The Role of the Interteach in Interteaching

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THE ROLE OF THE INTERTEACH IN INTERTEACHING

by

Thorhallur Orn Flosason

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
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Interteaching is a relatively new instructional method, based on behavioral approaches to education, that has been offered as an alternative to the traditional lecture format in the college classroom. The present study examined the role of the cooperative learning component of interteaching in an undergraduate statistics class. An alternating treatments design, with conditions counterbalanced across two sections of the course, was used to determine whether or not the effectiveness of interteaching depends on the interteach (cooperative learning) component. Weekly exams were administered to measure student learning and social validity was assessed via a questionnaire that required students to rate their preferences and the extent of learning with lecture and interteaching. The results of the study indicated that when the other components of interteaching are implemented (detailed study objectives, frequent practice, frequent exams), adding the collaborative learning component does not affect exam scores. There was also no apparent difference in study behaviors between conditions, and students generally had a strong preference for lectures over interteaching. The implications of these findings and their relation to previous research on interteaching are discussed.
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Thorhallur Orn Flosason
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INTRODUCTION

Most college classes are taught using the familiar lecture-based format. Students attend lectures two to three times a week, read assigned texts, possibly complete individual or group assignments, and take a midterm and final exam to demonstrate what they have learned. During lectures, instructors typically talk about the assigned material and elaborate on it by providing additional examples, clarifying difficult issues, answering students’ questions, and perhaps facilitating discussion. Many lectures are accompanied by slides or visual aids, such as PowerPoint® presentations, and in some cases printed or online versions of the slides are available to students. While the lecture is being delivered, students generally take notes and then use these notes, along with other texts, to prepare for exams or work on assignments. Thus, the final grade is usually determined by the student’s performance on a few exams and possibly several other assignments. Although there are obviously many variations in the manner in which college courses are taught, most seem to follow this general lecturing format (Benjamin, 2002).

College instructors have different views of what they are trying to accomplish with their teaching, which might be influenced by the academic discipline or their personal view of their role as instructors (Cross, 2005). Instructor “enthusiasm” and “knowledge of the subject matter” are qualities that are considered important for delivering effective instruction, and it is thought that instructors should be “able make the connections between what students already know and what we want them to learn” (Cross, p. 2). It is quite common that college instructors have had either limited or no
formal training in teaching and therefore tend to teach the way they were taught
themselves (McKeachie, 2002).

Behavior analysts and others have criticized traditional instructional methods in
both higher education and other settings, emphasizing the need for evidence-based
educational methods that are both effective and efficient (Moran, 2004). But what is
meant by effective instruction? Frederick and Hummel (2004) define effective instruction
as “instruction that enables students to demonstrate, maintain, and generalize competency
on pre-specified learning outcomes faster than students would be able to accomplish this
either on their own or with less effective instruction” (p. 10). Research has shown that
effective instruction consists of clear learning objectives, modeling of correct responding,
practice opportunities, immediate feedback on responses, self-pacing, mastery learning,
reinforcers for accurate responding, and well-established measures that are linked to the
learning objectives and frequently used to evaluate student performance (Frederick &
Hummel).

It is clear that traditional, lecture-based college courses lack most of the elements
of effective instruction described above. For example, it is rare that students learn the
material to mastery, practice opportunities and feedback on performance are infrequent,
and in many cases the instructional objectives are either vague or non-existent. Even
though instructors may try to facilitate discussion and provide feedback on student
performance in class, this can be difficult because of large class sizes and social
contingencies that encourage only a few individuals to participate (Boyce & Hineline,
2002). Without the components of effective instruction in place, many students in higher
education tend to have limited tools and guidelines to facilitate learning and there is a strong reliance on their self-management skills (Boyce & Hineline).

A common criticism of the lecture format in particular is that students are passive receivers of information; as the instructor covers the material, there is typically little active responding by the students and the instructor has limited means of providing students with feedback on their individual performances. Another limitation of lectures is that they expose all students to the material at the same pace, regardless of how well they are learning. For some students, the lecturer covers too much material in class, and for others, too little. In essence, lectures tend to be content oriented rather than outcome oriented (Axelrod, 1976) and focus more on the instructor’s behavior rather than the students’ behavior. Instructors provide information about the subject matter or content, but there are typically infrequent and limited opportunities for students to exhibit their knowledge of the subject matter (e.g., a midterm and final exam). In other words, in most lecture courses there is little focus on the desired outcome of the instruction or mastery of material. Also, it has been argued that lectures are an unnecessary feature of college classes if lectures provide only the same information as the assigned text for the course (Michael, 1991).

Student motivation is another important issue that should be taken into consideration when courses are developed and taught. The average college student has numerous competing contingencies that affect study behavior and the time available for studying (Michael, 1991). Working, playing sports, meeting with friends, family responsibilities, and watching television are some of the things that students must fit into their schedule in addition to studying. There are several motivating variables that can
influence study behavior, such as intrinsic interest in the subject matter, social reactions contingent on study behavior and accomplishments, and immediate or delayed payoffs, such as getting a good job (Michael). Instructors, however, must rely on the only motivational factor over which they have any direct control: the course grade.

The course grade is a measure of the student’s accomplishments, and as such, it is valuable to students when they apply for jobs or graduate school. In most college classrooms, students are given test dates and assignment deadlines at the beginning of the semester, giving them ample time to complete the assignments, prepare for exams, and thus earn a good course grade. However, students often do not engage in the academic behaviors necessary to succeed until right before the test date or the assignment due date, and then they do so with high frequency. This is sometimes referred to as the procrastination scallop (Michael, 1991). In many cases, the condition right before the deadline may become so aversive that it generates escape responses, whereby the student works to leave or avoid the learning situation.

Before 1950, most research on college teaching focused on comparisons between conventional lectures, discussion, and independent study (Robin, 1976). Dubin and Taveggia’s (as cited by Robin) review of that literature revealed nonsignificant difference in achievement scores when the different methods were compared. But in the 1950s, research on individualized instruction grew rapidly. Research has shown that there are variations of the lecture format and other alternative instructional methods that are more effective than traditional lectures, as measured by achievement scores (Kulik, Kulik, & Bangert-Downs, 1990; Kulik, Cohen, & Ebeling, 1980; Kulik, Kulik, & Cohen, 1979;
Many of these methods were derived directly from behavioral principles and are described below.

