those questions were created

to use on unit exams. An isomorphic question is similar to the original question, asking about the same concept or example, but from a different perspective or with a different cover story. Examples of these questions can be found in Appendix E. All multiple-choice questions had four response options, of which one was correct. The aim of the questions was to assess students' understanding of concepts and application thereof, such as an example of a concept rather than the definition of a concept. Questions that require simple recall of factual information were not included. These questions were written with the goal that no more than 70% of students (see Bruff, 2009) were expected to answer them correctly, basing some incorrect answers on common student misconceptions, when possible. In order to reach this level of calibration, it would have been necessary to test each of the questions prior to the study and adjust accordingly. However, this was not a possibility for the current study due to the amount of time and resources needed for this task. None of the questions included response options that could be eliminated without much consideration, such as humorous answers that were obviously not related to the course content. Despite criticisms of using multiple-choice questions for testing understanding (e.g., Feinberg, 1990), properly written multiple-choice questions can be a valid measurement of concept learning and application (Haladyna, 2004).

Exams. Exams consisted of multiple-choice questions, fill in the blanks, short-answers, and essay questions. Eight questions on each exam were similar (isomorphic) to clicker questions asked during lectures. The isomorphic questions were mostly multiple-choice but some short-answer items were also included. This means that eight items on each exam (except for Unit 6 in Section 1 and Unit 7 in Section 2) tested for understanding or application of material included on the in class multiple-choice

questions. Exams were based on study objectives and additional material provided in class. Each exam was worth 35 points.

Social validity questionnaire. It is important to measure social validity since new educational procedures will not be adopted if they are met with resistance or dissatisfaction. Wolf (1978) emphasized the use of a feedback system that allows us to measure the level of acceptability from the perspective of the consumers of the intervention or procedures, i.e., students in the current study. A social validity questionnaire (see Appendix F) was administered at the end of the course, which asked about students' perceptions of learning, preference for instructional conditions, and more. Informal interviews with both instructors were also conducted in order to gauge their experiences with respect to the two conditions and using clickers as an instructional tool.

Technology

TurningPoint™ audience response clickers, produced by Turning Technologies, LCC, were used in both sections to collect responses from students. This system consists of three components: software, wireless handheld keypads, hereafter called clickers, and a USB receiver. The software is integrated into Microsoft PowerPoint® and allows the instructor to author various types of questions that can then be presented to his or her class as part of the PowerPoint® presentation. Authoring of question slides occurs in a typical PowerPoint® environment where both the question and the response options, including a correct response indicator, are entered onto a slide which has been designated as a clicker slide. The software stores all the responses made by the audience via clickers and displays them graphically. A count of student responses is also displayed as they are being made, allowing the instructor to monitor the number of responses being submitted.

The clickers enable students to respond to questions posed via PowerPoint® by clicking the button that corresponds to their selected answer. This tool makes it possible to respond to one or more of up to 10 response options. The clickers emit radio frequencies, with a range of up to 200 feet which is then received by the USB receiver plugged into the instructor's computer that hosts the PowerPoint® presentation. The clickers are 3.3" x 2.1" x 0.3", and weigh approximately 1 oz. Each clicker uses two CR2032 (3.0V) Lithium batteries. This system has 82 channels available which means that up to 82 sessions can be run simultaneously in close proximity to each other without interference. The receiver is powered by a USB port, measures 1.1" x 3.7" x 0.4", and weighs 1.0 oz. Each receiver has a capacity for up to 1000 clickers. The system used for the current study included 60 clickers and the same system was used in both sections. The TurningPoint™ software automatically stores each response made with a clicker, by individual students, and assigns points for each response as prescribed during question construction. Those data were then generated as Microsoft Excel® spreadsheets. Each instructor used a PC computer and a classroom projector to display PowerPoint® slides, including questions.

Experimental Research Design

An alternating treatments design (ATD; Barlow & Hersen, 1984) was used to evaluate the effects of peer discussion on learning. The two conditions, clickers with discussion and clickers without discussion, alternated across eight units in a semi-randomized order so that one condition was not in effect for more than two consecutive units, thus avoiding possible sequencing effects. The study was replicated across the two sections, thus providing an assessment of external validity. In order to evaluate the

possible confounding effects of unit difficulty, exam scores by units from previous semesters were analyzed and compared to exam scores from the current study.

Using an ATD allows for a quick comparison of two instructional methods without the implementation of a baseline phase. One advantage of the ATD is that it is insensitive to background trends in performance. For example, if students improve their performance over the course of the semester due to factors outside the experimental manipulation, the differences between the two experimental conditions would still be visible. In addition, the ATD eliminates intersubject variability while providing direct observation of any effect and controlling for threats to internal validity. Carry-over effects between units and conditions are not thought to be a disadvantage of the ATD in this study, since each unit is considered independent in terms of content and learning objectives.

Procedures

Prior to the beginning of the study, conditions were randomly designated across the eight units. Four units were taught with clickers and discussion and four units with clickers only, but each condition occurred for no more than two consecutive units. Clickers were registered to students in TurningPoint's™ database so that each student used the same clicker over the course of the semester, thus allowing the researchers to track the performance and attendance of individual students. To facilitate the distribution of clickers in class, small stickers numbered 1 through 60 were placed on the back of the clickers and attendance sheets were created that listed all students and the number of their respective clickers. At the beginning of each class period in Section 1, teacher assistants handed out clickers as students walked in, using the attendance sheet to mark off the

clickers used for that class. Students in Section 2 picked their clickers up from a desk in the classroom which had been prepared by the instructor.

Lectures were delivered for 75 minutes each class with four multiple-choice questions presented on the class projection screen during lecture. Each question was presented after the instructor had discussed the material that related to that question, usually at the end of each lecture. The way in which students answered these questions depended on the condition in effect (see below). Students were able to ask questions throughout the lecture.

In the beginning of the semester, self-reported, anonymous, demographic data were collected in order to compare participants across the two sections (Appendix A). The data collected included students' cumulative GPA, number of psychology classes previously taken, number of credit hours taken during the semester, whether students were currently employed and, if so, how many hours they worked per week, and their undergraduate status. Students were also asked about previous experience with clickers.

Clickers with discussion. In the beginning of each class period, students were asked to pair up with another student with whom they discussed clicker questions during lectures. Students were asked to work with a student they had not worked with before. Once multiple-choice questions were presented, the instructor prompted students to discuss the questions and their proposed answers with their peer for no longer than two minutes before they responded individually, using their clickers. Students were required to provide an explanation for their answer to their peer. This requirement was stated on each of the question slides in the discussion condition ("Discuss with your partner and provide an explanation for your answer"). During this period, the instructor monitored the

number of responses being submitted and reminded students to submit their answers within the two minute period, occasionally mentioning the incentive system in effect (explained below). During this time, students were not allowed to use their notes or textbook since it would have taken time away from the discussion. Once students submitted their answers, the instructor displayed a bar graph that showed how students allocated their answers across the four response options. This screen included a visual indicator for the correct answer. The instructor then provided a brief rationale for the correct answer and encouraged students to ask questions if they needed further clarification. Students earned 1 point for incorrect answers and 2 points for correct answers, with total clicker points for the whole semester adding up to as much as 5% of the total course grade. Updated points were available to students on a grade sheet that was distributed to students after every unit exam. Student responses from each class period were stored electronically as an individual file. At the end of each class, students returned their clickers to the instructor or teacher assistants.

Clickers without discussion. This condition was identical to the clickers with discussion condition with the obvious exception of the discussion component. After each question was presented, students in this condition had up to two minutes to respond with their clickers, with the following prompt on each question slide: “Work alone: Think about an explanation for your answer before you respond.” As in the discussion condition, students were not able to use course materials during question time. The same point system, described previously, was in effect of this condition.

Exams. For both sections, unit exams were administered every third class period, on average (see Appendices B and C for syllabi). Students who did not take an exam

received a score of zero on that exam, but two make-up exams were offered during the semester. Neither scores of zero nor make-up exams were included in the data analysis. Scores for items related to in class multiple-choice questions, eight in total, were analyzed separately from the overall test scores in order to evaluate whether discussion impacted exam performance. Instructors and teacher assistants used answer keys to grade exams.

Interobserver Agreement

Twenty-five percent of the exams for each unit exam were randomly selected and independently graded on the eight exam items included for this study by two raters, either a teacher assistant, instructor, or the primary investigator. Point-by-point interobserver agreement was then calculated by dividing the number of agreements by the sum of the agreements and disagreements and multiplying the quotient by 100. The data recording sheet used was designed so that raters would not be influenced by each other's scoring (see Appendix G). Interobserver agreement for Section 1 was 99.7 and 98.7% for Section 2.

Dependent Measures

The primary dependent variable was the proportion of correctly answered questions on unit exams that corresponded to the multiple-choice questions asked during class. Visual inspection of both individual exam performance and the section as a whole (mean score) was conducted to compare the effects of peer discussion in Sections 1 and 2. Second, students' responses on the social validity questionnaire were analyzed, including written comments.

Results

The data presented here for each unit only consist of the responses of students who attended both lectures and took the exam for that unit. This ensures that students who were not exposed to all of the clicker questions and the discussion condition for each unit were excluded from the data analysis.

In-class Clicker Questions

Tables 1 and 2 display mean scores for in-class clicker questions in Sections 1 and 2, respectively.

Table 1

Mean Percentage Correct for In-Class Clicker Questions by Condition for Section 1

	Unit			
	1 (<i>n</i> = 44)	2 (<i>n</i> = 44)	5 (<i>n</i> = 34)	7 (<i>n</i> = 41)
Discussion				
<i>M</i>	77.9	84.2	83.2	86.9
<i>SD</i>	13.6	14.8	19.1	14.2
No discussion	3 (<i>n</i> = 49)	4 (<i>n</i> = 44)	6 (<i>n</i> = 42)	8 (<i>n</i> = 37)
<i>M</i>	58.9	67.9	80.4	76.8
<i>SD</i>	22.5	22.5	17.9	17.9

Table 2

Mean Percentage Correct for In-Class Clicker Questions by Condition for Section 2

	Unit			
	3 (<i>n</i> = 21)	4 (<i>n</i> = 20)	6 (<i>n</i> = 22)	8 (<i>n</i> = 19)
Discussion				
<i>M</i>	72.5	85.0	68.2	72.4
<i>SD</i>	10.4	14.4	20.2	15.4
No discussion	1 (<i>n</i> = 28)	2 (<i>n</i> = 24)	5 (<i>n</i> = 21)	7 (<i>n</i> = 25)
<i>M</i>	85.3	54.7	58.3	85.0
<i>SD</i>	11.8	16.0	17.4	19.1

The mean score on in-class clicker questions for all eight units by condition for Sections 1 and 2 are displayed in Figures 1 and 2. It should be noted here that unit six in Section 1 and unit 7 in Section 2 included only four clicker questions since only one lecture was included in those units.

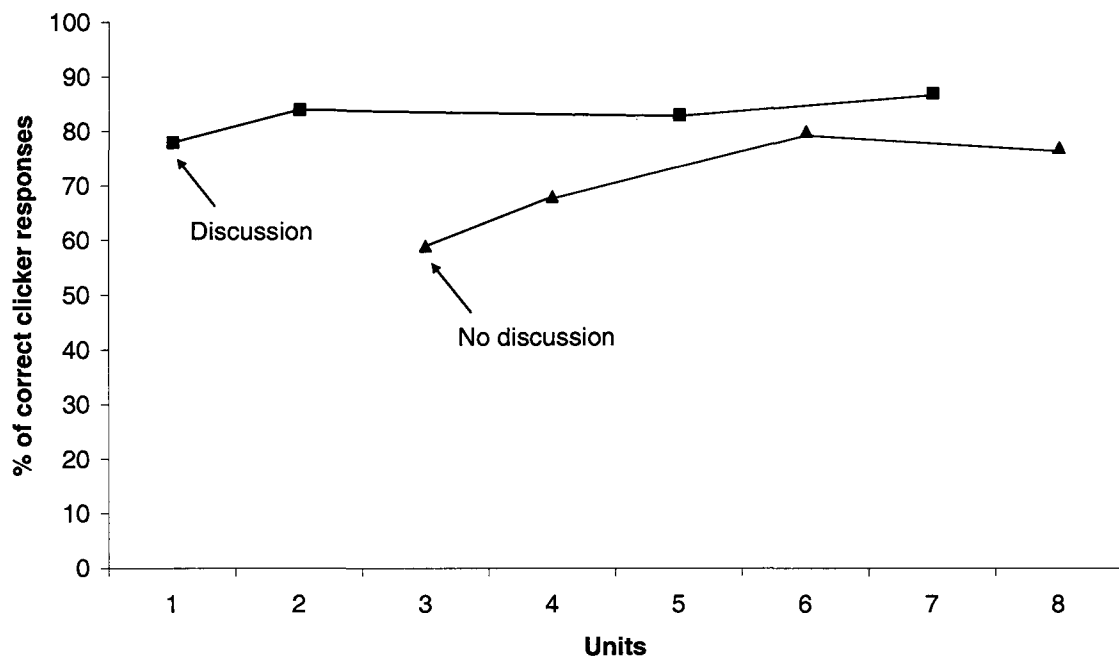


Figure 1. Mean Percentage of Correct Responses on In-Class Clicker Questions in Section 1.

Figure 1 reveals a clear separation of the proportion of correct responding across the two conditions.

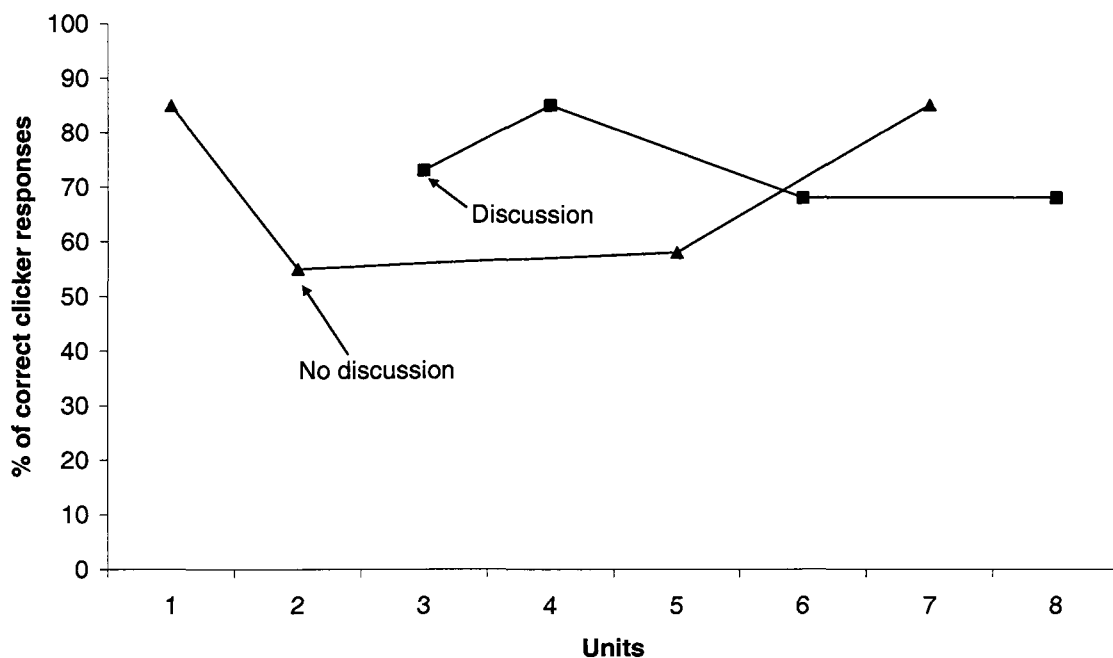


Figure 2. Mean Percentage of Correct Responses on In-Class Clicker Questions in Section 2.

There is no consistent separation on performance between conditions in Section 2, but in addition to the fact that Unit 7 only included four clicker questions, questions asked during Unit 1 may have been easier than questions for the remaining units, given initial challenges with determining the difficulty level for questions during question construction.

Exam Performance

Mean percentage of correct responses on the isomorphic exam items for Section 1 is displayed in Table 3 for Section 1 and Table 4 for Section 2. For each unit, these tables only include data from students who were exposed to all of the in-class clicker questions.