**Behavioral Approaches to Higher Education**

*Programmed Instruction.* Programmed Instruction was first developed by B.F. Skinner in the 1950s (Skinner, 1968; Vargas & Vargas, 1991). Skinner criticized teachers for relying too much on aversive control as part of their instructional methods. Instead, Skinner argued, teachers should shape and reinforce the appropriate behaviors. He noticed that teachers rarely reinforced individual student's responses, which is a crucial component to building an extensive repertoire (Vargas & Vargas). The basic idea behind programmed instruction was to break down the material into small parts and gradually combine those steps into a functional repertoire. Prompts are frequently used in order to keep error responding low, and then faded out (Vargas & Vargas). Programmed instruction is also self-paced, with students progressing through the instructional materials at their own pace rather than following an instructor-determined schedule.

A meta-analysis conducted on 56 studies that compared the effectiveness of programmed instruction to conventional teaching methods in higher education showed that programmed instruction generally resulted in higher achievement scores (Kulik et al., 1980). Programmed instruction helped shift the focus away from teacher behavior and content to the behavior of the learner – that is, the outcome of the learning. It also emphasized the advantages of self-pacing and mastery learning (Vargas & Vargas, 1991). Many of the principles of programmed instruction have been incorporated into modern instructional design models, particularly those used to develop computer-based instruction (Lockee, Moore, & Burton, 2004).
Personalized System of Instruction. One of the most effective instructional methods to be applied in college and university settings is the Personalized System of Instruction (PSI; Keller, 1968). Fred Keller is credited with the development of PSI, which he and his colleagues started in the early 1960s while establishing the Department of Psychology at the University of Brazil (Keller). Keller and his associates were not satisfied with the traditional lecture format and felt that they “should look for fresh applications of reinforcement thinking to the teaching process” (Keller, p. 80).

PSI consists of five key elements (Keller, 1968). The first is self-pacing, wherein each student progresses through the course at his or her own pace. The second is the mastery requirement, which requires students to demonstrate mastery of each unit before continuing on to the next unit. The third feature is the use of lectures primarily as a source of motivation rather than delivery of information. Lectures in PSI, if used at all, are typically optional, short, and used for clarifying difficult material. An emphasis on the written word is the fourth component of PSI. Rather than relying on lectures to deliver course content, the instructor provides students with textual materials that serve as the major source of information for the course. The last component of PSI is the use of proctors to administer and score exams, deliver feedback to students, and provide tutoring. Proctors are usually undergraduate students who have already taken the course and demonstrated excellent understanding of the material.

The use of PSI quickly grew and generated a large amount of research, much of which was conducted in university settings (Sherman, 1992). In 1977 US colleges and universities offered around 1,200 PSI courses in 36 different areas (Beyer, 1977; Kulik et al., 1979). An extensive review of the literature showed that PSI was generally found to
be superior to traditional teaching methods (Kulik, et al., 1980; 1990). In addition, a meta-analysis of 72 studies that compared the effects of PSI to traditional methods found that PSI resulted in greater achievement, as measured by final exam scores, student satisfaction, and other measures (Kulik et al.). PSI, or variants thereof, such as the Computer-Aided Personalized System of Instruction (Pear & Martin, 2004), are still used in a variety of settings (e.g., Crosbie & Kelly, 1993; Hambleton, Foster, & Richardson, 1998; Martin, Pear, & Martin, 2002; Pear & Novak, 1996; Price, 1999), but there has been a steep decline in the number of PSI courses offered and research published on the topics (Sherman).

**Precision Teaching.** Precision Teaching (PT) is not a method of instruction per se, rather it is a measurement system by which teachers can evaluate student progress and decide how to organize and implement the instruction (Merbitz, Vieitez, Merbitz, & Pennypacker, 2004). PT follows four guiding principles. First, as with other behavioral approaches to education, PT focuses on observable behavior. Second, PT uses response rate or frequency as a measure of performance and mastery rather than accuracy alone. By using rate as a measure, teachers and students can focus on behavioral fluency as the outcome of instruction. Fluent skills are those which the learner can exhibit even after periods of no practice (retention), can perform for long durations without fatigue (endurance), can apply to new situations or combine with other skills (application), and can perform even in the face of distractions (stability; Binder, 1996). Precision teachers seek to identify rates of responding for individual skills that predict the learning outcomes of fluency, and use these frequency aims as the mastery criteria for the skills. The third principle is the use of the Standard Celeration Chart (SCC), developed by Ogden
Lindsley. The SCC is a chart with a logarithmic scale on the y-axis to represent responses, and 140 successive calendar days (the length of a typical school semester) listed on the x-axis. Organizing the chart this way allows users to easily plot both infrequent and frequent behaviors on the same chart for a whole semester. The final principle of PT is that “the learner knows best,” meaning that student performance guides instructional decisions. For example, if the student’s response rate indicate that he or she is not making progress, the instruction is to blame (rather than the student) and needs to be adjusted and improved (Merbitz et al.).

Precision teaching has been used mostly with elementary and middle school children in teaching reading, writing, spelling and arithmetic (Maloney, 1998). But variations of PT have also been used in higher education, usually with a technique known as SAFMEDS, or Say All Fast a Minute Every Day Shuffled (Merbitz et al., 2004). SAFMEDS is a flash card learning system, with a question or a concept on one side of the card and the answer to the question or the definition of the concept on the other. Students use the deck of cards with multiple questions and concepts to practice verbal responses to the questions and concepts as fast as they can, typically with another person checking and recording answers. This technique has also been applied using a computer-based format (McDade, Austin, & Olander, 1985; McDade & Goggans, 1993; Parsons, 2000).