Table 3

Mean Percentage Correct for Isomorphic Exam Questions by Condition for Section 1

	Unit			
	1 (<i>n</i> = 44)	2 (<i>n</i> = 44)	5 (<i>n</i> = 34)	7 (<i>n</i> = 41)
Discussion				
<i>M</i>	87.7	69.0	69.7	82.6
<i>SD</i>	14.6	15.8	16.4	16.2
No discussion	3 (<i>n</i> = 49)	4 (<i>n</i> = 44)	6 (<i>n</i> = 42)	8 (<i>n</i> = 37)
<i>M</i>	73.0	80.7	83.9	78.0
<i>SD</i>	17.9	15.5	18.1	13.7

Table 4

Mean Percentage Correct for Isomorphic Exam Questions by Condition for Section 2

	Unit			
	3 (<i>n</i> = 21)	4 (<i>n</i> = 20)	6 (<i>n</i> = 22)	8 (<i>n</i> = 19)
Discussion				
<i>M</i>	82.5	85.6	77.9	72.4
<i>SD</i>	15.4	9.3	15.7	15.4
No discussion	1 (<i>n</i> = 28)	2 (<i>n</i> = 24)	5 (<i>n</i> = 21)	7 (<i>n</i> = 25)
<i>M</i>	76.3	81.3	83.9	92.0
<i>SD</i>	17.1	16.9	20.2	17.3

Figures 3 and 4 display mean percentages for correct responding on isomorphic exam items across all eight units in Sections 1 and 2.

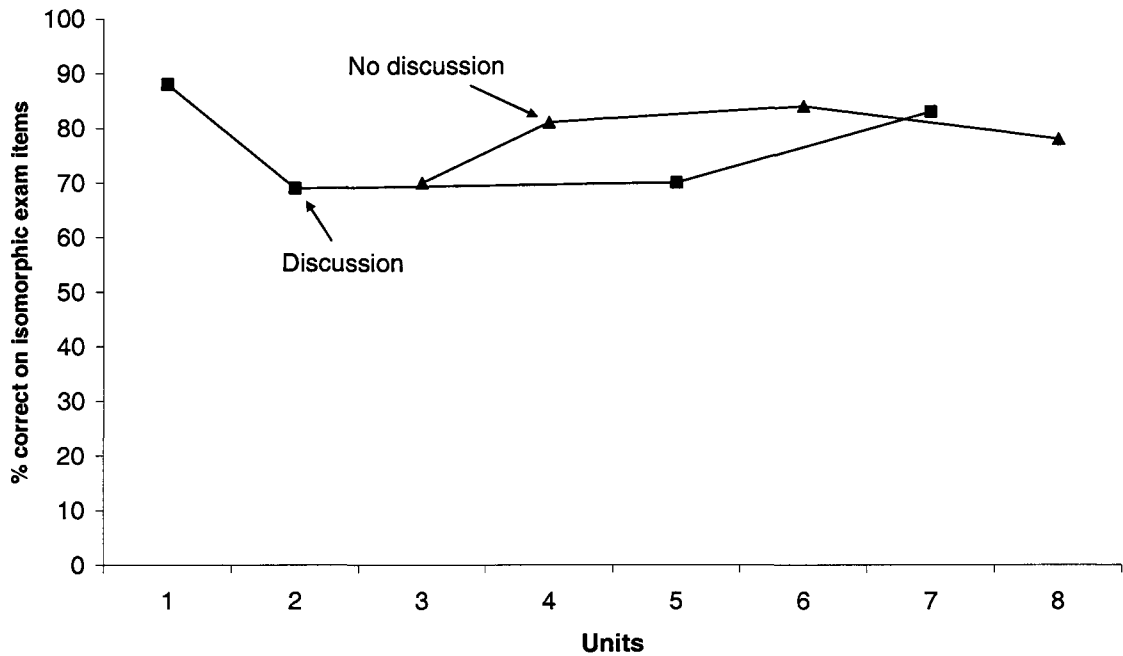


Figure 3. Mean Percentage of Correct Responses on Isomorphic Exam Questions across Units for Section 1.

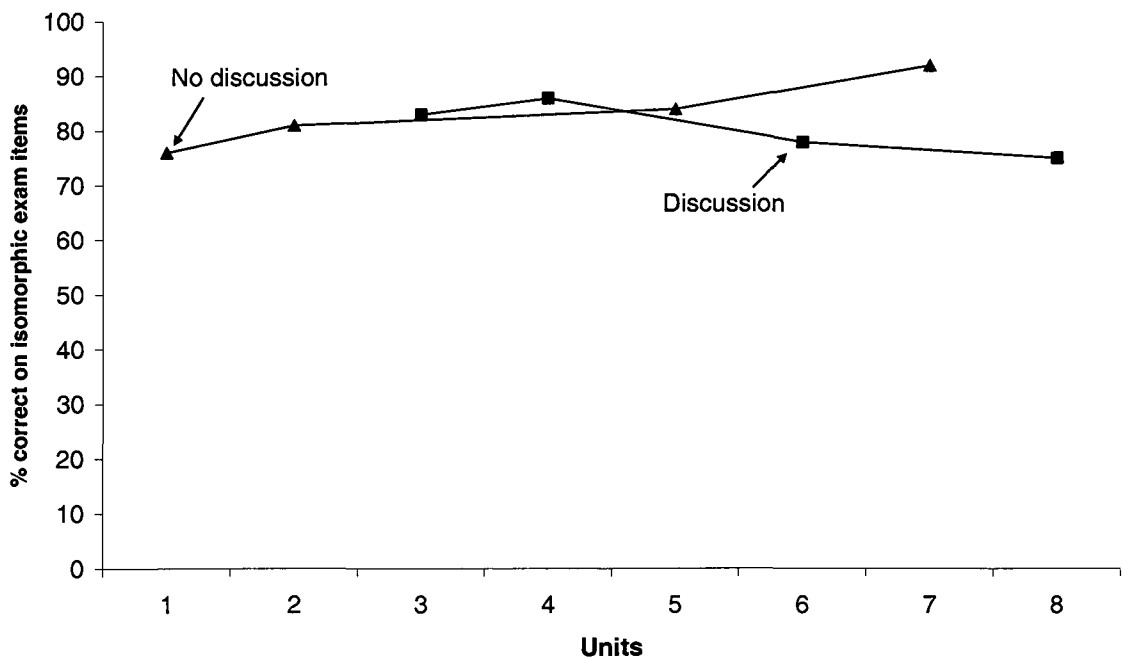


Figure 4. Mean Percentage of Correct Responses on Isomorphic Exam Questions across Units for Section 2.

Out of the 57 questions in Section 1 and 59 questions in Section 2 that were included in this study across the eight units, only 28 of those were presented in both sections, of which 16 were presented in the discussion format in one section while it was presented in the no discussion in the other section. This allows for the comparison of how students responded to the same questions under two different condition, using data from the two sections. Figure 5 displays this comparison.

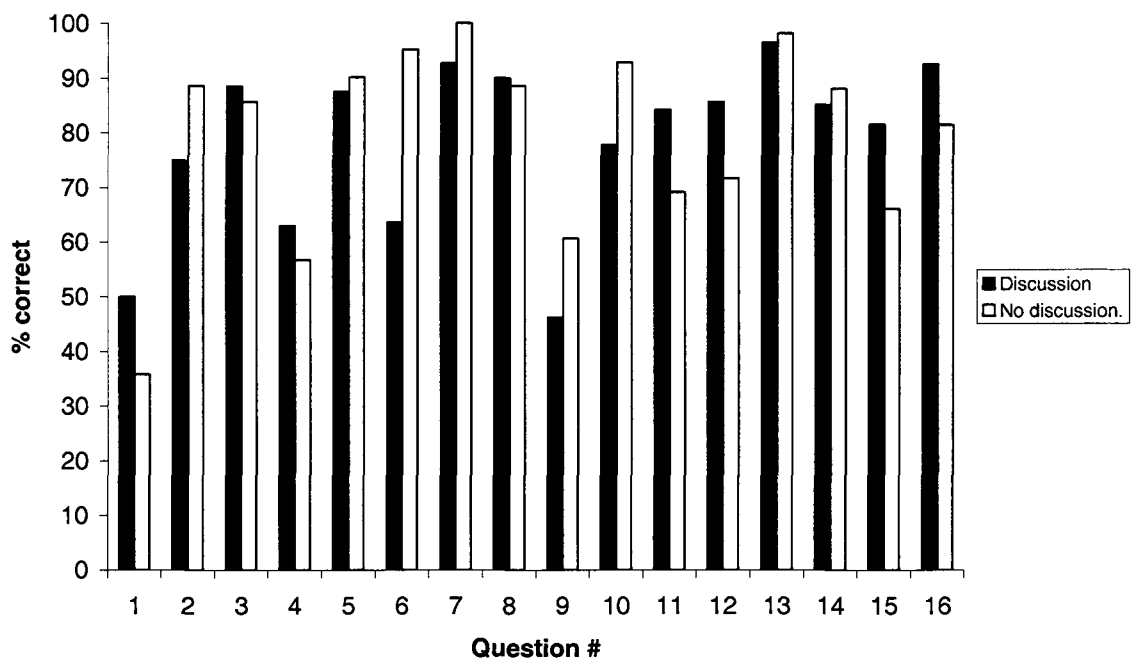


Figure 5. Comparison of Correct Responding to Identical Questions under the Discussion and No Discussion Conditions in Sections 1 and 2.

There is no consistent difference in accurate responding to questions across the two conditions. Given the observed variability across questions, which could be a function of difficulty or complexity of questions, differential effects of the independent variable are not visible.

Ratings of Clicker Use

Figures 6 thru 14 depict the distribution of responses to the questions on the social validity questionnaire in Sections 1 and 2.

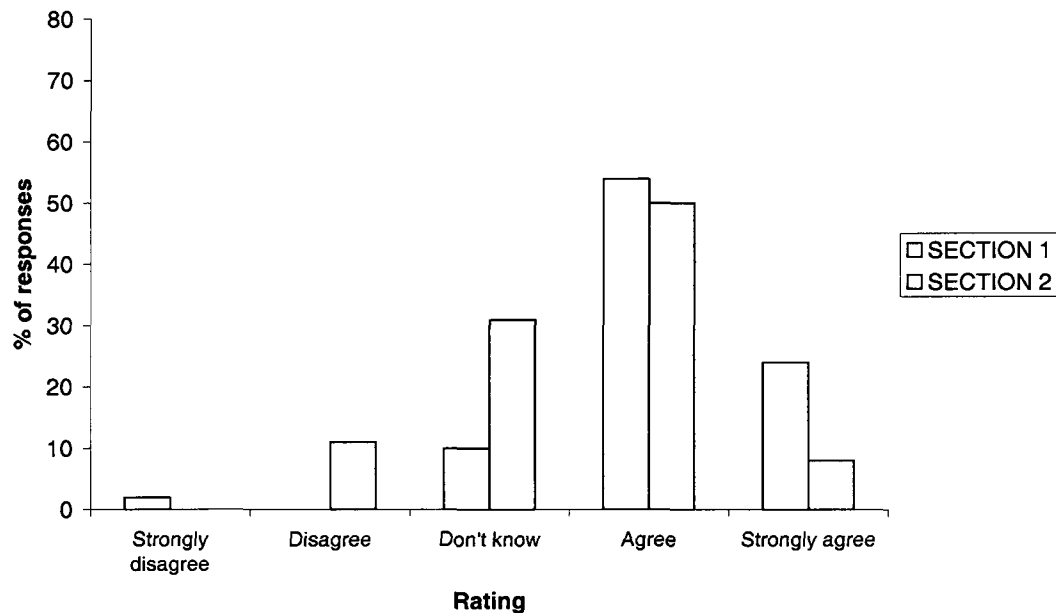


Figure 6. Distribution of Students' Responses to the Statement "I liked using clickers in this class to answer questions."

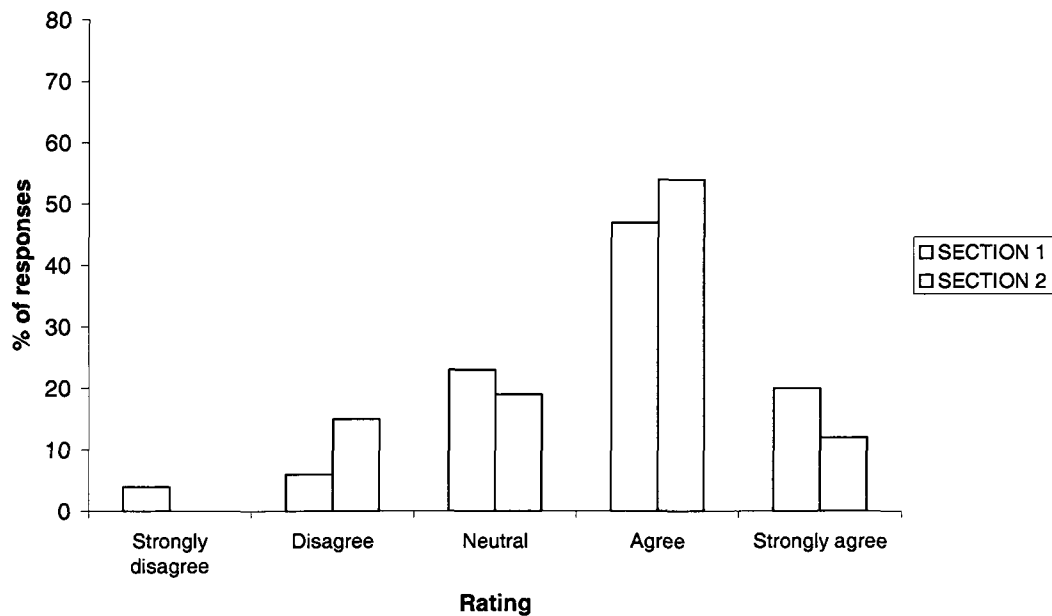


Figure 7. Distribution of Students' Responses to the Statement "I think using clickers in this class helps me learn the material."

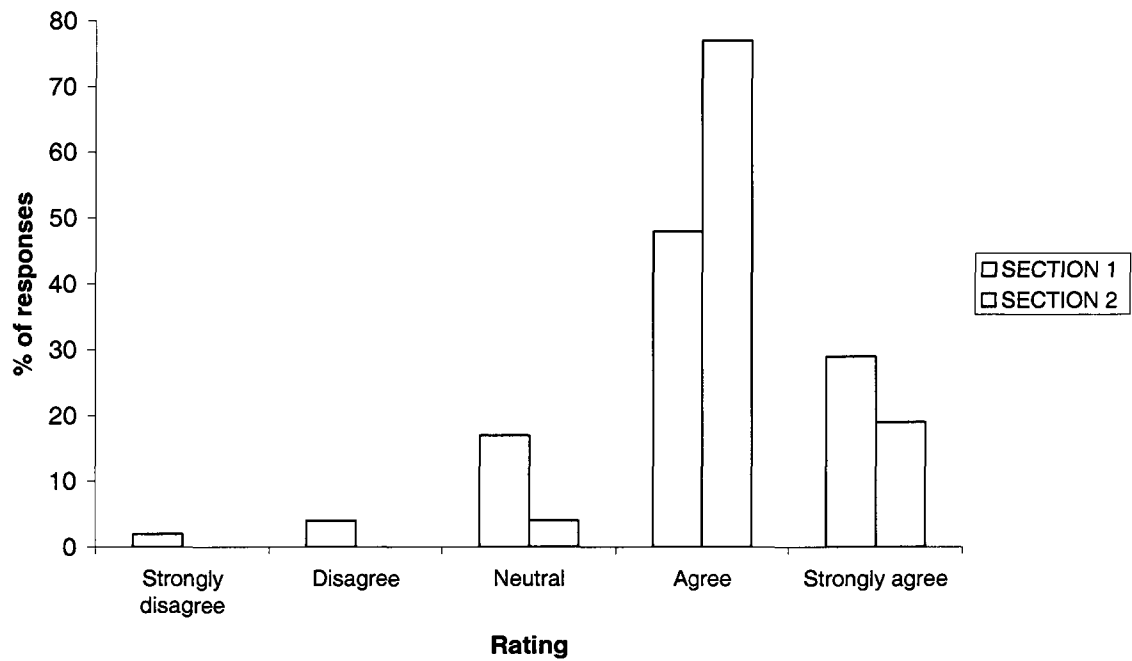


Figure 8. Distribution of Students' Responses to the Statement "I think the clicker questions asked were generally fair and tied to the course objectives."

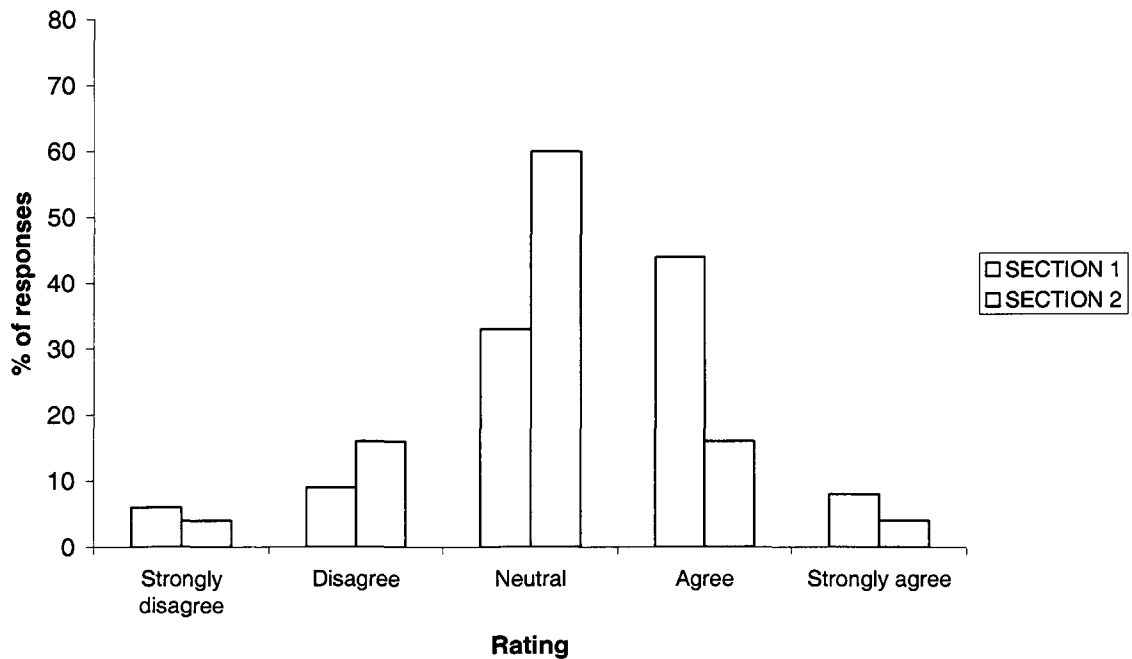


Figure 9. Distribution of Students' Responses to the Statement "I think the clicker questions helped me do better on exams."

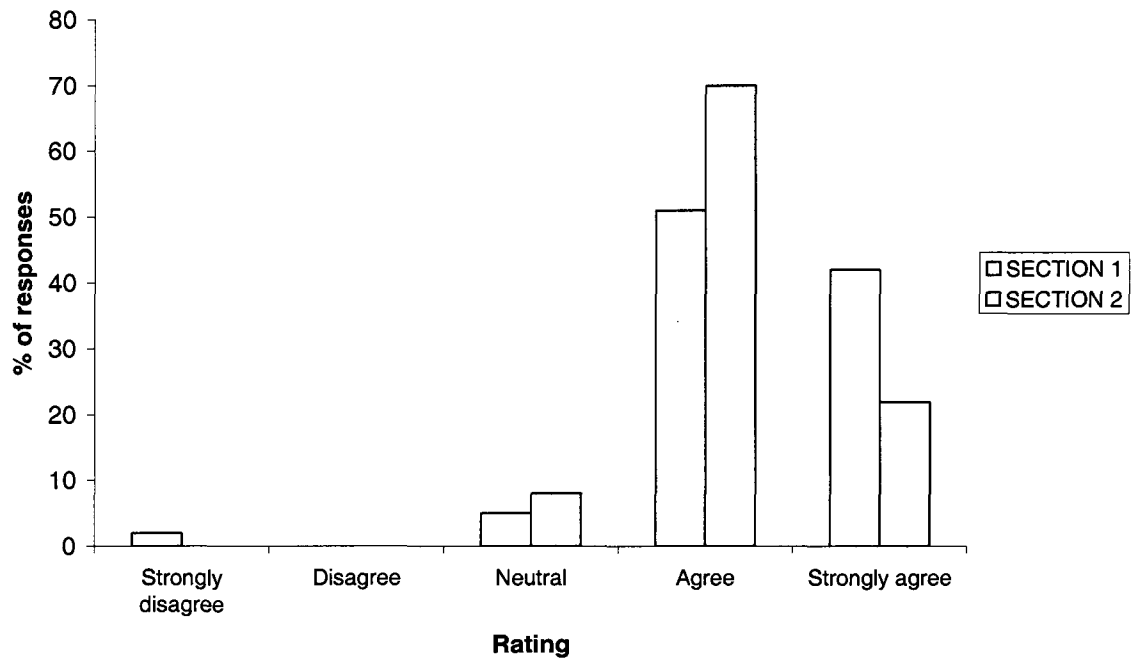


Figure 10. Distribution of Students' Responses to the Statement "I think the point system was fair."

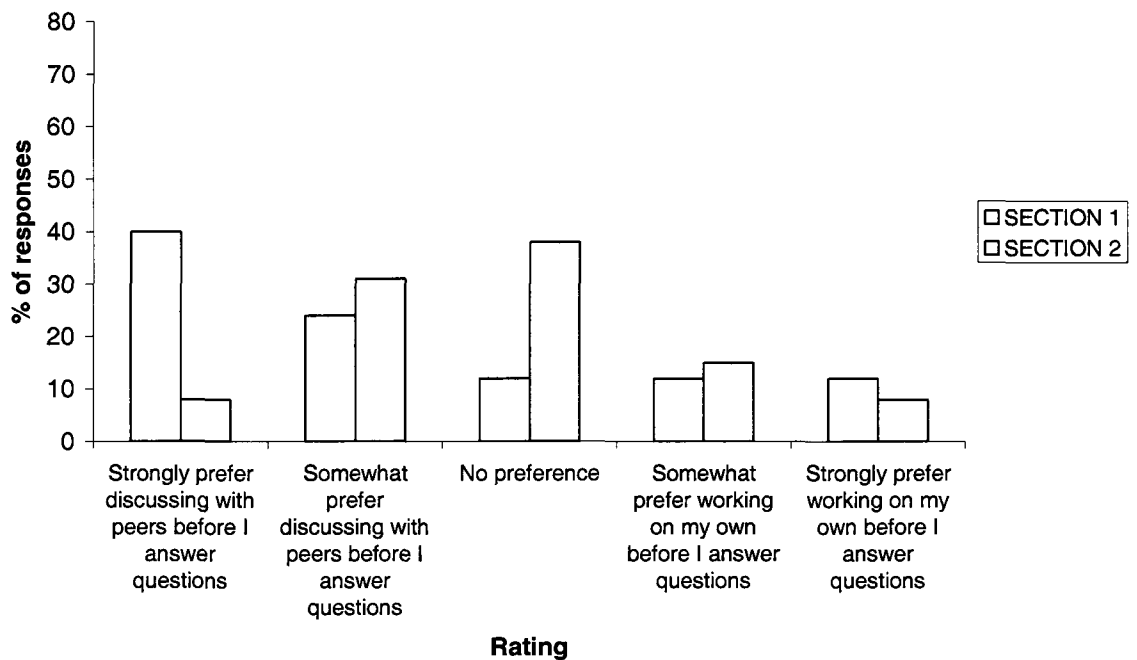


Figure 11. Distribution of Students' Responses to the Question "Thinking about the two ways we used clickers this semester (discussion vs. no discussion), which method did you prefer?"

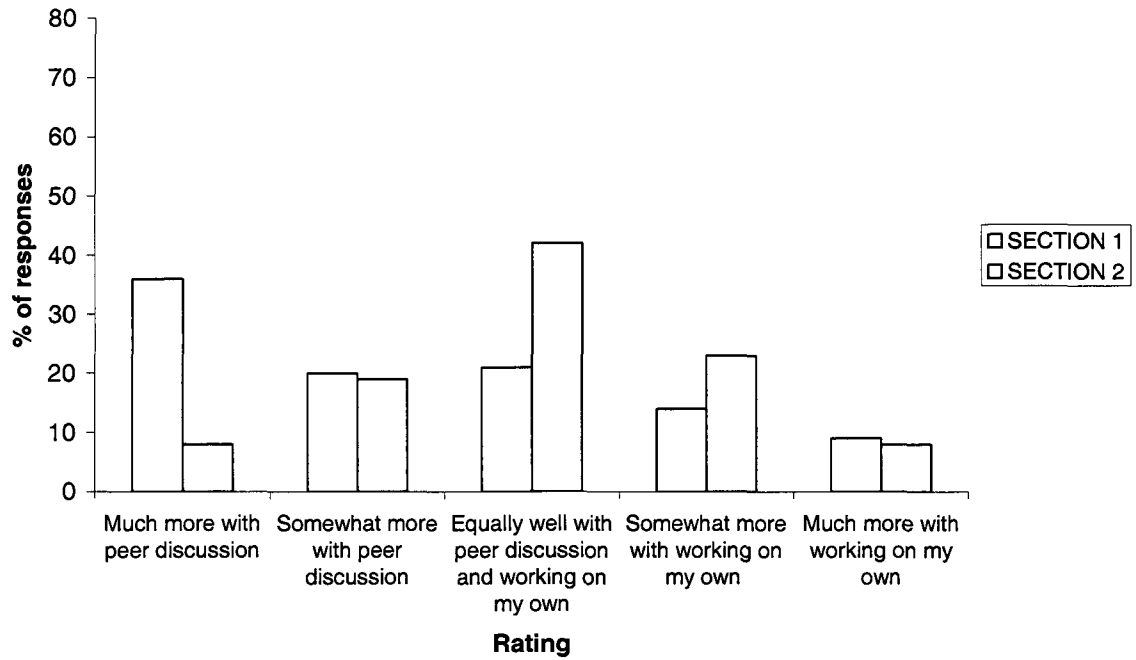


Figure 12. Distribution of Students' Responses to the Statement "Extent of learning with peer discussion versus working on your own."

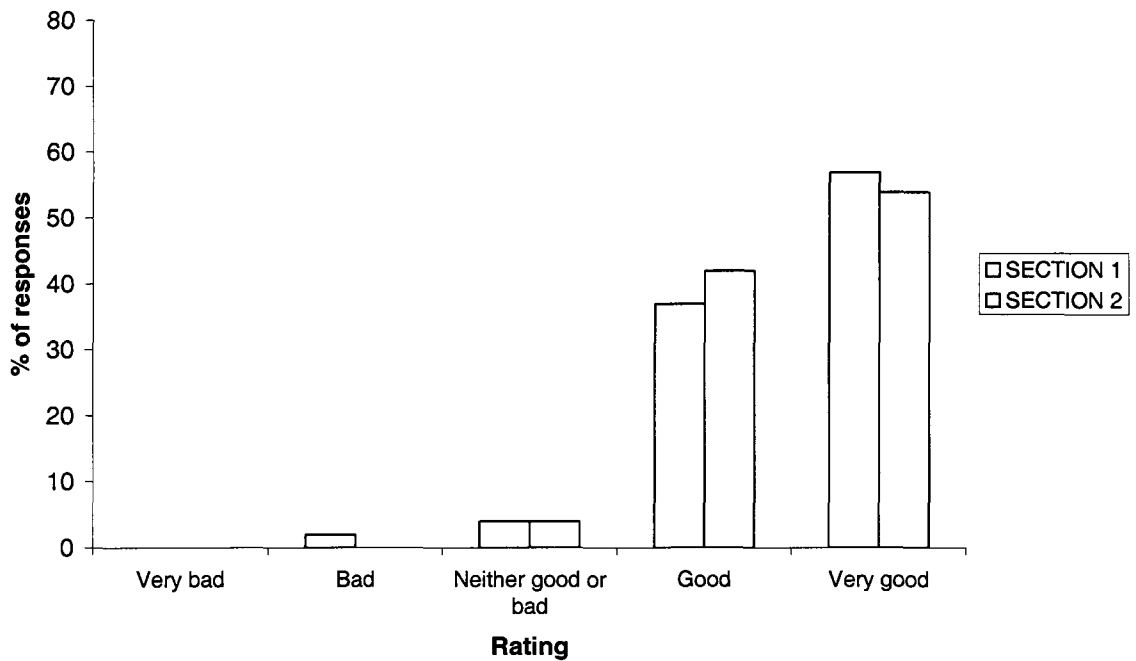


Figure 13. Distribution of Students' Responses to the Statement "Please rate how good your instructor was at lecturing."

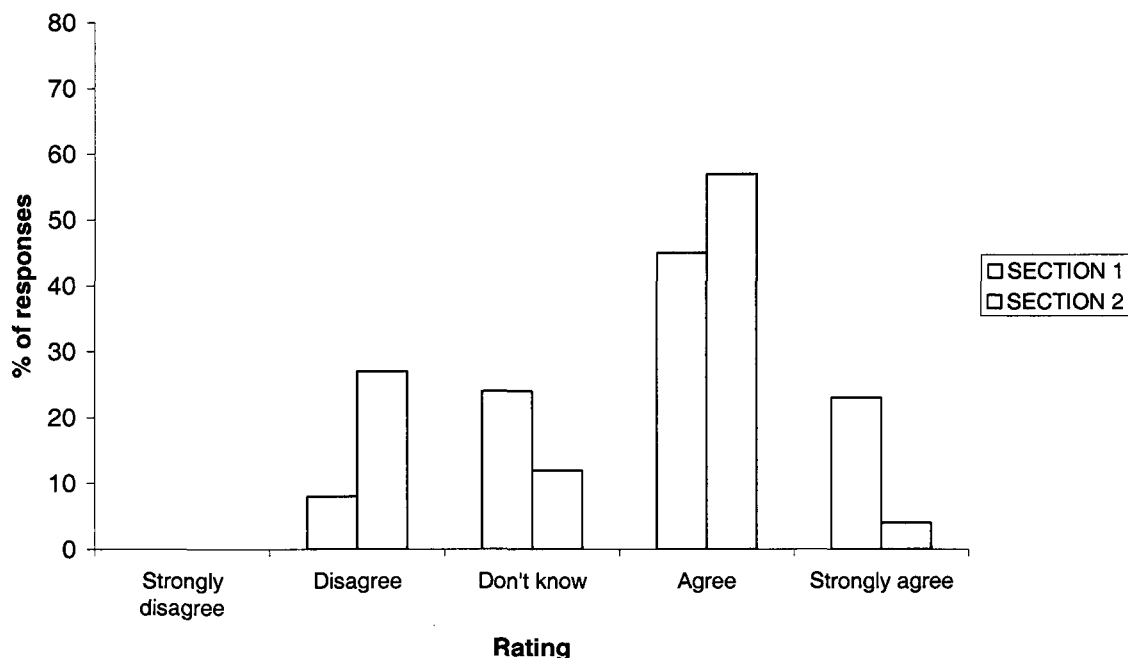


Figure 14. Distribution of Students' Responses to the Statement "I would like to use clickers in my future classes."

While 78% of students in Section 1 either agreed or strongly agreed with the statement that "I liked using clickers in this class to answer questions," 58% of students in Section 2 answered this item in the same way. Sixty-seven percent of students in Section 1 either agreed or strongly agreed with statement that the clickers helped them learn the material and roughly the same proportion of students in Section 2, or 66%, answered in the same manner. The majority of students in both sections either agreed or strongly agreed on the relevance of the clicker questions with respect to study objectives (77% and 96%, respectively) and the fairness of the point system (93% and 92%, respectively). Students' response distribution on the question of whether clickers helped them do better on exam is close to normal for Section 2, whereas a larger proportion of students in Section 1 agree with this notion (Figure 11). More students in Section 1 demonstrated preference for the discussion format in class (64% either preferred or strongly preferred peer

discussion compared to working on their own), but students in Section 2 did not show as strong of a preference for format. In the same vein, 56% of students in Section 1 thought that they learned more when discussing with peers, compared to working on their own, but the responses of students in Section 2 are close to being normally distributed. Both instructors were viewed favorably by students; with 94% of students in Section 1 rating their instructor as either “Good” or “Very Good”, and 96% of students in Section 2. Lastly, the majority of students in both sections, 68% and 61%, respectively, either agreed or strongly agreed with the statement that they would like to use clickers in future classes. Written comments from students are included in Appendix H.