Research on fluency-based instructional methods such as Precision Teaching has demonstrated its effectiveness in higher education. For example, students who are taught terms, concepts, and formulae in statistics using PT generally solve more word problems than students who do not get PT (McDade & Goggans, 1993). Also, college students
taught with PT demonstrate better retention of reading material (Oleander, Collins, McArthur, Watts, & McDade, 1985; Spangler & Hankins, 1975).

Challenges of Implementing Behavioral Approaches to Instruction in the College Classroom

Despite the efforts of behavioral psychologists to introduce alternative, effective instructional methods, lecturing remains the instructional method of choice for college classes (Machado & Silva, 1998). One possible reason for this is that a greater amount of work is often required for the initial development of courses using these alternative approaches (e.g., PSI; Pear & Crone-Todd, 1999). Also, the self-paced nature of many behavioral approaches to education does not fit the academic calendar well, and the tradition of the teacher-centered, rather than learner-centered, classroom seems resistant to change (Fox, 2004). The success of behavioral approaches can also work against them, as administrators generally do not like the bimodal distribution of exam scores that tends to occur, wherein many students earn A’s but many students drop or fail the course (Boyce & Hineline, 2002).

Enhancements to the Lecture Format

A number of methods have been used to increase student participation during lectures in order to make the traditional format of instruction in college more effective (Greenwood, Delquadri, & Hall, 1984). These methods are often referred to as active student responding (ASR; Heward, 1994). ASR methods promote student participation and responding during lectures, but are easier to implement in college classrooms than methods such as PSI because they do not require self-pacing and generally do not require
much more work for the instructor. The most prominent ASR methods are guided notes and response cards (Austin, 2000).

Guided notes. Guided notes are handouts, prepared by the instructor, that provide the students with an outline of the material covered in class and guide students in writing down important points and examples presented during lecture (Barbetta & Skaruppa, 1995). For example, the guided notes may include short paragraphs with definitions and examples but with blank spaces where certain key words and terms should be. During the lecture, students are required to fill in these blanks, based on the instructor’s lecture. In other words, students are provided with incomplete notes and they must attend to key issues during lecture in order to complete the notes. By using guided notes, students get the opportunity to make active responses during class that may help them respond correctly on exams. Research on the effectiveness of guided notes has shown that they can improve achievement scores of students (Austin, 2000; Baker & Lombardi, 1985; Neef, McCord, & Ferreri, 2006).

Response cards. Response cards are cards that students use to answer questions from the instructor during lecture (Austin, 2000). Each card contains letters or symbols that correspond to the answers, so that with each card, students can easily give answers to true or false questions or multiple choice questions with up to four choices (Marmolejo, Wilder, & Bradley, 2004). During lecture, the instructor asks students in the class questions regarding the subject matter every 5-10 minutes in order to assess student understanding and maintain student attentiveness. When the teacher asks a question, students immediately display their answers by holding the cards up, orienting the card so that their answer is displayed. The instructor looks over the class to determine how many
students answered the question correctly. If a sizable number of students answer incorrectly, the instructor may spend more time on the topic; otherwise, the instructor moves on to the next topic. Response cards are therefore an effective way for instructors to monitor student progress and tailor the lectures according to the students' performance. This method has proven effective for increasing student exam scores in university settings (Kellum, Carr, & Dozier, 2001; Marmolejo et al.).

While there is some evidence of the utility of ASR, the effects of both guided notes and response cards have been somewhat inconsistent (Neef et al., 2006) or minimal (Marmolejo et al., 2004). For example, Marmolejo et al. found that the difference in exam scores between the baseline condition and the response card condition was only about 10% (63.6% correct and 73.4% respectively). The effects of using guided notes in lectures have also been positive, but minimal (Austin, 2000; Neef et al.).

**Interteaching**

Boyce and Hineline (2002) recently introduced a method of college instruction, interteaching, which they claim is "an arrangement for college classroom instruction that departs from the standard lecture format and offers an answer to criticisms commonly directed at behavioral teaching techniques" (p. 215). Interteaching is not a new method, *per se*, but it is a new combination of already existing instructional methods. It incorporates methods such as reciprocal peer tutoring (Griffin & Griffin, 1998), preparation guides that specify instructional objectives, and frequent testing.

In general, the instructor using interteaching first provides his or her students with "preparation guides” that include questions relevant to a specific unit of the course and corresponding reading material. Students use the preparation guides to guide them
through the readings before class, pointing out important topics and questions. Once in class, the instructor provides a brief lecture addressing key points of interest or difficulty (as identified by the interteaching records, described below), and then students form small groups and discuss the questions on the prep guides. During the discussions, the instructor and teacher assistants rotate among groups and answer questions, help with difficult material, and ensure that students are coming up with the right answers. At the end of the class period, students fill out an interteaching record, stating which topics they found difficult or interesting and would like to have covered in the next class. The interteaching record also gives the student an opportunity to provide comments and suggestions about the course. Students will also take quizzes over the material on regular basis. Additionally, contingencies for improving the quality of discussion during interteaching are often implemented in the form of what are called quality points.

Interteaching shares with PSI the use of peer tutoring and a decreased emphasis on lecture. Boyce and Hineline (2002) presented interteaching as a way for instructors to use behaviorally based methods “that are less at odds with the customs and administrative arrangements of typical college or university” (p. 218). Therefore, interteaching is presented as an appealing alternative to the traditional lecture format that is easily implemented and administered. What follows is a description of the components that are used in interteaching.

The interteach. Individualization is one of the key features of behavioral instruction; students learn the material on their own and demonstrate their knowledge by taking individual tests. A core component of interteaching, and the one from which the strategy’s name is derived, is “the interteach.” Boyce and Hineline (2002) define an
interteach as “a mutually probing, mutually informing conversation between two people” (p. 220). It is based on an instructional method that has not been used extensively in behavioral education: reciprocal peer tutoring (RPT; Riggio, Fantuzzo, Connelly, & Dimeff, 1991).