Both instructors viewed clickers in a very positive way. The fact that clicker use generated class-wide discussions and prompted further questions from students was the most commonly cited benefit. The instructor in Section 1 reported that on some occasions, post-response discussions sometimes took up too much time, which made it difficult to cover all topics within each lecture.

Discussion

Visual analysis of in-class clicker responses, especially in Section 1 (see Figure 1), suggests that students answer more questions correctly when they have discussed the questions with a fellow student before they respond. The data are not as convincing for Section 2, but it should again be pointed out that the unusual proportion of correct responding in unit 7 may be explained by the fact that the unit only included 4 questions in all, which required half the amount of reading, or preparation, compared the other seven units. Seeing the difference between the two conditions, and assuming stimulus generalization across similar questions, one might expect to see this effect carry over to

students' responses on each exam, since the exam items included were similar (isomorphic) to the clicker questions presented during class. This is not the case, as is illustrated in Figures 3 and 4. There is no distinction between the two conditions in terms of correct responding, which ranges from 69-88% for discussion and 70-84% for no discussion in Section 1 and 75-86% and 76-92% for Section 2, respectively. To put it differently, even though students were more likely to respond correctly in class when they worked with peers, it does not mean that all of the students had learned the concept in question, at least not to the extent that they could generalize their responding to similar discriminative stimuli, i.e., questions, presented at a later time. This is also supported by the data shown in Figure 5 where there are no consistent differences in correct responding on exam items across the two conditions. On the other hand, it is possible that peer discussion does give students an advantage, but study behavior taking place during the time between lectures and exams could make up for that advantage.

The results of the social validity questionnaire demonstrate students' support in favor of using clickers to answer questions related to course objectives during lectures. These findings are consistent with previous studies conducted with clickers (e.g., Crossgrove & Curran, 2008; Preszler et al., 2007; Stowell & Nelson, 2007). Even though students' responses were similar for some of the questions, there are some clear differences between sections, most notably on the questions that asked about the relationship between clicker use and exam performance (Figure 11), preference for method (Figure 13) and amount of learning with each method (Figure 14). This difference is interesting, since the two sections were very similar in terms of content, how clickers were used, and the rating of instructors. There are at least three plausible

explanations for this. First, Section 1 included twice as many students as Section 2. In a larger class, students may feel more reluctant to participate and ask questions compared to a smaller class where students have more opportunities to ask questions. Therefore, students in a larger class may view the opportunity to participate in a discussion in a more positive way than students in a smaller class that already have a higher level of interaction (Weaver & Qi, 2005). Another factor that may have affected students' perceptions of the benefits of clickers is the time of day during which lectures were held. Section 1 had evening lectures whereas Section 2 had morning lectures. Discussing course material with fellow students in the early morning may be less reinforcing than discussing during an evening class, a result that can be a function of motivating operations, such as sleep deprivation. Related to this finding, Hoekstra (2008) found that about 20% of students choose not to engage in peer discussion, suggesting a lack of either motivating variables or the appropriate social skills needed for peer discussion. The third possible reason that could explain the differences in responses on the social validity questionnaire is that the discussion that often followed the instructor's presentation of the histogram and the correct answer may have contained more helpful information in the evening class than the morning class as a function of the same motivating operations just mentioned. Students reported different reasons for why they perceived clickers and discussion helpful (see Appendix H). Some said that they thought more about the question when working with others, and others stated that hearing different explanations helped them understand. Overall, the content of students' comments was in most cases very general and of limited value.

STUDY 2

Method

Participants and Setting

In addition to the 95 participants included in Study 1 (fall semester), 93 undergraduate students enrolled in two additional sections (spring semester) of the same Organizational Psychology for non-majors class that was included in Study 1, were added to Study 2. Fifty-eight of these students were enrolled in Section 3 and twenty-five in Section 4. The instructors who taught Section 1 taught also taught Section 3 and the instructor who taught Section 2 also taught Section 4. General course logistics for Sections 3 and 4 were identical to the ones described for Sections 1 and 2 in Study 1. Students' demographics across all four sections are presented in Table 5.

Table 5
Summary of Students' Demographics across the Four Sections

	Section 1	Section 2	Section 3	Section 4
Mean GPA	3.3	3.3	3.16	3.13
Mean age	20.6	21.1	21.6	21.7
Gender ratio	Female: 79% Male: 21%	Female: 70% Male: 30%	Female: 69% Male: 31%	Female: 81% Male: 19%
Mean credit hours	14.5	14.4	14.1	14.3
Psych courses previously taken (median)	3	3	3	3
Status	Sophomore 9% Junior 36% Senior 55%	Sophomore 4% Junior 50% Senior 46%	Sophomore 22% Junior 36% Senior 42%	Sophomore 15% Junior 33% Senior 52%
Employed	68%	63%	58%	70%
Mean work hours per week	19.7	18.3	21.4	20.5

Materials

The same materials that had been used in Study 1 were also included in Study 2, with the following exceptions for Sections 3 and 4. Students in those sections did not use clickers to answer questions during lectures, nor did they have the opportunity to view the questions used in Sections 1 and 2. However, the same isomorphic questions used in Sections 1 and 2 were also included on unit exams in Sections 3 and 4. Instructors had slightly modified other items of some of the exams. The social validity questionnaire was not administered to participants in Study 2 since they did not use clickers.

Experimental Research Design

A quasi-experimental design (Gravetter & Wallnau, 2005) was used in this study, where exam performance of students in Section 1 (clickers used) was compared to the exam performance of students in Section 3 (no clickers used), with the same format being applied to Sections 2 (clickers used) and 4 (no clickers used). Sections 1 and 3 and Sections 2 and 4 were comparable with respect to students' demographics and course-specific factors, for example, instructor and course materials.

Procedures

The procedures used in Sections 1 and 2 have already been described in Study 1. The same procedures were used in Sections 3 and 4 with two distinct differences. First, students in Sections 3 and 4 did not get exposed to the clicker questions to which students in Sections 1 and 2 responded, using clickers. Instead of earning points by using clickers, students in Sections 3 and 4 could earn up to as much as 5% of the course grade by completing several short quizzes that were randomly given at the end of some lectures over the course of the semester. Even though the two incentive systems differed, both

could potentially encourage attendance, if nothing else. In this study, there was no distinction made between the two conditions under which clicker responses occurred, discussion versus no discussion. Rather, Sections 1 and 2 constitute the clicker condition and Sections 3 and 4 make up the no-clicker condition.

Interobserver Agreement

Interobserver agreement (IOA) for Sections 1 and 2 was already reported in Study 1. The same procedures were followed for grading exams in Sections 3 and 4, but given a very high interobserver agreement in Study 1 (99.7% and 98.7%) and the time and effort required for conducting IOA, it was not considered necessary to calculate agreement for all eight units. Instead, IOA on 25% of the exams for three out of the eight unit exams was calculated for Sections 3 and 4. IOA for these two sections was 99.3% for Section 3 and 96.7% for Section 4.

Dependent Measures

The dependent measure was the mean percentage of correct responses on the isomorphic exam items. Additionally, data on students' perceptions of using clickers and peer discussion in Sections 1 and 2 are presented in Study 1.

Results

The data presented here for each unit include responses from all students who took that unit exam. Table 6 includes exam data from Section 1, which used clickers, and Section 3, which was not exposed to in-class clicker questions. Table 7 displays the same data for Sections 2 and 4.

Table 6
Mean Percentage Correct for Isomorphic Exam Questions
for Sections 1 and 3 across Units

	Units							
	1	2	3	4	5	6	7	8
Clickers (Section 1)	(<i>n</i> = 53)	(<i>n</i> = 54)	(<i>n</i> = 56)	(<i>n</i> = 52)	(<i>n</i> = 51)	(<i>n</i> = 50)	(<i>n</i> = 48)	(<i>n</i> = 52)
Lecture attendance	92%	81%	88%	88%	86%	88%	94%	81%
<i>M</i>	84.9	67.1	70.1	78.1	69.5	82.0	81.2	73.9
<i>SD</i>	16.9	16.2	20.5	18.0	16.7	19.6	16.7	16.4
No clickers (Section 3)	(<i>n</i> = 57)	(<i>n</i> = 56)	(<i>n</i> = 49)	(<i>n</i> = 58)	(<i>n</i> = 49)	(<i>n</i> = 54)	(<i>n</i> = 55)	(<i>n</i> = 54)
Lecture attendance	N/A	N/A	N/A	71%	85%	72%	63%	74%
<i>M</i>	73.4	62.1	70.2	67.9	65.6	75.9	68.8	66.7%
<i>SD</i>	13.0	17.3	17.8	21.0	17.9	25.2	18.4	19.6
Test of significance	<i>t</i> =4.00	<i>t</i> =1.59	<i>n/a</i>	<i>t</i> =3.00	<i>t</i> =1.13	<i>t</i> =1.36	<i>t</i> =3.55	<i>t</i> =2.05
($\alpha=0.05$)	<i>p</i> <0.001	<i>p</i> =0.116		<i>p</i> =0.003	<i>p</i> =0.262	<i>p</i> =0.176	<i>p</i> =0.001	<i>p</i> =0.042

Four out of the eight comparisons across conditions revealed a statistically significant difference. Attendance data are not available for the first three units in Sections 3 and 4, since it was assumed that attendance would be similar to Sections 1 and 2. When attendance was found to be worse in Sections 3 and 4 after the first three units, attendance data were taken for all units after that.

Table 7
Mean Percentage Correct for Isomorphic Exam Questions
for Sections 2 and 4 across Units

	Units							
	1	2	3	4	5	6	7	8
Clickers (Section 2)	(<i>n</i> = 28)	(<i>n</i> = 28)	(<i>n</i> = 25)	(<i>n</i> = 26)	(<i>n</i> = 25)	(<i>n</i> = 29)	(<i>n</i> = 26)	(<i>n</i> = 24)
Lecture attendance	98%	93%	86%	88%	86%	86%	93%	84%
<i>M</i>	76.3	81.3	80.0	83.7	82.5	77.3	91.3	70.8
<i>SD</i>	17.1	15.8	15.3	13.1	21.7	16.4	17.2	14.6
No clickers (Section 4)	(<i>n</i> = 25)	(<i>n</i> = 23)	(<i>n</i> = 27)	(<i>n</i> = 20)	(<i>n</i> = 19)	(<i>n</i> = 24)	(<i>n</i> = 22)	(<i>n</i> = 24)
Lecture attendance	N/A	N/A	N/A	83%	89%	88%	63%	63%
<i>M</i>	70.0	79.3	75.9	79.4	82.2	67.8	83.3	51.8
<i>SD</i>	23.1	18.7	20.5	17.3	17.8	26.4	17.0	27.6
Test of significance	<i>t</i> =1.12	<i>t</i> =0.39	<i>t</i> =0.81	<i>t</i> =0.95	<i>n/a</i>	<i>t</i> =1.60	<i>t</i> =1.61	<i>t</i> =2.99
($\alpha=0.05$)	<i>p</i> =0.267	<i>p</i> =0.695	<i>p</i> =0.423	<i>p</i> =0.345		<i>p</i> =0.116	<i>p</i> =0.114	<i>p</i> =0.004

Only one of these eight comparisons is considered statistically significant, but there is a consistent, but small, difference in means across units (Figure 16).

The mean percentage of correct responses to isomorphic exam items for all the students who took individual unit exams in Sections 1 (clickers) and 3 (no clickers) is displayed in Figure 15. Figure 16 displays the mean percentage of correct answers to isomorphic exam questions for Section 2 (clickers) and Section 4 (no clickers).

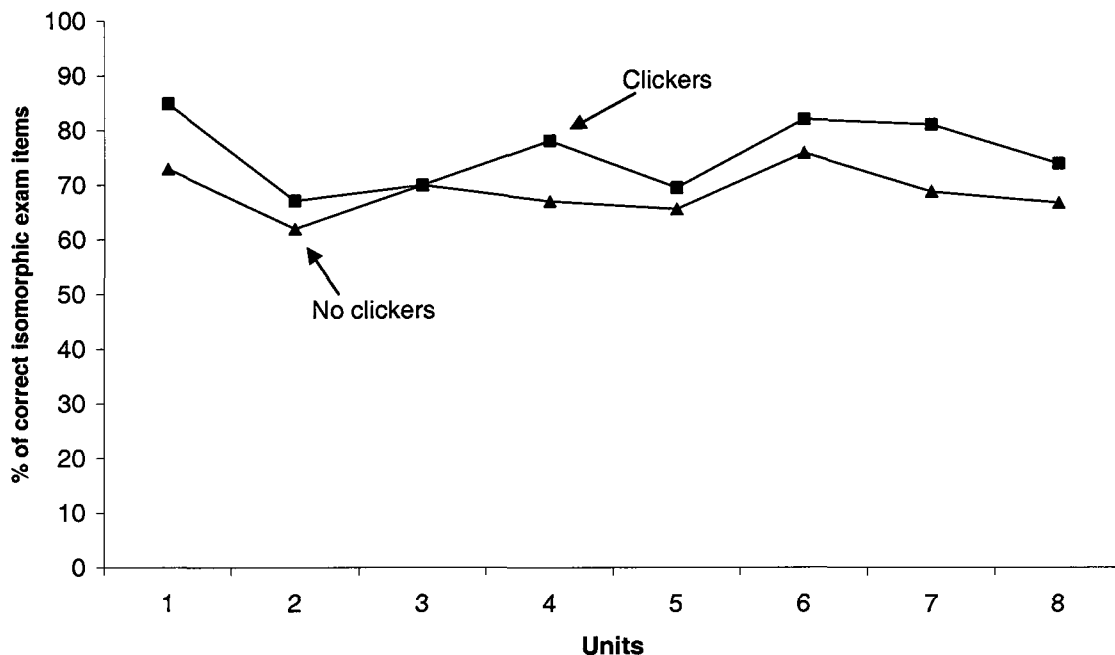


Figure 15. Mean Percentage of Correctly Answered Exam Items by Students in Section 1 (clickers) and Section 3 (no clickers).

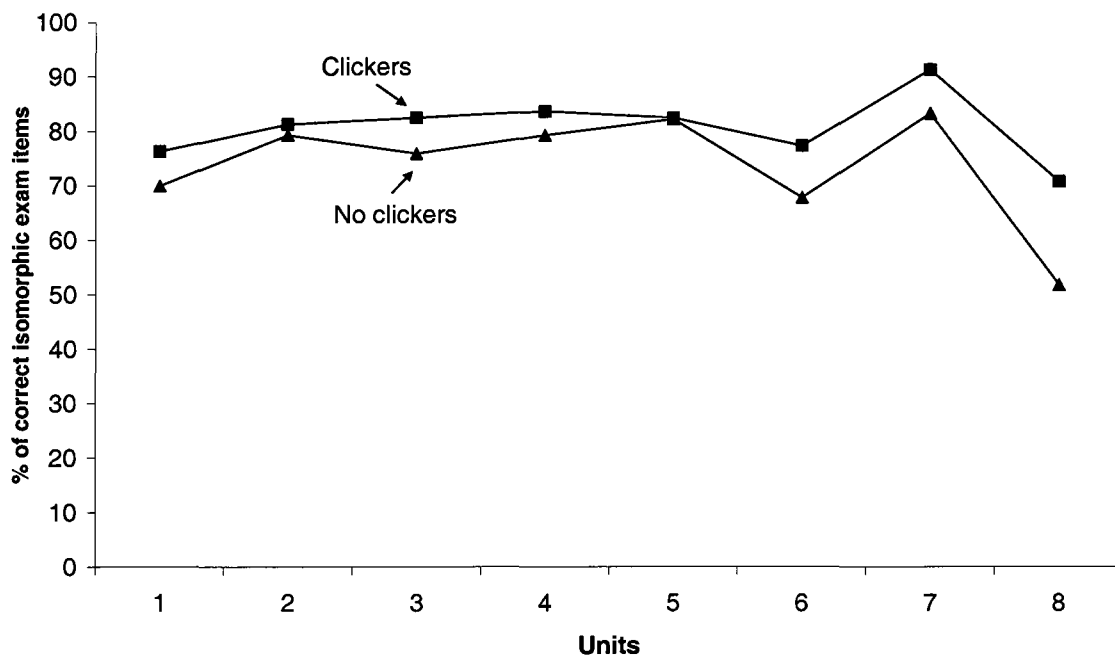


Figure 16. Mean Percentage of Correctly Answered Exam Items by Students in Section 2 (clickers) and Section 4 (no clickers).