In RPT, students generate questions about the material and then ask each other these questions in order to prepare themselves for exams (Fantuzzo, Dimeff, & Fox, 1989). The actual format of RPT varies in terms of how the sessions are conducted and how many students are working together (Riggio et al., 1991). Studies on RPT conducted in college settings reveal somewhat conflicting results. Some studies that have compared RPT and non-RPT methods in college settings have demonstrated virtually no effect in terms of exam scores (Griffin & Griffin, 1998; Rittschof & Griffin, 2001). Those studies have showed, however, that students think RPT helps them learn the material, even though the exam scores do not seem to improve using RPT. Other studies have been able to demonstrate that RPT results in greater improvement in exam scores (Fantuzzo et al.; Riggio et al.).

RPT seems to be a somewhat helpful teaching strategy because when students are teaching each other they are simultaneously building their own repertoire and actively responding. Students’ study behavior may be maintained through the social contingencies of the RPT sessions, as students prompt each other and provide consequences for each other’s responses and level of preparation. For example, students can immediately praise the correct responding of their peers or provide verbal prompts if the peer is struggling. Students who are not prepared for an RPT session will slow down the session, and this
might become aversive to their fellow students who might, in turn, provide aversive consequences (such as in the form of reprimands) to the unprepared student.

The main difference between RPT and the way interteach sessions are conducted in interteaching is that in interteaching the instructor provides the students with the questions, whereas in RPT the students themselves generally develop the questions. RPT, as used in interteaching, changed from having students evaluate each other's responses to answering the questions and solving problems in collaboration. An interteach “lasts 30 to 40 min, and deals with the main points in a specified selection of material (textbook or articles)” (Boyce & Hineline, 2002, p. 220). Boyce and Hineline propose that groups of two are the most successful format since in bigger groups not everybody tends to participate and contribute to the discussion. They also suggest that students should be required to work with different students each class session to prevent the weaker students from working together. This definition of interteach closely relates to another popular approach to having students teach each other: cooperative learning, also called collaborative learning (Slavin, 1992). RPT is a form of collaborative learning, and interteaching is actually closer to being a variation of collaborative learning than RPT, since it involves students discussing the course material rather than evaluating each other’s performance.

Cooperative learning itself is not a single method, however. Rather, it refers to a number of teaching methods in which students work in small groups and help each other learn academic material (Slavin, 1996). Generally, cooperative learning is not meant to replace the teacher as a source of instruction, but instead takes the place of individual assignments during class. The group as whole makes sure that everybody in the group is
able to achieve their goal, as described in the course objectives. Students have to be accountable for their own performance and also the performance of their group mates (Axelrod & Greer, 1994).

There are several variations of cooperative learning. In some cases, students are provided with structured tasks as antecedents but at the same time no specific consequences are provided for correct responses, except for the social contingencies that are an inevitable part of the college classroom. Other variations include consequences in the form of points, grades or certificates for either group or individual performance (Axelrod & Greer, 1994).

Cooperative learning has been studied extensively (Slavin, 1996). For example, a meta-analysis of 168 studies that compared the efficacy of cooperative learning, competitive learning and individualistic learning found that cooperative learning results in higher individual achievement scores on exams (Johnson, Johnson, & Smith, 1998). Cooperative learning methods have been used with good results; for example, they have improved exam scores at all educational levels with many different subjects (Slavin, 1996; Springer, Stanne, & Donovan, 1999). It has been beneficial in various college classes, such as mathematics (Dees, 1991; Springer et al.), chemistry (Bowen, 2000) and computer instruction (Keeler & Anson, 1995). Results also show that cooperative learning is generally well liked by students (Dees; Singhanayok & Hopper, 1998; Springer et al.). A review of the literature has shown that cooperative learning is most effective when groups are rewarded based on the performance of individuals in the group (Slavin).
Cooperative learning can make valuable contributions to behavioral education because it is generally accepted by educators, research has demonstrated its effectiveness, and it includes behavioral techniques, such as group contingencies and individual contingencies (Axelrod & Greer, 1994). It can also be considered a form of self-paced instruction, which is one of the key elements of PSI. However, researchers in the field of cooperative learning are not consistent in using behavioral terminology, and some researchers even avoid the use of behavioral terminology altogether (Johnson & Johnson, 1986). Axelrod and Greer also raise the issue of whether group contingencies should be used to improve academic achievement, since some students may lack the prerequisite skills necessary to perform successfully. There has also been discussion about whether cooperative learning is beneficial to high achievers, but there seems not to be a consensus on the issue (Slavin, 1992, 1996; VanTassel-Baska, Landrum, & Peterson, 1992). In addition, cooperative learning might be difficult to implement in college classrooms, due to issues such as the larger class sizes and physical constraints of the classroom.

**Preparation guides.** Either before class or in class, students in an interteaching course are provided with a preparation (prep) guide that outlines the objectives for that session. These guides contain questions pertaining to definitions of concepts and terms, application-level questions, and problem-oriented questions. For example, an item on the prep guide may require students to describe the advantages and disadvantages of particular interventions or apply concepts from the reading material to novel situations. Students use these prep guides as study aids to help them identify key issues while studying and to facilitate discussion during the interteaching sessions. Prep guides and study objectives more generally are essentially tools to shape student repertoires
(Michael, 1991). Boyce and Hineline (2002) also point out that there should be a clear link between items on the prep guides and items on the exam.

**Role of instructor and lectures.** In interteaching, lectures are not excluded but they take up a much smaller portion of the instruction, no more than one third of class time. Boyce and Hineline (2002) state that lectures in interteaching serve the same function as lectures in PSI: they are simply a source of motivation. It has been pointed out that lecture attendance is generally highest when the lecture includes material that will be covered on exams (Lloyd, Garlington, Lowry, Burgess, Euler, & Knowlton, 1972), so lectures might generate high attendance when students themselves mand for the material covered in lectures, which might in turn affect learning in a positive way (Shimoff & Catania, 2001). In interteaching, students provide the instructor with information on what they would like to be covered in lectures via the interteaching record (see below), allowing the instructor to filter out redundant information and focus on topics that students report they find particularly interesting or difficult.

**Interteaching records.** At the end of each interteaching session, students fill out an interteaching record that includes information such as the name of students working together, date and duration of the session, quality rating of the interteaching session, and a list of difficult and/or interesting topics. Students are also encouraged to provide the instructor with comments or suggestions on the interteaching record. The instructor then uses the information on the interteaching records to focus the content of the lectures.

**Probes.** A probe is a measurement instrument that is used to evaluate students’ knowledge on the subject matter. Probes have essentially the same function as tests, but students know the possible questions beforehand. The probe includes items such as
multiple-choice questions, true-false questions, definitions and short-essay questions. These items are usually based on the questions on the preparation guides. It is recommended that probes be administered frequently, no less than five times during a semester (Boyce & Hineline, 2002). In some interteaching courses students are allowed to drop their lowest probe score. Research has demonstrated that students who take frequent exams generally perform better on the exams compared to students who take exams less frequently (Rysberg, 1986).

**Points for participation, quality, and attendance.** Various methods have been used in interteaching to improve student attendance, participation in class, and preparation outside of class. At this point, there is not one specific method considered crucial for the implementation or success of interteaching. Some of the methods reported in the literature are described below. Saville, Zinn, Neef, Norman, and Ferreri (2006) reported three different contingencies to facilitate participation. First, teaching assistants (TAs) circulated around the classroom during interteaching and handed out tickets to students who were actively engaged in discussion that was focused on the topic for that particular unit. Those tickets were then exchangeable for an opportunity to earn extra points in a drawing at the end of each class. In a second study reported by Saville et al., students earned points for participating in interteaching sessions, which made up about 8% of the final grade in the course. These points were not contingent upon any specific responses during the session; students got the points simply for attending. In the third method reported by Saville et al. (also reported by Boyce & Hineline, 2002), quality points were given based on students’ essay answers on exams. If both of the students who worked together during an interteaching session earned an A or B on a specific essay
question for that unit, both students earned four bonus points toward their course grade. If one or both students earned less than a B on an essay question, neither student received the bonus points. The fourth method, also reported by Boyce and Hineline, required students to rate the quality of each interteaching session on a scale of 1 to 10 and to provide justification of their rating. Points were awarded based on the rating and made up a specific proportion of their final grade.

Research on Interteaching

Interteaching addresses some of the concerns that often arise when alternative methods of college instruction are introduced and implemented, as discussed earlier. And, more importantly, it incorporates several components that have been demonstrated to improve learning at all stages of education (Frederick & Hummel, 2004): clear objectives (prep guides), opportunities for active responding (peer tutoring), immediate feedback (peer tutoring), and frequent measures of responding linked to the objectives (probes). Research on interteaching is limited, but the results so far are promising (Saville, Zinn, & Elliott, 2005; Saville et al., 2006).

The first formal evaluation of interteaching was conducted in a laboratory setting by assigning undergraduate students to one of four experimental conditions: interteaching, lecture, reading, or control (Saville et al., 2005). Participants in the interteaching condition spent 15 minutes reading an article and individually answering questions on a prep guide, 15 minutes discussing the material with another student, and 15 minutes listening to a lecture from the instructor based on the participant’s questions. Students in the lecture condition listened to a 45-minute lecture on the material covered in the article. Students in the reading condition spent 45 minutes individually reading and
studying the article. Students in the control condition did not receive any information on the article. Participants in all four groups returned a week later and took a multiple-choice quiz over the material. Results showed that participants in the interteaching group performed significantly better on the quiz than other participants. Mean scores for participants in the interteaching group was 74.09, the lecture group 60.00, the reading group 55.22, and the control group 51.50.

Saville et al. (2006) compared the effectiveness of interteaching and traditional lecture format in a university setting in two separate studies. In the first study, researchers alternated lectures and interteaching sessions across eight class sessions. During lecture sessions, 40- to 60-min lectures covering the course objectives were delivered. At the end of the lecture, students got the opportunity to earn bonus points by submitting written questions on the material covered in the lecture. During the interteaching sessions, students were divided into dyads and triads and were asked to work through the prep guide for 40-60 minutes. During this discussion, TAs gave out tickets to students, contingent on them discussing the prep guides. These tickets gave students the opportunity to win extra points at the end of the session. Teacher assistants (TAs) and the instructors were available for assistance during the discussion. At the end of the session, students filled out an interteaching record, which the TAs used for developing a lecture for the next class period. Pretests, consisting of short-answer questions, were administered for each of the eight units. Similar tests were administered at the end of each unit. The primary finding was that posttest scores were higher after interteaching sessions than after lectures. Mean test scores following interteaching sessions and lectures were 4.68 and 3.32 (out of 6 possible points), respectively. A major limitation of
this study was that it did not control for material difficulty; the material covered during
the interteaching session might have been "easier" than material covered during lecture.

The second study reported by Saville et al. (2006) was similar to the first, but
controlled for material difficulty by counterbalancing the lecture and interteaching
sessions across two different sections of the course. Participants in the second study also
received points for each interteaching session and quality points based on test
performance. Tests in the second study consisted of essay questions, short-answer
questions and fill-in-the blank questions. In addition, a cumulative final test was
administered in the second study. Results showed that, on average, students scored higher
on tests that followed interteaching sessions than tests that followed lectures. On four of
the tests, students who had interteaching scored 12% higher on average compared to the
lecture group. On the remaining two tests, interteaching students scored 3.5% higher than
students who received lecture. For both studies, students generally preferred interteaching
over lecture, as measured by the social validity questionnaire. A weakness of this study is
that the class length was different for the two sections; one met twice a week for 75 min
and the other met three times a week for 50 min.

Rationale for the Current Project

While the early research on interteaching has demonstrated positive results, an
important limitation of the studies is that they do not reveal which components of
interteaching contribute to its effectiveness. Interteaching contains a number of
instructional techniques that have been shown to be effective on their own, such as
cooperative learning, the use of specific study objectives, and frequent testing. Thus, it is
not clear which components of interteaching are most essential to the success of the approach. Interteaching advocates have highlighted the importance of the “interteach” (the cooperative learning discussion sessions; Boyce & Hineline, 2002), but it is possible that the other components are more important for influencing learning. Previous studies have also suffered from limitations such as differences in class length between groups and uncontrolled variables such as material difficulty.