Visual analysis of data plotted in Figures 15 and 16 shows an overall difference in mean exam scores across the two conditions, even though this difference is minimal or nonexistent for exam 3 in Sections 1 and 3 and exams 2 and 5 in Sections 2 and 4.

Additional t-tests were conducted where the average percentage of correctly answered isomorphic exam items in Sections 1 and 3 (aggregated scores) were compared Sections 3 and 4, respectively. This analysis included only students who took at least six of the eight unit exams. The results are shown in Table 8.

Table 8
Mean Percentage Correct Overall by Condition

	N	Mean	SD	Significance test	Effect size
Clickers (Section 1)	53	76.1	10.5	$t = 3.27$ $p < 0.001$	$d' = 0.62$
No clickers (Section 3)	56	69.4	10.7		
Clickers (Section 2)	24	79.7	8.9	$t = 2.11$ $p = 0.041$	$d' = 0.62$
No clickers (Section 4)	24	72.7	13.5		

Table 8 shows a statistically significant difference of exam scores for both comparisons with a relatively high effect size. Averaging out unit exam scores for individual students eliminated some of the variability, in terms of the standard deviation, that is apparent when individual units are analyzed. Limited attendance data from Sections 3 and 4 prevent meaningful analysis of the relationship between attendance and exam performance.

Discussion

These results suggest that students' responses on exams can be influenced by whether or not opportunities were provided to answer clicker questions during lectures. Students in Sections 1 and 2 answered more questions correctly, on average, than students in Sections 3 and 4. Even though only some of the comparisons across sections were statistically significant, visual inspection reveals a consistent difference in exam scores across conditions, but that difference is very small or non-existent. The procedural differences between those sections are that students in Sections 1 and 2 used clickers, which included a response contingency, whereas students in Sections 3 and 4 did not use clickers, but were able to earn the same amount of points as students in the clicker conditions by taking short quizzes, administered randomly across the semester. Only one of the comparisons in scores between sections 2 and 4 was statistically significant. A likely factor that may have contributed to this difference in scores between conditions is the proportion of students who attended lectures in each condition and overall, data suggest that exam performance is likely affected by attendance (see Tables 6 and 7). Students in Sections 1 and 2 who failed to attend either one or both lectures before taking a unit exam scored 2-23% lower, on average, on exams than students who attended both lectures before a unit exam. This is an important finding, given the fact that attendance in the non-clicker sections was considerably worse than in the clicker conditions, especially when Sections 1 and 3 are compared. Thus, it is possible that the difference in exam scores across conditions can be explained by different levels of exposure to course material via lectures, rather than using clickers during lectures, *per se*. Clickers may have influenced students' attendance, via the point system, and thus their performance, by

means of the response contingency in effect. The alternative point system used in Sections 3 and 4 (randomly assigned quizzes) may have not been as effective in maintaining high attendance. Since individual attendance data were not collected for Sections 3 and 4 it is difficult to make claims about the role of attendance in this context, but this should be examined in more detail in future studies.

GENERAL DISCUSSION

The purpose of the two studies was to address questions related to the effectiveness of using clickers in an undergraduate psychology class. The first question asked whether or not peer discussion improves learning when used in conjunction with clickers. The second, and more fundamental question asked was whether students do better on exams when they have used clickers to answer questions during lectures.

The data presented here suggest that that learning, as measured on exam performance, is not affected by the social context in which responding to clicker questions occurs during lectures. In other words, discussing a topic during class before answering a question about it does not seem to increase the proportion of correct responses to exam questions that cover the same topic. On the other hand, students that used clickers to answer questions during lectures tended to do better on related exam questions, compared to students that do not use clickers to answer questions during class. This finding is consistent with previous studies in this area (e.g., Mayer et al., 2009 & Smith et al., 2009). In addition, students generally viewed clicker use in a positive way and several students perceived them as conducive to learning. It should be mentioned that the quasi-experimental design used in Study 2 did not include random assignment of

participants into sections, which can be a limitation. On the other hand, demographic data collected indicated similar characteristics across sections.

Each response students make to instructional antecedents, such as questions in class or on exams, is a function of several variables. For example, study behavior, exposure to materials, class attendance, structure and content of lectures, practice opportunities, feedback and incentives for responding, in class discussion, motivating operations, and interactions between any or all of these variables could play a role in learning. Some of these variables were addressed in the current study.

Peer Discussion

Peer discussion can potentially contribute to learning by expanding students' verbal repertoire with respect to course content. Functionally, it can be described as an event that provides opportunities for students to reinforce and shape each others' responses, thus facilitating generalized, and perhaps derived, responding. This is referred to as "constructing knowledge" in the context of social constructivism (Duit & Treagust, 1998). Studies have consistently documented the benefits of having students discuss course content in a structured format (see Slavin, 1996; Springer et al., 1999). Among these are studies that suggest that peer discussion, when used in conjunction with clickers can improve learning outcomes. For example, Smith et al. (2009) demonstrated that students do generate correct responses to questions during discussions among themselves, even when none of them knows the correct answers initially. In the words of Smith et al., students were able to achieve "conceptual understanding on their own, through the process of group discussion and debate" (p. 123). These findings show that the benefits of peer discussion are not necessarily based on the assumption that more knowledgeable

students provide the correct answers to students who are less knowledgeable. Crouch and Mazur (2001) also demonstrated the benefits of peer discussion, but as described previously, those results could also have been attributed to variables other than peer discussion.

The findings of the current study are not consistent with the results reported by Crouch and Mazur (2001) and Smith et al. (2009). There may be several reasons for this, some of which will be discussed here. First of all, more knowledgeable students may simply provide correct answers to less knowledgeable students during peer discussion, without any learning taking place. In behavioral terms, knowledgeable students provide prompts for correct responding during lectures, but are not facilitating generalized responding to similar stimuli, in this case isomorphic exam questions presented at a later time. It is possible that peer discussion would have resulted in measurable learning gains if isomorphic questions were presented shortly after the clicker question, for example during the same class period, as opposed to the quiz administered seven to ten days later. From this perspective, it could be argued that the outcome measures relied too much on generalization of learning across time. However, we assume that exam performance is a valid indicator of learning. In most higher education courses, exam performance is the *only* indicator of learning and also a common outcome measure for educational research.

Another potential reason why peer discussion did not result in improved exam performance is the format of the discussion component. As pointed out earlier, peer discussion is conducted in different formats, and the effectiveness of the method may be found in some of these variations. For example, in Peer Instruction, as described by Crouch and Mazur (2001), students first answer clicker questions on their own and then

again after they have seen the initial responses of their fellow students and discussed the question in a small group. The main differences between the studies by Crouch and Mazur (2001) and Smith et al. (2009) and the current study is that participants in the former studies responded twice to each question under different conditions, and in the case of Smith et al., students had an immediate opportunity to demonstrate generalization to a similar question. Students in the current study only responded once to each question during class but the occasion for the generalization response was not set until at least a week later. It may not be a good use of class time to require students to answer each question twice, especially since the benefits of that practice are not clear at this moment.

Still another factor that may affect the potential benefits of peer discussion is the type of questions that are being asked and the instructions students receive about how to conduct the discussion. Students may benefit from discussing questions that require long behavior chains, for example complex calculations since there are multiple opportunities to prompt and shape those response patterns that result in a choice of a particular answer. The current study mostly included questions that were conceptual in nature, which may not trigger as much interaction between peers as questions that occasion a string of prescribed behaviors, such as calculations. In order for students to engage each other in discussion they would have to have mastered the verbal content of the course up to an extent; prerequisites for successful or “meaningful” discussion may have not in place in the present study. This is especially true if students have not read the assigned material before coming to class. Even though students were required to provide an explanation for each of their answers, it is impossible to determine what the content of those discussions was and whether or not students truly did provide a logical explanation for each answer.

Participants in this study, especially students in Section 1, thought that peer discussion did help them learn the material, suggesting that students did more than just provide the answer to each other. It is unclear how the perceived benefits affect learning, but perhaps a positive “attitude” towards a course can influence study behavior and attendance.

Clickers

Several studies have demonstrated the benefits of clickers in the college classroom, both in terms of learning outcomes (e.g., Mayer et al., 2009; Smith et al., 2009,) and student likability (e.g., Carnaghan & Webb, 2007; Crossgrove & Curran, 2008; Graham, Tripp, Seawright, & Joeckel, 2007; Judson & Sawada, 2002). The current study showed limited support of these findings, where mean exam performance across conditions was statistically significant, but small, and not necessarily meaningful or practical.

Instructors use clickers for different reasons, for example to increase student participation during lectures, increase engagement, and to gather real-time feedback on student learning (Bruff, 2009), all of which may lead to increased learning gains and student satisfaction. Here, we attribute the effectiveness of clickers to several factors that independently or in combination can potentially enhance a student’s verbal repertoire and thus exam performance.

As mentioned previously, active responding in the classroom can provide practice opportunities and immediate feedback on specific responses, both effective instructional components (Frederick & Hummel, 2004) which in and of themselves can increase the probability of same or similar responses in the future. Clickers are often used in conjunction with an incentive system where students can earn points for responding.

These systems can affect student behavior in several ways. First, it may increase class attendance, thereby increasing the proportion of students who come in contact with instructional antecedents. Data from the current study show that perhaps the effectiveness of clickers could be attributed to this fact since both clicker sections had higher attendance than the sections that did not use clickers and students with lower attendance did worse on exams, on average, than students with higher attendance. However, students in the sections that did not use clickers had an opportunity to earn the same amount of points by taking quizzes that were administered randomly during the semester, but it did not facilitate active responses during each class period. The advantage of clickers is that the incentive system is easily administered and it increases exposure to course material during lectures. The incentive structure may also influence student's preparation: Students can avoid losing points during class by engaging in study behaviors outside of class. Process measures, i. e. data on study behavior, were not collected in the current study nor have any previous studies that examined the effectiveness of clicker use. Different incentive structures may also affect how peer discussion is conducted. Willoughby and Gustafson (2009) analyzed transcripts of peer discussion in a study that examined two different incentive systems for responding. In the low stakes condition, students earned the same amount of points for responding, irrespective of accuracy, and in the high stakes condition students earned one point for correct responding but none for incorrect responding. Students in the low stakes condition were more likely to discuss their lack of understanding and their choice for answer and reframing the questions in their own words. On the other hand, students in the high stakes condition spoke 20% less than their counterparts in the low stakes condition, suggesting that differential

reinforcement may under some conditions suppress participation from less knowledgeable students who would benefit from being provided with feedback on their responses during this period. James (2006) came to a similar conclusion where he found that more knowledgeable students dominated discussion under a high stakes condition, but more students contributed to the discussion in the low stakes condition.

Finally, clickers tend to generate class discussion when answers are displayed to students (Bruff, 2009). The role of the instructor is to summarize the rationale for each correct answer and stimulate further discussion on the topic. As reported by instructors in the current study, lengthy discussions and questions from students often followed the display of the histogram of responses. The instructor-led discussion may be functionally equivalent to peer discussion, therefore making the peer discussion component redundant since it provides various antecedents and consequences that may increase the future probability of correct responding.

Limitations and Future Directions

While the data presented here suggest limited impact of clickers in the classroom, there are several limitations that are worth addressing. The most challenging aspect of Study 1 was to ensure consistency in questions across units in terms of difficulty. That is, clicker questions and isomorphic exam questions across units should be equal in terms of difficulty to allow for a legitimate comparison of exam scores across units and conditions. Variability in Sections 3 and 4 show the difference between the highest and lowest exam scores (mean) is not more than 11%, which suggests that difficulty level is similar across sections. However, more variability was observed in Study 1 where the difference between the highest and the lowest mean was 19%.

Question difficulty can be measured in terms of how many students answer correctly, after having read the relevant course material. In order to achieve a particular difficulty level, each question would have to have been calibrated in an earlier section of the same class. Calibration of questions would have taken months to complete, something that was not feasible in the current study. Another possibility to control for question difficulty would include counterbalancing of conditions across identical sections of this class (Saville et al., 2006), but given different sequencing of topics and different study objectives across sections in this study, this was not possible. Even though data from previous sections of the class taught by Instructor A (see Appendix I) confirmed that variability of exam scores across units was limited, it is not sufficient to rule out the possibility of a confound due to different levels of difficulty. However, question construction was based on one or more of the study objectives to which students had access prior to coming to class, and therefore the topic of all questions were presented equally across units. It is worth noticing that the average total scores on unit exams are consistently higher than the isomorphic questions, thereby suggesting that isomorphic questions did not necessarily accurately reflect the difficulty level of the overall unit. But at the same time the issue of ceiling effect is not a concern in this study since performance on isomorphic items is lower than the overall exams. Another potential limitation is the way in which clicker questions were presented. In Section 1, nearly all of the questions were presented one after the other at the end of the second lecture for each unit. In Section 2, half of the questions were presented at the end of the first lecture and the other half at the end of the second lecture. The instructor in Section 1 had requested this format since leaving all the questions until the end ensured that enough time was

allotted to presenting content. However, since these two sections were not compared against each other, this issue may not be of concern.

Furthermore, a limitation of this study is that data for individual attendance in Sections 3 and 4 were not collected, eliminating the possibility to fully address the issue of the effects of attendance on exam performance. Attendance data from Sections 1 and 2 suggest that attendance may have influenced the average exam scores for each section. None of the previous studies covered in the review of the literature directly controlled for this confound, even though some have acknowledged the effects of attendance as a confound (e.g., Mayer et al., 2009). Future studies should examine the interaction effects between clickers and attendance. As for external validity, generalization of the results to other content areas may not be justified. Most of the questions used in this study were conceptual in nature, focusing on definitions and applications of these definitions to scenarios. Replicating this study using questions or content that require more of a step-by-step problem solving approach, for example, mathematics or statistics, may reveal other benefits of using clickers, peer discussion, or both.

This study did not control for a simple exposure to clicker questions or the opportunity to answer questions by other means than clickers, such as writing down the answers. Mayer et al. (2009) addressed this issue in their study by including a condition where students indicated their answers to in-class questions by writing them on a sheet of paper and handing them in for grading. Despite this opportunity, students in this group did significantly worse on exams compared to the clicker group. The authors attributed this to the logistics of using the paper-based implementation, primarily the disruption to the flow of the class and the fact that more time that was required for collecting responses.

Both of the instructors who participated in this study were aware of its purpose and research design which may have resulted in some level of researcher bias, such as subtle, but unintentional changes in instructor behavior, especially in Study 1. Nonetheless, this effect would have been minimal, since both instructors tailored their lectures around pre-determined study objectives and the questions that were created ahead of time. It is unlikely that instructor behavior was differentially affected by conditions.

Some have suggested that the impact of clickers is due to its novelty effect (see Mayer et al., 2009). New technology may function as a motivating operation (value-altering effect), altering the effectiveness of the incentive system, but that effect may perhaps not be sustainable over time. As indicated on the demographics questionnaire, 75% of students in Section 1 and 75% of students in Section 2 had used clickers in 1-3 classes before this study. Given the overwhelming support of clicker use in both of these sections, it is unlikely that novelty effects, if real, would wear off any time soon.

College classes are naturally made up of students who range in academic capabilities. Some students do well in most or all classes, irrespective of the content, structure or instructional method being used. These students could be defined as high-performing students. Other students may be affected to greater extent by the way courses are structured, and this is important to keep in mind when educational research is conducted. It is possible that the independent variables in the current study may have affected students' learning in a different way, depending on their general level of performance. For example, students who struggle with the subject matter may benefit from discussing course content with their fellow students. Or the impact of clickers is

greater for lower performing students. Unfortunately, it was not possible to address this question in the current study since access to individual student performance data, in this case, overall Grade Point Average (GPA) was denied due to confidentiality reasons. Future research is needed to evaluate the differential effects that clickers and discussion could have on the performance on lower performing students.

Conclusion

A number of studies have demonstrated the benefits of using clickers in the classroom, both in terms of achievement scores and likability. Overall, the current study shows limited support for those findings. Students who use clickers to answer questions during lectures tend to do better on related exam questions than students who do not use clickers. On the other hand, peer discussion does not seem to impact students' performance on exams, which is inconsistent with previous research, although evidence to the contrary have been found (Flosason et al., 2007). This study was conducted in a typical college classroom, with somewhat limited experimental control, but it provided a realistic context for the experimental questions asked. A thorough component analysis is needed to better determine the role of each of the factors that are associated with peer discussion and clicker use. It may well be that the impact of clickers may be at least partly attributed to the fact that the built-in response contingency simply increases attendance and therefore exposure to instructional antecedents, rather than reinforcement of accurate responding. Either way, future research will hopefully shed some lights on those questions that still remain unanswered.

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Appendix A

Anonymous Demographic Questionnaire

Anonymous Demographics Questionnaire

1. What is your current cumulative grade point average?

Answer: _____

2. How many psychology courses have you taken prior to this semester?

Answer: _____

3. How many credit hours are you taking this semester?

Answer: _____

4. What is your undergraduate student status? (circle one)

Freshman

Sophomore

Junior

Senior

5. Are you currently employed? (circle one)

Yes

No

6. If so, how many hours per week do you work?

Answer: _____

7. Gender (circle one)

Male

Female

8. How old are you?

Answer: _____

9. Have you ever used clickers (wireless response systems) during your education (K-12 or college)?

More than 3
classes

In 2-3 classes

In one class

Never

Appendix B

Course Syllabus - Section 1

PSYCHOLOGY 3440: ORGANIZATIONAL PSYCHOLOGY FOR NON-MAJORS
WESTERN MICHIGAN UNIVERSITY
COURSE SYLLABUS & CALENDAR
FALL 2009

COURSE AND INSTRUCTOR INFORMATION
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Meeting Time: Mondays & Wednesdays Hall 5:00pm – 6:15pm 1710	Location: Wood Room
Instructor: Krystyna Orizondo-Korotko Mondays & Wednesdays Email: korizondo@gmail.com – 7:15pm Office: Wood Hall, Room 2530 appointment	Office Hours: 6:15pm or by

Email is the preferred and easiest way to reach me; I check it frequently throughout the day.

GENERAL COURSE DESCRIPTION

Organizational Psychology is a broad field of study which includes the study of personnel selection, organizational theory, organizational design and development, and organizational behavior (among other areas). Performance Management (PM) is one area of specialization within the broad field of organizational psychology, which aligns itself most closely with the area of organizational behavior and personnel/human resource management, and is what the majority of this course will focus on.

The concepts used in PM originated from the field of behavior analysis, a relatively new field in psychology, having historical roots in the laboratory operant research of the early to mid 1900's. In the mid 1960's, operant procedures were first employed in clinical settings with significant and often dramatic results. For the first time, principles of learning were applied with human populations. These principles regularly produced socially significant changes in behavior and scientists demonstrated experimental control of the treatment stimuli involved. Applied Behavior Analysis (ABA) emerged as a distinct discipline in the late 1960's, primarily focusing on social, educational, and environmental factors affecting human behavior. When ABA is used to solve organizational problems such as training, safety, productivity, and quality deficits, the collective set of procedures is known as Performance Management.

This course will cover the application of basic principles of behavior in business and industry settings. Students are expected to master the fundamentals of ABA and to be able to apply those fundamental principles to a variety of performance problems in business and industry. At the end of this course, students who have mastered the material should be able to:

- Describe and analyze the shortcomings of traditional managerial practices relative to a PM approach
- Analyze performance problems systematically using PM principles
- Pinpoint problem performances and suggest appropriate solutions
- Develop reliable performance measures for these performances

- Identify sources of performance problems and their consequent remedies

COURSE MATERIALS

The following materials are required for the course and are available at Western's Campus Bookstore located in the Bernhard Student Center:

1. **Text:** Daniels, A.C., & Daniels, J.E. (2004). *Performance management: Changing behavior that drives organizational effectiveness*. Atlanta, GA: Performance Management Publications.
2. **Text:** Carnegie, D. (1981). *How to win friends and influence people*. (Revised ed). New York: Pocket Books.
3. **Course Pack:** The course pack contains the study objectives and handouts for each unit of the course, along with additional required readings. Copyright permissions have been obtained for all of the material.

Please bring the relevant study objectives and reading materials for each unit to lecture. I will refer to them frequently.

GENERAL COURSE FORMAT

Two class lectures followed by a 35-point exam. The days of the exams will rotate between Monday and Wednesday throughout the semester. Please refer to the calendar at the end of the syllabus for the course schedule.

CLICKERS IN CLASS

In this class we will be using a classroom response system (clickers) during lectures. Clickers are really cool gadgets that increase participation in class and help you learn the material. You will use the clickers to answer multiple-choice questions during class. Four questions will be posed during each class period, all of which are related to the course material for that unit. You will earn points towards 5% of the total course grade by using the clickers: You earn 1 point for each incorrect answer and 2 points for each correct answer. We will update your points every week on the course website. We will be exploring different ways of using the clickers, so in some classes you can discuss the questions with the person sitting next to you before you answer, but in others you cannot discuss the questions with your peers. During those discussion periods, which are not going to take more than 2 minutes, you can ask your neighbor about the question or provide him/her with information. **For each question, try to provide an explanation for why you think your answer is the correct one.** After everybody has submitted their answer we will be able to look at how the class responded and discuss your answers. **Other students will not see how you answer, only your instructor will know, so pick the answer that YOU think is the correct one.** You will be provided with a clicker at the beginning of each class which you have to return at the end of each class. You must use the clicker we provide you with in class, even though you own a clicker that you use for other classes. You cannot switch clickers with other students in class, since each clicker has been assigned to a particular student.

UNIT STUDY OBJECTIVES

There are study objectives for each unit in the course pack. The material to be included in the unit's assignment is listed at the top of the study objectives. Only the text material specified in the objectives will be covered on the exam (although keep in mind that the exams may also cover additional material that I provide in lecture). It is important that you keep all of the study objectives so that you can refer to them later in the course. You will need to restudy some of the objectives if you take the make-up exams. For the make-up exams, I will select several study objectives from previous units and ask that you restudy them. I will give you a list of these review objectives prior to both make-up exams.

HOW TO STUDY FOR THIS COURSE

Read the materials before coming to class. Some material may be difficult to understand. If you have read through the materials, you will know what you have questions over and I can answer those questions during class.

Come to class. As previously stated, there will be material on the exam that will be over lecture material. Also, get to know your classmates. If you miss a day, you can get the notes from a classmate. I suggest getting the phone numbers and/or emails of a couple of your classmates just in case.

Write out the study objectives for the readings. Answer as many of the study objectives as you can before class, based on the readings. Use lecture notes to clarify any confusing points and to answer questions not answered in the readings. Many people find that using index cards to study helps them to do well on exams. Write out the question on one side of the index card and write the answer on the other side. Quiz yourself by reading through the questions and seeing if you can answer them without flipping the index card over to look at the answer. When you can get through all of the questions without looking at the answers, shuffle the index cards and go through them again (so you don't rely on the order of the questions to come up with the answers).

Make sure that you can answer the objectives precisely and completely. This will help you greatly on the exams. If you are having problems with the material, please arrange to see me

UNIT EXAMS

Exams will consist of a mix of multiple-choice, fill in the blanks, true/false, matching, listing information, and short-answer essay questions. They will be based on the study objectives and *ANY* additional material that I provide in lecture. There will be material on the exam that is based on lecture material that is not provided in the text. If you miss a lecture, you are still responsible for the material covered, and therefore you should get the notes from a fellow classmate or have someone tape record the lecture for you. I will **NOT** review the missed material for you, give you the notes, or record the lecture.

EXAM REGRADE POLICY

After the exams have been graded, returned and discussed in class, you may submit your exam to me for regrading if you believe that an item was not graded accurately. Regrade request forms can be obtained from me at any time. **Regrade requests must be returned to me in class, in writing, and within one week after the exams have been returned.** When submitting a regrade request you should attach the exam and the answer sheet for that exam. The request should state the reasons why more points should be awarded for a particular answer. References to a text page and paragraph or to specific lecture material will make it more likely that your request will be granted. It is not appropriate to state things such as "because it is right" (without further explanation), "but that is what I meant to say" (I can only grade what you said, not what you meant to say), "I missed that lecture," "Jim gave the same answer and you marked his right" (maybe I graded Jim's paper too leniently), etc.

MAKE-UP EXAMS

If you miss an exam for *ANY* reason (illness, car trouble, injury, an athletic event, too busy to study, etc.), the missing exam score will turn into a **zero** if you do not take the make-up exams or if you miss more exams than allowed by the make-up exam policy. Two make-up exams will be given during the semester that will permit you to make up for two such absences. In other words, you may miss one exam each half of the semester without having it hurt your grade as long as you then take the scheduled make-up exams.

If you are involved in ANY activity (a sporting activity, a band, family obligations, social activities) that requires you to miss more than one exam each half of the semester, DROP THIS COURSE IMMEDIATELY.

The first make-up exam is given WEDNESDAY, OCTOBER 28TH, and will review material from Units 1-4. *The score you earn on this exam may be used to replace a missing score for one of the first four unit exams.*

The second make-up exam will be given MONDAY, DECEMBER 14TH at 5:00pm during the University's final exam week. It will review material from Units 5-8. *The score you earn on this second make-up exam may be used to replace a missing score for one of these last four unit exams.*

I will give you study objectives for the make-up exams. I will select 30-40 study objectives from the relevant units for you to restudy.

If you do not miss any exams, and only if you do not miss any exams, the score you obtain on the first make-up exam may be used to replace the lowest score obtained on Exams 1-4, and the score you obtain on the second make-up exam may be used to replace the lowest score on Exams 5-8. If your make-up exam scores are lower than the scores of your unit exams, then the make-up exam scores will be discarded. In other words, the make-up exams cannot hurt your grade.

If you do not miss any exams, the make-up exams are optional. If you are satisfied with the scores you have obtained on the unit exams, then you do not have to take the make-up exams – you get the day off!

ADDITIONAL MAKE-UP EXAMS

No make-up exams will be given in addition to the two that are scheduled. Under VERY special circumstances (such as a documented long illness), you may be able to take a special make-up exam but this will be at my discretion.

COURSE GRADES

Your course grade will be based on the number of points that you earn on the unit exams. There may be opportunities to earn extra credit throughout the semester. There will be a total of 8 exams and each will be worth 35 points. Clicker responses can earn you a maximum of 15 points total. The total number of possible points is thus 295. Grades will be determined as follows:

	A	BA	B	CB	C	DC	D	E
Percent	90	85	80	75	70	65	60	<60*
Points	265	250	236	221	206	192	177	<177*

* "<" means less than

ATTENDANCE AT LECTURES

Attendance at lectures is not required. However, if you miss a lecture for whatever reason you are responsible for the lecture material and any announcements regarding changes in the weekly assignment, exam schedule, room change, etc. If you must miss a lecture, you should ask another member of the class to take notes for you or, better yet, to tape record the lecture. I will not review the missed material with you, take notes for you, or record the lecture for you.

COMPUTERS, IPODS, CELL PHONES AND PAGERS

Computers/Laptops, Ipods, cell phones and pagers must be turned off during all classes.

INCOMPLETES

In keeping with the University's policy on the grade of Incomplete, a grade of Incomplete (I) will NOT be given as a substitute for a failing grade - the failing grade

Incompletes are only given when a student who is passing the course with a grade of C or better has to miss the remainder of the semester due to an unavoidable circumstance (e.g., a serious/extended illness or injury). Contact me as soon as possible if you believe you need (and are eligible) to take an incomplete for the course. Depending upon the number of classes and exams that you missed, and your attendance and performance on the exams you took before the problem arose, I may be willing to give you an incomplete for the course.

ACADEMIC DISHONESTY

You are responsible for making yourself aware of understanding the policies and procedures in the Undergraduate Catalog (pp. 274-276) that pertains to Academic Integrity. These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity and computer misuse. If there is reason to believe you have been involved in academic dishonesty, you will be referred to the Office of Student Conduct (OSC). You will be given the opportunity to review the charge(s). If you believe you are not responsible, you will have the opportunity for a hearing. You should consult with me if you are uncertain about an issue of academic honesty prior to the submission of an assignment or test.

If I have evidence of any form of academic dishonesty, I will charge the student with violating the Academic Honesty Policy of the University in a report to the Office of Student Conduct. A student who is found responsible for an act of academic dishonesty will be given a failing grade in the course and may be suspended or expelled from the university.

Cheating consists of, but is not limited to, looking at another student's examination, using external aids (such as books, notes, conversation with others) when taking the examination, or altering your original exam answers when submitting regrade requests. No course books or materials should be within the student's view during the exam.

STUDENTS WITH DISABILITIES

If you have a documented disability and need reasonable accommodations, please contact me during the first week of classes so that I can ensure that your needs are met in a timely manner.

The Americans with Disabilities Act (ADA) requires that all qualified persons have equal opportunity and access to education regardless of the presence of any disabling conditions. Access to education means providing students with the tools needed to be successful in higher education, including physical accommodations in the classroom and lab space, course substitutions and/or waivers, modifications of classroom presentations, and modifications in testing and course requirements.

If you have some specific learning disability, hearing impairment, visual impairment, seizure disorder, motor impairment, psychological disorder(s), and/or any other disabilities, you should register with the University's Disabled Student Resources and Services and the Office of Services for Students with Learning Disabilities at the beginning of the semester to inform them of the disability and obtain information about services that can facilitate learning.

According to University policy: "Any student with a documented disability who needs to arrange reasonable accommodations must contact the professor and the appropriate Disability Services office at the beginning of the semester."

EMERGENCY CLASS CANCELLATION

In the event that classes are officially canceled (due to a snow storm, for example), the following schedule changes will automatically be in effect:

1. If the day canceled is a day on which an exam has been scheduled, then the exam will be given on the first day that classes resume. For example, if an exam is scheduled on Monday, and classes are canceled on Monday, the exam will be given on Wednesday. If Wednesday classes are canceled as well, the exam will be given on the following Monday.
2. If the lecture day that immediately precedes the exam is cancelled, the exam will be given on the regularly scheduled day, or on the first day that classes resume. For example, if an exam is scheduled on Wednesday, and the preceding Monday lecture is canceled, then the exam will be given as scheduled on Wednesday.

PLEASE READ THE EMERGENCY CLASS CANCELLATION POLICY CAREFULLY. IT IS NOT POSSIBLE TO PREDICT WHEN CLASSES WILL BE CANCELLED, AND THUS, I AM NOT ABLE TO REVIEW THIS POLICY AT THE CRITICAL TIME.

COURSE CALENDAR

The class will meet every Monday and Wednesday from 4:00pm to 5:15pm as outlined below. Reading assignments and study objectives should be completed *before* that class date.