This study attempted to address some of these issues. In particular, the effectiveness of cooperative learning as part of the interteaching package was examined in detail. Students in an undergraduate statistics course were exposed to two alternating learning conditions, one incorporating all of the major components of interteaching and the other incorporating all of the major components except cooperative learning. The impact of interteaching on student study behavior, rather than just exam scores, was also examined in this study. In addition, material difficulty was controlled for by using a counterbalanced alternating treatments design across two sections of the course, and both sections had the same class length and number of class periods during the week. This design provided valuable information about the role “interteach” sessions (i.e., cooperative learning) play in the effectiveness of interteaching.

METHOD

Participants and Setting

Sixty-five undergraduate students (44 females and 21 males, mean age = 21.7 years) enrolled in an introductory statistics course participated in this study. The students were enrolled in two sections of the course, with each section meeting at different times
on the same days. Each section met three times per week, on Mondays, Wednesdays and
Fridays, for 50 minutes each time. Monday and Wednesday classes were used for lectures
and interteaching sessions and exams were administered on Fridays. Each section had a
different instructor. Student registration determined the section in which each student was
enrolled. All sessions were conducted in a typical college classroom, equipped with a
whiteboard, a projector and a seating capacity for approximately 50 people.

In the first class period, self-reported, anonymous, demographic data was
collected in order to compare participants across the two sections (see Appendix A). The
data collected included cumulative GPA (mean GPA was 3.24 for Section 1 and 2.97 for
Section 2), number of psychology classes previously taken (mean: 3.66 for Section 1 and
3.50 for Section 2), number of credit hours taken during the semester (mean: 14.93 for
Section 1 and 14.35 for Section 2), whether students were employed (47% for Section 1
and 46% for Section 2), the number of hours they worked per week (mean: 22.5 hours for
Section 1 and 24.9 hours for Section 2), and their undergraduate status (50% in Section 1
were juniors and 40% were sophomores, the remaining 10% were freshmen and seniors;
40% in Section 2 were juniors and 50% were sophomores, the remaining 10% were
freshmen and seniors).

Materials

Textbook and study objectives. The class was divided into 12 weekly units, with
each unit corresponding to roughly one chapter from the course textbook (Gravetter &
Wallnau, 2005; see Appendix B for the course syllabus). Students were also provided
with detailed study objectives for each unit (see an example in Appendix C). These study
objectives identified questions, definitions, and practice problems covered in the
textbook, and were designed to help students focus on the topics in the text most relevant
to the exam. The number of study objectives for each unit ranged from 11 to 37,
depending on the material for each unit. There were several types of study objectives:
definitions of concepts and terms, constructing graphs, conducting data analyses, and
various application-level questions. The objectives for all units were available on the
course website throughout the semester.

Assignments. Two assignments were developed for each weekly unit, one for the
Monday class and one for the Wednesday class. These assignments contained statistical
problems and other application-level questions tied to the study objectives (see Appendix
D for an example), and are comparable to the prep guides in other interteaching studies.
Students earned points for those assignments worth up to 7.5% of the total course grade.
A detailed description of the point system is included in Appendix B. The assignments
for each unit were identical for the both the lecture and interteaching conditions. The only
difference was that students in the lecture condition completed the assignment
individually as homework, while students in the interteaching condition completed the
assignment in class with a partner.

Lecture slides. Lecture slides for all units (in PowerPoint® format) were available
to all students on the course website throughout the semester, irrespective of whether the
students attended lectures or interteaching sessions for that unit. To ensure equitable
access to course materials, all of the slides presented during a full lecture for a unit were
included in the lecture slides, although during the interteaching condition students were
only exposed to a fraction of those slides in class.
Feedback forms. A feedback form was developed for administration at the end of each non-exam class period. On the feedback form the student could rate the usefulness of the class period (lecture or interteaching), list any topics found to be difficult or requiring further clarification, and provide any comments or suggestions to the instructor (see Appendixes E and F). The feedback form for lecture classes was virtually identical to the feedback form used for interteaching classes. The interteaching feedback form is similar to what has been called an “interteaching record” in the literature.

Exams. Weekly exam items consisted of multiple-choice questions, short-answer questions, and calculation problems that were closely related to the study objectives. Students were allowed to use calculators and they were provided with statistical tables and complex formulas necessary to answer the questions on the exam. Each exam was worth a maximum of 35 points.

Study behavior questionnaire. A brief questionnaire was developed to collect self-reported data on student study behavior for each unit. The questionnaire was administered anonymously at the end of each unit exam and required students to use Likert-type scales to rate the extent to which they read the lecture slides, looked at the study objectives, read the book, and prepared for the first class in that unit (Appendix G).

Social validity questionnaire. To evaluate the social validity of the instructional methods used in this study, a questionnaire was developed and administered at the end of the course (see Appendix H). The questionnaire was similar to a questionnaire used in previous interteaching research (Saville et al., 2006), but included additional questions. The questionnaire included questions about the amount of learning with the two instructional methods, the quality of the instructor, benefits of the assignments in each
section, their assessment of collaborative learning in general, and preference for
instructional methods. A space for comments was also provided on the questionnaire.

Experimental Research Design

An alternating treatments design (Cooper, Heron, & Heward, 1987) with two
conditions semi-randomized within course section and counterbalanced across the two
course sections was used for this study. This design permitted the comparison of the two
instructional methods within each section of the course without the need for a baseline
phase or withdrawal of treatment.

Procedure

Before the course began, each of the weekly units for one section was randomly
designated either interteaching or lecture with the constraint that each condition occur an
equal number of times and for no more than two consecutive units. To control for
material difficulty, the second section of the course received the conditions in a
counterbalanced order. For example, if Section 1 was in the lecture condition for a
particular unit, Section 2 was in the interteaching condition for that same unit. Each
section of the course was exposed to six weekly units taught via lecture and six weekly
units taught via interteaching. Attendance points accounted for 7.5% of the total course
grade in each section of the course. Guidelines for assigning attendance points are
provided in Appendix B.