Wednesday DAY	October 28 DATE	Make-Up Exam 1 READING DUE
Monday	November 2	Lecture, Unit 5: Wilk & Redmon, Austin et al., & Carnegie : Part
Wednesday Monday	November 4 September 14	Exam 5, Unit 5 Lecture 1 Unit 1: Daniels: Ch. 1, 2, & 3
Monday	November 9	Lecture, Unit 6: Daniels: Ch. 20 & 22, Brethower & Smalley,
Wednesday Monday	November 11 September 21	Exam 6, Unit 6 Exam 1 Unit 1
Monday	November 16	Lecture, Unit 7: Gaetani et al., Lamere et al., Dickinson &
Wednesday Monday	November 18 September 28	Lecture, Unit 7: Sulzer-Azaroff et al., Devries et al. Lecture 2 Unit 2: Daniels: Ch. 13 (cont.) 23, & Eikenhout &
Monday	November 23	Exam 7, Unit 7
Wednesday Monday	November 25 October 5	No Class: Happy Thanksgiving! Lecture 1 Unit 3: Daniels: Ch. 11, 6 & 7
Monday	November 30	Lecture, Unit 8: Brethower, Rummler & Brache: Ch. 2 & 3
Wednesday Monday	December 2 October 12	Lecture, Unit 8: Rummler & Brache: Ch. 4 & 5 Exam 3, Unit 3
Monday	December 7	Exam 8, Unit 8
Wednesday Monday	December 9 October 19	<i>Return Exam 8 & Hand Out Make-Up Exam 2 Objectives</i> Lecture Unit 4: Daniels: Ch. 17 & 18, Stalkovic & Luthans
Monday	December 14	5:00pm-7:00pm; Make-Up Exam 2
Monday	October 26	Lecture, Unit 5: Daniels: Ch. 21, 15, & 16

Appendix C

Course Syllabus - Section 2

Psy 3440, Organizational Psychology for Non Majors
Fall 2009 Course Syllabus and Calendar

INSTRUCTOR INFORMATION

Instructor:	James Squires	Office:	TBD
		Office Hours:	TBD
Cell Phone:	(248) 921-6784	Office Phone:	use cell phone number
Email:	james.l.squires@wmich.edu		

Course Assistants: TBD

COURSE MATERIALS

Text and Coursepack can be purchased at Western's Campus Bookstore located in the Bernhard Student Center.

1. Daniels, A.C., & Daniels, J.E. (2004). *Performance management: Changing behavior that drives organizational effectiveness*. Atlanta, GA: Performance Management Publications.
2. Course Pack: The pack contains the study objectives for each unit in the course and required reading materials. Copyright permissions have been obtained for all of the material.

Bring the relevant study objectives and reading materials for each unit to lecture. I will refer to them frequently.

GENERAL COURSE DESCRIPTION

The majority of this course will focus on a sub-area of Organizational Psychology called "Performance Management." We will spend seven units learning Performance Management techniques and how they are used to help improve organizational performance. In the final unit, I will introduce and provide a brief overview of another sub-area of Organizational Psychology: Behavioral Systems Analysis.

General Course Format

Two class lectures followed by a 35-point exam. The days of the exams will rotate between Tuesday and Thursday throughout the semester. Please refer to the calendar at the end of the syllabus for the course schedule. NOTE: Unit 4 will only have one lecture followed by a 35-point exam.

Clickers

In this class we will be using a classroom response system (clickers) during lectures. Clickers are really cool gadgets that increase participation in class and help you learn the material. You will use the clickers to answer multiple-choice questions during class. Four questions will be posed during each class period, all of which are related to the course material for that unit. You will earn points towards 5% of the total course grade by using the clickers: You earn 1 point for each incorrect answer and 2 points for each correct answer. We will update your points every week on the course website. We will be exploring different ways of using the clickers, so in some classes you can discuss the questions with the person sitting next to you before you answer, but in others you cannot discuss the questions with your peers. During those discussion periods, which are not going to take more than 2 minutes, you can ask your neighbor about the question or provide him/her with information. **For each question, try to provide an explanation for why you think your answer is the correct one.** After everybody has submitted their answer we will be able to look at how the class responded and discuss your answers. **Other students will not see how you answer, only your instructor will know, so pick the answer that YOU think is the correct one.** You will be provided with a clicker at the beginning of each class which you have to return at the end of each class. You must use the clicker we provide you with in class, even though you own a clicker that you use for other classes. You cannot switch clickers with other students in class, since each clicker has been assigned to a particular student.

Course Grades

Your course grade will be based on the number of points that you earn on the weekly exams. Points cannot be earned by doing alternative or extra activities. There will be a total of 8 exams and each will be worth 35 points. Clicker responses can earn you a maximum of 15 points total. The total number of possible points is thus 295. Grades will be determined as follows:

	A	BA	B	CB	C	DC	D	E	
Percent	92	88	84	80	76	72	68	<68*	
Points	271	260	248	236	224	212	200	<200*	

* "<" means less than

Students with Disabilities

If you have a documented disability and need reasonable accommodations, please contact me during the first week of classes so that I can ensure that your needs are met in a timely manner. Students with disabilities should contact the University's Disabled

Student Resources and Services and the Office of Services for Students with Learning Disabilities at the beginning of the semester to inform them of the disability and obtain information about services that can facilitate learning. According to University policy: “Any student with a documented disability who needs to arrange reasonable accommodations must contact the professor and the appropriate Disability Services office at the beginning of the semester.”

Unit Exams

Exams will consist of a mix of multiple-choice questions, fill in the blanks, matching, listing information, and short-answer essay questions. They will be based on the study objectives and ANY additional material that I provide in lecture. Approximately 15-20% of the exam is based on lecture material that is not provided in the text. If you miss a lecture, you are still responsible for the material covered and therefore you should get the notes from a fellow classmate or have someone tape record the lecture for you. I will not review the missed material for you, give you the notes, or record the lecture.

Unit Study Objectives

There are study objectives for each unit in the course pack. The material to be included in the unit’s assignment is listed at the top of the study objectives. Only the text material specified in the objectives will be covered on the exam (although remember that the exams will also cover additional material that I provide in lecture). It is important that you keep all of the study objectives so that you can refer to them later in the course. You will need to restudy some of the objectives for the make-up exams. For the make-up exams, I will select several study objectives from previous units and ask that you restudy them. I will give you a list of these review objectives prior to both make-up exams.

How to Study for This Course

Read the materials before coming to class. Some material may be difficult to understand. If you have read through the materials, you will know what you have questions over and I can answer those questions during class.

Come to class. As previously stated, approximately 15-20% of each exam will be over lecture material.

Write out the study objectives for the readings. Answer as many of the study objectives as you can before class, based on the readings. Use lecture notes to clarify any confusing points and to answer questions not answered in the readings. Many people find that using index cards to study helps them to do well on quizzes. Write out the question on one side of the index card and write the answer on the other side. For long study objectives, it is helpful to break the objective into manageable pieces, using multiple index cards. Quiz yourself by reading through the questions and seeing if you can answer them without flipping the index card over to look at the answer. Begin with the first objective. When you can answer that objective without looking at the answer,

add the next objective. When you can answer that objective without looking at the answer, go back and answer the first and then the second objective. If you can answer both without looking at the answer, move on to the third objective. Study this objective until you can answer it without looking at the answer and then go back and try to answer objectives 1-3 without looking at the answers. Continue until you are able to answer all of the objectives. When you can get through all of the questions without looking at the answers, shuffle the index cards and go through them again (so you don't rely on the order of the questions to come up with the answers). **MAKE SURE THAT YOU CAN ANSWER THE QUESTIONS PRECISELY AND COMPLETELY WITHOUT LOOKING AT THE ANSWER. THIS WILL HELP YOU GREATLY ON THE EXAMS.**

Exam Regrade Policy

After the exams have been graded, returned and discussed in class, you may submit your exam to me for regrading if you believe that an item was not graded accurately. **Regrade requests must be returned to me in class, in writing, and within one week after the exams have been returned.** The request should state the reasons why more points should be awarded for a particular answer. References to a text page and paragraph or to specific lecture material will make it more likely that your request will be granted. It is not appropriate to state things such as "because it is right" (without further explanation), "but that is what I meant to say" (I can only grade what you said, not what you meant to say), "I missed that lecture," "Jim gave the same answer and you marked his right" (maybe I graded Jim's paper too leniently), etc.

Make-up Exams

If you miss an exam for ANY reason (illness, car trouble, injury, an athletic event, too busy to study, etc.), the missing exam score will turn into a zero if you do not take the make-up exams or if you miss more exams than allowed by the make-up exam policy. Two make-up exams will be given during the semester that will permit you to make up for two such absences. In other words, you may miss one exam each half of the semester without having it hurt your grade as long as you then take the scheduled make-up exams.

<p>If you are involved in ANY activity (a sporting activity, a band, family obligations, social activities) that requires you to miss more than one exam each half of the semester, DROP THIS COURSE IMMEDIATELY.</p>
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The first make-up exam is given **THURSDAY, OCTOBER 23rd**, and will review material from Units 1-4. The score you earn on this exam may be used to replace a missing score for one of the first four exams. The second make-up exam will be given **TUESDAY, DECEMBER 11th at 10:15 am** during the University's final exam week. It will review material from Units 5-8. The score you earn on this second make-up exam may be used to replace a missing score for one of these unit exams. I will give you study objectives for these exams – I will select 30-40 study objectives from the relevant units and post them on WebCT.

If you do not miss any exams, and only if you do not miss any exams, the score you obtain on the first make-up exam may be used to replace the lowest score obtained on Exams 1-4, and the score you obtain on the second make-up exam may be used to replace the lowest score on Exams 5-8. If your make-up exam scores are lower than the scores of your unit exams, then the make-up exam scores will be discarded. In other words, the make-up exams cannot hurt your grade.

If you do not miss any exams, the make-up exams are optional. If you are satisfied with the scores you have obtained on the unit exams, then you do not have to take the make-up exams – you get the day off!

Additional Make-up Exams

No make-up exams will be given in addition to the two that are scheduled. Under VERY special circumstances (such as a documented long illness), you may be able to take a special make-up exam but this will be at my discretion.

Bonus Point Opportunities

I will offer two bonus point opportunities during the semester (5 points each). These opportunities are **optional**. One opportunity will occur when we have finished the Daniels book. This is your chance to use what you have learned about performance management to design a PM project that addresses a real or simulated performance problem. The second opportunity will come toward the end of the semester. Find and critique an article **from a peer reviewed journal** that addresses safety, pay, feedback, or any other topic covered in class.

BONUS POINT OPPORTUNITY #1 PM PROJECT (3-5 PAGES)

Using a job that you hold, have held, or know about through someone else, identify a problem performance and design a PM intervention to improve performance.

Format:

1. Introduction to the organization
 - a. Describe the organization and job you are analyzing
2. Introduction to the problem
 - a. Describe the performance issue
 - b. What results are you concerned with
 - c. What behaviors produce those results
3. Analyze the problem
 - a. Use ABC and PIC/NIC analysis to identify whether it is a can't do or a won't do problem
 - b. Based on your analysis, determine whether you will focus on behaviors or results

- c. How will you measure the performance?
4. Design the intervention
 - a. Based on your analysis, what will you do to improve the performance?
 - b. How will you know the performance improved?
5. Summary
 - a. What are the potential results of your intervention?

BONUS POINT OPPORTUNITY #2 ARTICLE CRITIQUE (3-5 PAGES)

Write a critique of a research article from:

Journal of Organizational Behavior Management
Journal of Applied Psychology
Personnel Psychology
Academy of Management Journal
Performance Improvement Quarterly
Journal of Applied Behavior Analysis

1. Cite what article you are critiquing.
2. Briefly summarize IN YOUR OWN WORDS what the study investigated and why the study was important
3. Briefly describe the experimental design, subjects and setting, IV and DV, and how behavior was measured. How did their methods compare to what we've discussed in this class? Did they look at actual behaviors and/or results?
4. What were the results and conclusions of the study? Do you agree with the authors' conclusions?
5. Describe whether you thought the study was well conducted? Did you note any problems with the study? What could have been done better?
6. Provide a brief summary. Be sure to tie your summary back to your introduction (i.e., Did their investigation answer the question posed? Were results significant? Overall, what are your thoughts?).

Attendance at Lectures

Attendance at lectures is not required. However, if you miss a lecture for whatever reason you are responsible for the lecture material and any announcements regarding changes in the weekly assignment, exam schedule, room change, etc.

Cell Phones and Pagers

Cell phones and pagers must be turned off during all classes.

Academic Dishonesty

You are responsible for making yourself aware of and understanding the policies and procedures in the Undergraduate and Graduate Catalogs that pertain to Academic Honesty. These policies include cheating, fabrication, falsification and forgery, multiple

submission, plagiarism, complicity and computer misuse. [The policies can be found at www.wmich.edu/catalog under Academic Policies, Student Rights and Responsibilities.] If there is reason to believe you have been involved in academic dishonesty, you will be referred to the Office of Student Conduct. You will be given the opportunity to review the charge(s). If you believe you are not responsible, you will have the opportunity for a hearing. You should consult with me if you are uncertain about an issue of academic honesty prior to the submission of an assignment or test.

If I have evidence of any form of academic dishonesty, I will charge the student with violating the Academic Honesty Policy of the University in a report to the Office of Student Judicial Affairs (OSJA). A student who is found responsible for an act of academic dishonesty will be given a failing grade in the course.

Cheating consists of, but is not limited to, looking at another student's examination, using external aids (such as books, notes, conversation with others) when taking the examination, or altering your original exam answers when submitting regrade requests. No course books or materials should be within the student's view during the exam.

Incompletes

In keeping with the University's policy, I will NOT give an incomplete as a substitute for a failing grade – the failing grade stands.

However, if an extended illness or injury prevents you from completing the class, do let me know about it. Depending upon the number of classes and exams that you missed, and your attendance and performance on the exams you took before the problem arose, I may be willing to give you an incomplete for the course.

Emergency Class Cancellation

In the event that classes are officially canceled (due to a snow storm, for example), the following schedule changes will automatically be in effect:

1. If the day canceled is a day on which an exam has been scheduled, then the exam will be given on the first day that classes resume. For example, if an exam is scheduled on Tuesday, and classes are canceled on Tuesday, the exam will be given on Thursday. If Thursday classes are canceled as well, the exam will be given on the following Tuesday.
2. If the lecture day that immediately precedes the exam is cancelled or if BOTH lecture days are canceled, the exam will be given on the regularly scheduled day, or on the first day that classes resume. For example, if an exam is scheduled on Thursday, and the preceding Tuesday lecture is canceled, then the exam will be given as scheduled on Thursday.

**PLEASE READ THE EMERGENCY CLASS CANCELLATION
POLICY CAREFULLY. IT IS NOT POSSIBLE TO PREDICT WHEN
CLASSES WILL BE CANCELED AND THUS I AM NOT ABLE TO
REVIEW THIS POLICY AT THE CRITICAL TIME.**

COURSE CALENDAR

(Note: L means lecture, E means exam, and the number refers to the Unit)

Tuesday

	9/25	L3: Measurement, Feedback, &
9/02	First Class	R+
9/09	L1	10/09 E3
9/16	L2: More ABCs & Pinpointing	10/16 E4
9/23	E2	10/23 ME1
10/07	L3	10/30 E5
10/14	L4: Goals, Unwanted Behavior, Implementation & Evaluation	11/06 L6
10/21	L5: Feedback & Goal Setting	11/13 L7: Incentives & BBS
10/28	L5	11/20 E7
11/04	L6: Training & Customer Service	11/27 NO SCHOOL -
11/11	E6	THANKSGIVING
11/18	L7	12/04 E8
11/25	L8: Behavioral Systems Analysis	
12/02	L8: Behavioral Systems Analysis	THURSDAY, DECEMBER 11TH,

Thursday

10:15 AM – 12:15 PM: MAKE-UP

9/04	L1: Intro to PM & ABCs	EXAM 2
9/11	E1	
9/18	L2	

Appendix D

Sample Study Objectives

PSY 344, UNIT 6, PART 1: Brethower & Smalley, Chapter 9
Langeland, Johnson & Mawhinney (1998)

Brethower & Smalley, Chapter 9

I included this chapter because training is so often sought as the answer to performance problems. However, training, as it typically occurs, will often not solve performance problems for several reasons. Three of those reasons are: (1) you're dealing with a consequence problem, not an antecedent problem; (2) the consequences currently in place do not support behaviors learned in training (instead they often support the "status quo"); and (3) the training environment and/or content is not similar enough to the employees' job to ensure transfer of training. Reasons 2 and 3 can be eliminated if training is performance-based and adequately linked to the workplace. This chapter from Brethower & Smalley's book *Performance-Based Instruction: Linking Training to Business Results* will give you a brief overview of how to tie training (Antecedent) to real workplace behaviors (Behavior) and the consequences for those behaviors (Consequence).

1. Describe training as the authors do. (106,1) What is an essential aspect of training (performance-based instruction)?
2. What are "linkages" and how are they formed? (107,1)
3. What should the specification of the business need spell out? After the desired results are identified, what must occur before the training can be designed? (112,5)
4. What must be included in the support plan that is created in Design Phase One? (113,0)
5. When designing the instructional system, where should some (if not all) of the guided observation, guided practice, and demonstration of mastery take place? (113,0)
6. What does the process of linking training to the workplace enable? (113,1)
7. Be able to reproduce Figure 9.2. These are the seven key linkages discussed earlier in the chapter.

Langeland, Johnson & Mawhinney (1998)

8. What are metacontingencies? Why should we be concerned with them? How can the OBM paradigm help? (22,1-23,1)

9. How are not-for-profit and for-profit organizations similar from a metacontingency standpoint? How are they different? (23,2-25,1) Let me help. (continued on next page)
- a. Both types of organizations must provide products/services that add value to their markets (consumer and financial) at a revenue/cost ratio of at least 1. This means they must bring in at least as much money as it costs to run the business. For obvious reasons, in a for-profit organization that ratio should be much higher. This is the first difference between the two types of organizations. In a for-profit organization, *financial profitability* is the number one objective. And because they are private, the *allocation of financial resources is under their own control*. In a not-for-profit organization, the number one objective is to *satisfy the client groups*. This, of course, is not determined by the amount of money the clients are spending on services, but by the amount of time spent with clients and the quality of services received. In a not-for-profit, the *majority of financial control is held by funding agencies*, not the organization itself.
 - b. Both types of organizations need to manage the behaviors that produce the products/services that add that value. In a for-profit organization, this often means *investing profits into the management of employees through incentives and rewards* for improvements in performance. This is difficult, if not impossible in some cases, in the not-for-profit environment where financial resources are controlled externally.
10. Why was this study initiated? (28,2-29,0) Describe the setting and subjects. (29,1-30,1)
11. What were the dependent variables? Describe each of the three job performance measures. Briefly describe the experimental design. (30,2-31,1)
12. Describe each of the phases of the experiment. (31,2-32,5)
13. Describe the results for each of the three job performance measures. (33,2-35,3)
14. The authors discuss employee reactions to various components of the intervention. (36,2-37,0) Why is this important? Note: The answer to this question is not in the article, but based on what you know about behavior, you should be able to answer it.

END UNIT 6, PART 1

Appendix E

Sample of Clicker Questions and Isomorphic Exam Questions

JS Section – Unit 3 Exam

	No.	Clicker Question	No.	Exam Question
Concept: Measurement	1.	<p>As a supervisor, you need to measure several different types of results. Some of the results are more <i>valuable</i> to the organization than others. Of the answers below, what is the <i>best way to</i> ensure that differences in value across results are captured by your measurement system?</p> <ol style="list-style-type: none"> 1. Using a multiple-baseline design 2. Using a point system 3. Using quantity measures 4. Using quality measures 	16.	<p>Let's say we have to measure three types of results for an organization: cost, unit produced and waste. If these measures are different in terms of value to the organization (e.g. cost being more important than waste), what type of measurement system would be most appropriate to use? Answer: Point system (also allow weighting system).</p>
Concept: Perf. Mat	2.	Performance Matrix calculations	22.	Performance Matrix Calculations
Concept: Feedback	3.	<p>In providing feedback to Sarah the intern, Deb delivered specific information to Sarah about her processing errors. This was done on a weekly basis. If you would make one recommendation to Deb about improving her feedback to Sarah, what should it be?</p> <ol style="list-style-type: none"> 1. It's better to deliver feedback on a monthly basis 2. Performance data should be publicly posted to ensure accountability 3. Deb should deliver feedback to the interns as a group, not individually 4. Deb should focus on active performance, i.e. improvement, rather than error rates 	20.	<p>In order to improve the performance of his assembly team, Matt provided feedback to them by publicly posting the team's performance data in the break room every two weeks. If the team reached their goal, they earned extra breaks. Given this information, what one thing could Matt do to improve his feedback package?</p> <p>Answer: Increase the frequency of feedback delivery/do it weekly/daily, etc.</p>

Concept: Measuring performance	<p>4. While struggling to identify <i>objective pinpoints</i> to measure the quality of the overall performance of his secretary, Mr. Avery consulted a performance analyst who told him that _____ would be an appropriate method to measure performance in this case.</p> <ol style="list-style-type: none"> 1. Quantity 2. Counting 3. Judgment 4. Timeliness 	<p>13. The innovation team at Drake Furniture Inc. wanted to develop measures that could be used to objectively evaluate the extent to which their newly designed products improved the current standard. Which measurement category should the team focus on?</p> <ol style="list-style-type: none"> 1. Quality 2. Quantity 3. Timeliness 4. Cost
Concept: Premacks Principle	<p>5. Which of the following examples illustrates the Premack Principle?</p> <ol style="list-style-type: none"> 1. Providing feedback on performance on a boring task after it has been completed 2. Setting a specific goal and reinforce goal attainment while only providing feedback <i>privately</i> 3. Providing a rule that describes how boring tasks can become enjoyable over time and publicly displaying the results 4. Providing an employee with an opportunity to engage in preferred activities once less preferred activities have been completed 	<p>18. Which of the following examples illustrates the Premack Principle? (1)</p> <ol style="list-style-type: none"> A. Telling Mike that you appreciate that he included a graphic presentation of the data in his report B. Letting Mike present data to the group (which he likes to do), but only after he completes his paperwork (which he doesn't like to do) C. Setting a goal for paperwork timeliness that is difficult yet attainable and celebrating goal achievement when it occurs D. Setting a goal and communicating the reinforcement that will be available upon goal achievement and then delivering the reinforcement before the goal is achieved because Mike worked really hard

Concept: Types of reinforcers	6.	According to Daniels, a <i>memo</i> from the VP in your department, describing your exemplary performance and delivered shortly after the performance could potentially function as: 1. A tangible reinforcer 2. A social reinforcer 3. A reward 4. The Premack principle	21	After 5 years of dedicated service to the company, Mark received a gold watch from the board of directors. In this example, the gold watch would be considered: 1. A social reinforcer 2. A tangible reinforcer 3. A reward 4. Feedback
Concept: Graphs	7.	Identifying components of a graph	23.	Graph
Concept: CARE	8.	Managers do generally not have to be concerned with the <i>E</i> component of the <i>CARE</i> model when they are using _____. (Pick the <i>best</i> answer)	19.	Social reinforcement is very powerful because it fits all of the four characteristics of effective reinforcers. Two of those four characteristics were (1) readily available, and (2) repeatable. What were the other two characteristics? (1) 1. Learned and unlearned 2. Efficient and controllable 3. Tangible or social 4. Cost effective and tangible

Appendix F

Social Validity Questionnaire

Please rate each of the statements below by circling your response.

1. I like using clickers in this class to answer questions.

Strongly disagree	Disagree	Don't know	Agree	Strongly agree
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2. I think using clickers in this class helps me learn the material.

Strongly disagree	Disagree	Don't know	Agree	Strongly agree
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3. I think the clicker questions asked were generally fair and tied to the course objectives.

Strongly disagree	Disagree	Don't know	Agree	Strongly agree
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4. I think the clicker questions helped me do better on exams.

Strongly disagree	Disagree	Don't know	Agree	Strongly agree
----------------------	----------	------------	-------	----------------

5. I think the clicker questions helped me do better on exams.

Strongly disagree	Disagree	Don't know	Agree	Strongly agree
----------------------	----------	------------	-------	----------------

6. Thinking about the two ways we used the clickers this semester (discussion vs. no discussion), which method did you prefer?

Strongly prefer peer instruction before I answer questions	Somewhat prefer peer instruction before I answer questions	No preference	Somewhat prefer working on my own before I answer questions	Strongly prefer working on my own before I answer questions
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7. Extent of learning with peer instruction versus working on your own.

Much more with peer instruction	Somewhat more with peer instruction	Equally well with peer instruction and working on my own	Somewhat more with working on my own	Much more with working on my own
---------------------------------------	---	--	---	--

8. Please rate how good your instructor was at lecturing

Very bad	Bad	Neither good or bad	Good	Very good
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9. I would like to use clickers in my future classes.

Strongly disagree	Disagree	Don't know	Agree	Strongly agree
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10. If you preferred one method of using the clickers over the other (discussion vs. no discussion), please explain why.

11. Any other comments about using clickers in the classroom?

Appendix G
Sample IOA/Grading Sheet

Student # : _____				Student # : _____		
Item	Grader 1		A/D	Item	Grader 2	
2	1	0		2	1	0
8	1	0		8	1	0
10	1	0		10	1	0
12	1	0		12	1	0
14	1	0		14	1	0
24	1	0		24	1	0
25	1	0		25	1	0
26	1	0		26	1	0
Total				Total		

Student # : _____				Student # : _____		
Item	Grader 1		A/D	Item	Grader 2	
2	1	0		2	1	0
8	1	0		8	1	0
10	1	0		10	1	0
12	1	0		12	1	0
14	1	0		14	1	0
24	1	0		24	1	0
25	1	0		25	1	0
26	1	0		26	1	0
Total				Total		

Student # : _____				Student # : _____		
Item	Grader 1		A/D	Item	Grader 2	
2	1	0		2	1	0
8	1	0		8	1	0
10	1	0		10	1	0
12	1	0		12	1	0
14	1	0		14	1	0
24	1	0		24	1	0
25	1	0		25	1	0
26	1	0		26	1	0
Total				Total		

Appendix H

Written Comments from Students

Student's comments: *If you preferred one method of using clickers over the other (discussion vs. no discussion), please explain why.*

Section 1.

1. The extra points were helpful and seeing the way questions would be formed using the material was helpful.
2. Sometimes I was between two answers and the discussing them helped me.
3. Good to converse w/ classmates when in between answers.
4. I prefer using clickers over signing in for class because we still got points and it was beneficial.
5. I liked that we could discuss why or why not each option was or wasn't the answer.
6. Discussion helped us talk about it to work out the answer.
7. Prefer no discussion, prefer working alone. Discussion takes too much time. I didn't feel like there was a point to answering questions for points if we were all allowed to share answers beforehand. Why grade us if we just get the answer from everyone else?
8. Working alone seemed better b/c when working in a group, someone always shouts out the answer right away.
9. Did not prefer any method over the other.
10. I prefer using the clickers while discussing with my peers because it helped me understand when I heard many different explanations.
11. Discussion, if I knew the answer or someone else did it gave us a chance to discuss why we thought 1 was the right answer or why not.
12. Prefer working alone.
13. I liked being able to discuss w/classmates before and then discussing the right answer and why the others were wrong afterwards.
14. It's much easier to hear why an answer is correct. When someone explained the answer to me I remembered it better for the exam than I did when I just guessed.
15. I liked discussion because I could hear other's input and hopefully make a better decision.
16. Discussion, the material was new and you can't possibly have learned it all so someone can help you if they know something you don't and vice versa.
17. Discussion. Other people's point of view, in case I am wrong.
18. I liked the discussion better because I felt like I knew the correct answer.
19. I prefer discussion.
20. I liked when we discussed with a peer, helps to think about the question more.

21. Didn't matter, I did them alone.
22. After having just covered new material- discussing the questions was more helpful.
23. Discussion, majority rules.
24. I like to make sure I knew the answers before relying on others.
25. Discussion helps because you try to figure out the problem together and recall more information this way.
26. I preferred discussion b/c it helped be understand why I was wrong when I was wrong.
27. Discussion was better because sometimes my classmates picked up on stuff in the lecture that I did not.
28. Discussion, since it felt some of the answers I was stuck between 2 of them and talking w/ my peers helped me.
29. I preferred no discussion because it acted as a test for my understanding and my opinion was never swayed by anyone else (discussing them prevents this).
30. I prefer discussion because it allowed me to understand the material better.
31. No discussion helped me learn what I knew and what I didn't know better.
32. I liked hearing what others thought and if I misunderstood something, I'd get corrected before I got the wrong answer.
33. Discussion because I usually got the questions right then.
34. I liked discussion more because if I thought it was a different answer than the correct one I could discuss with a partner and the right answer.
35. I picked no discussion because it made me really think. Helped me know what I needed to more attention to.
36. I like discussion b/c it allows an opportunity to throw around ideas before coming to the correct conclusion.
37. was able to work out perceived ideas better along w/ setting up an argument for why I think an answer is correct.
38. Discussion. Peers could give input and we could all decide on correct question.
39. I somewhat preferred discussing with peers prior to answering the question because what my peers used as an explanation as to why they believed one answer was correct helped me to better remember the material for the exam.
40. Discussion helps you learn more because you had to solve it together.
41. I preferred discussion with my peers. That way we all explained our point of view. Clickers help a lot. I like them.
42. I would prefer discussion as it helped me clarify the material.

43. It helps to talk things out with classmates. It's easier to reason through the questions. Either method worked fine if not better when mixed. Using both allows the student to make decisions on their own and with the class.
44. Peer discussion. It helped me talk out the problems.

Section 2.

1. It is helpful to get someone else's input because some questions are tricky and your peers may have noticed what you didn't.
2. Discussion, because you could work with someone and hear their input, which made for more learning and overall better points.
3. Discussion, I always did better with discussion. I was able to talk about my choice and see what others were thinking.
4. Discussion, b/c I could have missed something in the lecture and someone could remind me.
5. I had no preference to either method. Possibly scatter questions throughout lecture with a few more at the end of lecture for more critical thinking.
6. Discussion was nice because you could get other people's input but the answer ultimately your decision.
7. Discussion helped, but it didn't help me learn the material. —This class is more individual focus, so group questions or group discussions, allowed weren't useful.
8. If you don't know anyone in class, it's just an awkward silence when discussing questions. —Liked being able to have input on why other people were picking for answer but ultimately I picked my answer.
9. Did not like discussion. You can't discuss on the test, so shouldn't discuss clicker questions.

Student's comments to the following: *Any other comments about using clickers in the classroom?*

Section 1.

1. It would be easier if you could change your answer.
2. It is great that we didn't have to buy them.
3. I liked them because it was a good review of the lecture and gave reason to pay attention.
4. Great to immediately test what we just learned.
5. I liked how they were provided for you.
6. I'm very glad I didn't have to pay for this clicker like I did in my other classes.
7. Some were a little lengthy and ambiguous. Better keeping them simple.

8. I like them.
9. I don't think there is that much of an advantage to using them.
10. I recommend other departments using them.
11. I would rather clicker points be extra credit separate from attendance points.
12. Clickers are good.
13. All in all it's a generally positive activity to incorporate.
14. First time using them and I really liked it.

Section 2.

1. Good way to get students to pay attention during lectures.
2. I thought they were good examples of the information for the test.
3. The fact they are free is excellent.
4. Very happy we didn't have to pay for them.
5. I don't like how I couldn't see if my answer went through. The other clickers I've used before showed if my answer went through by marking my class number turn green on a chart instead of red.
6. Some of the questions need to be changed, make them easier.
7. Some people weren't always open to discuss the questions so it was just better to do it on my own.
8. I thought they were fairly beneficial and they make students attend class.
9. -It was a small class and pretty separated so I didn't know anyone or generally have anyone sitting next to me so usually I worked alone anyways.
10. This was my first class using clickers and I found them very beneficial. It was a sort of test I used to evaluate myself and how well I understand lecture. Instant feedback was a plus!
11. It was nice to get feedback from a classmate and be able to bounce ideas off of each other. They're helpful but I don't like that if I missed one class points were taken off my grade. Sometimes things come up and you just can't make it.

Appendix I

Average Exam Scores from Previous Semesters

Table shows the mean percentage of correct exam responses by unit in four separate sections taught by the same instructor across four semesters. 35 points were available for each exam. Each exam was worth 35 points.

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
Fall 2007	84%	81%	86%	85%	83%	87%	85%	87%
Spring 2008	90%	86%	87%	90%	84%	90%	95%	88%
Fall 2009	83%	79%	84%	91%	84%	88%	85%	87%
Spring 2010	85%	82%	89%	87%	83%	89%	82%	82%

Appendix J
HSIRB Approval Letter

WESTERN MICHIGAN UNIVERSITY



Human Subjects Institutional Review Board

Date: August 18, 2009

To: Heather McGee, Principal Investigator
Thorhallur Flosason, Student Investigator for dissertation

From: Amy Naugle, Ph.D., Chair *Amy Naugle*

Re: HSIRB Project Number: 09-08-23

This letter will serve as confirmation that your research project titled "Evaluating the Impact of Small-Group Discussion on Learning in an Organizational Psychology Class Utilizing a Classroom Response System" has been **approved** under the **exempt** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: August 18, 2010

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