Lecture. During the lecture condition, traditional lectures were delivered in class
on Mondays and Wednesdays (with the exception of the first unit, which covered two
chapters of the textbook and included three lectures). The instructor delivered lectures
using PowerPoint® slides, covering the unit content and objectives in detail and
demonstrating how to calculate statistical problems when the objectives related to such calculations. Students were free to ask questions during lectures. At the end of each lecture, exercise assignments were handed out and students were instructed to complete the exercise assignments and hand them in at the beginning of the next class period. These assignments were completed individually by students outside of class and were worth the same number of points as assignments completed in class during the interteaching condition (see below). Students could earn up to 1.5 points for each assignment based on the accuracy of their responses, with no points awarded for accuracy levels below 80% (see Appendix B for a detailed description of scoring criteria). Students also completed and returned the feedback form at the end of each class. Feedback forms were used to track attendance and assign attendance points, and the instructor used the comments from the Monday feedback forms to clarify difficult topics during Wednesday’s lecture.

*Interteaching.* During the interteaching condition, interteaching sessions were conducted in class on Mondays and Wednesdays instead of full lectures (with the exception of the first unit, which covered two chapters of the textbook and included three interteaching sessions). At the beginning of each class, the instructor gave a brief, 10-15 minute lecture covering the unit’s key topics. Students were then provided with the assignment and the feedback form for that session, and instructed to form pairs (dyads) to discuss and work together on the assignment. They were required to work with a different student each week, as recommended by Boyce and Hineline (2002). The assignments provided the students with a structured format for how to conduct the session, but they had the opportunity to choose exactly how they progressed through the assignment. For
example, they might take turns on solving problems and describing each step of the procedure to their peer, or work together to solve each problem. The only requirement was that they collaborate on the assignment, and only one assignment sheet was turned in for each pair of students.

During the interteaching session, both the instructor and at least two undergraduate teaching assistants (TAs) were available to assist students and answer any questions that they had. The instructor and TAs also had an answer key to the assignment in order to be able to provide immediate feedback on the students’ performance on the assignment. At the end of class, each student completed a feedback form. As in the lecture condition, the feedback forms were used to track attendance and assign attendance points, and the instructor used the comments from the Monday feedback forms to clarify difficult topics during Wednesday’s brief lecture.

Exams. Unit exams were worth 35 points each and were administered in class on Fridays. Students who did not take an exam received a score of zero for that exam. Scores of zero were excluded from data analyses. At the end of each exam students completed the anonymous study behavior questionnaire (see Appendix G). Exams were graded by undergraduate TAs, with the instructor or a graduate teaching assistant supervising, and exam grades were typically posted to the course website within a few hours of completion.

End of semester. At the end of the semester, students completed the social validity questionnaire in class.
Interobserver Agreement

One third of the exams for each unit were randomly selected to be independently graded by two TAs using a detailed answer key. To ensure that the teaching assistants were not influenced by each other’s grading, a folded scoring sheet was used for collecting interobserver agreement data (see Appendix I) and the exam answer sheet itself was not marked. For each of the 35 points available on an exam, whether the two graders agreed or disagreed on the awarding of the point was recorded. 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. For every disagreement, the instructor was consulted and he or she determined which points to award and which points to deduct based on the structure and content of the answer. The mean agreement score for the exams was 97.5% with a range of 93% to 100%.

Dependent Measures

The primary dependent measure of this study was mean exam scores, with secondary dependent measures including self-reported study behavior, ratings of the value of individual class sessions from the feedback forms, and responses to a social validity questionnaire at the end of the semester.
RESULTS

Exam Scores

Mean exam scores for Section 1 are displayed in Table 1 and mean exam scores for Section 2 are displayed in Table 2.

Table 1
Mean Exam Scores by Condition for Section 1

<table>
<thead>
<tr>
<th>Lecture</th>
<th>1</th>
<th>4</th>
<th>7</th>
<th>9</th>
<th>10</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 33)</td>
<td>(n = 32)</td>
<td>(n = 30)</td>
<td>(n = 31)</td>
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<tr>
<td>M</td>
<td>30.27</td>
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<td>26.85</td>
<td>30.71</td>
<td>30.76</td>
<td>31.70</td>
</tr>
<tr>
<td>SD</td>
<td>2.92</td>
<td>3.44</td>
<td>4.59</td>
<td>3.38</td>
<td>2.30</td>
<td>2.60</td>
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<td>15.5-35</td>
<td>18-35</td>
<td>26-34</td>
<td>22-35</td>
</tr>
<tr>
<td>Interteaching</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>(n = 33)</td>
<td>(n = 31)</td>
<td>(n = 33)</td>
<td>(n = 33)</td>
<td>(n = 31)</td>
<td>(n = 31)</td>
</tr>
<tr>
<td>M</td>
<td>30.42</td>
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<td>27.15</td>
<td>27.83</td>
<td>29.64</td>
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<td>SD</td>
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<td>3.40</td>
<td>5.14</td>
<td>3.86</td>
<td>4.06</td>
<td>4.34</td>
</tr>
</tbody>
</table>

Note. The maximum possible score for each exam was 35.

Table 2
Mean Exam Scores by Condition for Section 2

<table>
<thead>
<tr>
<th>Lecture</th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>6</th>
<th>8</th>
<th>11</th>
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<tr>
<td>M</td>
<td>28.60</td>
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<td>26.32</td>
<td>26.53</td>
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<td>27.51</td>
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<tr>
<td>SD</td>
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<td>6.09</td>
<td>5.76</td>
<td>5.77</td>
<td>6.00</td>
<td>6.99</td>
</tr>
<tr>
<td>Interteaching</td>
<td>1</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(n = 31)</td>
<td>(n = 31)</td>
<td>(n = 28)</td>
<td>(n = 28)</td>
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<tr>
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<td>13-35</td>
<td>10-33</td>
<td>17-35</td>
<td>19-34</td>
<td>20-34</td>
</tr>
</tbody>
</table>

Note. The maximum possible score for each exam was 35.

The mean exam scores for both course sections are displayed in Figure 1. For all units taught with lecture, the mean of exams scores was 30.2 ($SD = 1.67$) for Section 1, 27.0 ($SD = 1.08$) for Section 2, and 28.7 ($SD = 1.93$) for both sections combined. For all units
taught with interteaching, the mean of exam scores was 29.2 ($SD = 1.48$) for Section 1, 27.11 ($SD = 2.18$) for Section 2, and 28.2 ($SD = 2.00$) for both sections combined.

Figure 1. Mean Exam Scores for Each Unit.
The distribution of exam letter grades for each section, aggregated across condition, is displayed in Figures 2 and 3. While the exam scores for Section 2

Figure 2. Distribution of Letter Grades for all Unit Exams in Section 1.

Figure 3. Distribution of Letter Grades for all Unit Exams in Section 2.
are more variable than those for Section 1, visual inspection does not reveal any clear
difference between the lecture and interteaching conditions for either section.

*Ratings of the Value of Individual Class Sessions*

Overall ratings of how valuable or useful students found each class session,
collected via the feedback form at the end of every class, are presented in Figures 4 and 5.
For Section 1, students agreed or strongly agreed that lecture sessions were
valuable/helpful 81% of the time, and agreed or strongly agreed that interteaching
sessions were valuable/helpful 59% of the time. For Section 2, students agreed or
strongly agreed that lecture sessions were valuable/helpful 80% of the time, and agreed or
strongly agreed that interteaching sessions were valuable/helpful 78% of the time.

![Figure 4. Distribution of Responses to “Today’s session was valuable/helpful” across all Units for Section 1.](image-url)
Figure 5. Distribution of Responses to “Today’s session was valuable/helpful” across all Units for Section 2.

Study Behavior

Figures 6 through 13 display the distribution of responses, aggregated across condition, to the questions on the study behavior questionnaire administered at the end of each exam.
Figure 6. Distribution of Responses to “Did you look at the lecture slides for this unit?” across all Units for Section 1.

Figure 7. Distribution of Responses to “Did you look at the lecture slides for this unit?” across all Units for Section 2.
Figure 8. Distribution of Responses to “Did you look at the study objectives for this unit?” across all Units for Section 1.

Figure 9. Distribution of Responses to “Did you look at the study objectives for this unit?” across all Units for Section 2.
Figure 10. Distribution of Responses to “Did you read the chapter for this unit?” across all Units for Section 1.

Figure 11. Distribution of Responses to “Did you read the chapter for this unit?” across all Units for Section 2
Figure 12. Distribution of Responses to “Did you read the chapter before coming to class on Monday?” across all Units for Section 1.

Figure 13. Distribution of Responses to “Did you read the chapter before coming to class on Monday?” across all Units for Section 2.
Visual analysis of these data does not reveal any significant differences in any of the study behaviors between conditions. To informally assess the reliability of student self-report of study behavior, tracking information collected by the course management system (WebCT) used for the course was examined. WebCT records the online activity of each student and tracks which materials on the site the student viewed or downloaded. For both the lecture notes and the study objectives, the number of students who accessed or downloaded that document for each unit was compared to the number of students who reported looking at the document on the weekly study behavior questionnaire (students who responded to the relevant study behavior questionnaire with *part of them*, *most of them*, or *all of them* were added together for this latter figure). These data are displayed in Figures 14-17.

![Figure 14. Comparison of Number of Students who downloaded Lecture Slides to Number of Students who reported looking at Lecture Slides for Section 1.](image-url)
Figure 15. Comparison of Number of Students who downloaded Lecture Slides to Number of Students who reported looking at Lecture Slides for Section 2.

Figure 16. Comparison of Number of Students who downloaded Study Objectives to Number of Students who reported looking at Study Objectives for Section 1.
Since performance on the assignments may also vary as a function of study behavior, assignment scores were also examined, but no difference was found between conditions.

Social Validity

Answers to questions on the social validity questionnaire are presented in Figures 18-23.
Figure 18. Distribution of Responses to “Overall, do you think that you learned more with interteaching or lecture?”

Figure 19. Distribution of Responses to “For units taught with lectures, the homework assignments helped me learn the material.”
Figure 20. Distribution of Responses to “For units taught with interteaching, the in-class assignments helped me learn the material”

Figure 21. Distribution of Responses to “How good was your instructor at lecturing?”
Figure 22. Distribution of Responses to “In your college classes in general, how much do you like working with other students during class time?”

Figure 23. Distribution of Responses to “Overall, which teaching method did you prefer?”

For units taught with lecture, 86% of students in both sections combined either agreed or strongly agreed with the statement that the homework assignments helped them learn the
material, and 0% of them disagreed or strongly disagreed (Figure 19). For interteaching, 53% of students agreed or strongly agreed with the statement that the in-class assignments helped them learn the material, and 15% either disagreed or strongly disagreed with the statement (Figure 20). When asked about their preference for one method over the other, 77% of students in both sections combined stated that they either somewhat or strongly preferred lecture and 12% of the students either somewhat or strongly preferred interteaching (Figure 23). Comments from students are in Appendix J.

DISCUSSION

The primary purpose of this study was to examine the role of the collaborative learning component in interteaching. The major findings demonstrate that the collaborative learning component (the “interteach”) did not affect learning outcomes, as measured by weekly exams. In other words, when the other components of interteaching (detailed study objectives, frequent practice opportunities, and frequent exams) were implemented with traditional lecture, replacing the lectures with interteaching’s collaborative learning activities neither increased nor decreased exam scores in a systematic manner. Students also generally preferred lecture over interteaching. These findings contradict previous research on interteaching (Saville et al., 2005; Saville et al., 2006), and are discussed in detail below.

Exam Scores

Comparing mean exam scores across the two conditions revealed practically no difference between lecture and interteaching, both when the combined performance of students in the two sections was examined. Furthermore, differences in the distribution of
letter grades earned with each instructional method are minor, but a few more students earned “As” following lectures than interteaching. These results suggest that interteaching may not be any more effective than a well-designed lecture course that includes known components of effective instruction, such as detailed study objectives, practice opportunities, and frequent exams (Frederick & Hummel, 2004). Previous research has thoroughly documented the importance of these components (see Moran & Malott, 2004).

The results of the current study are not consistent with previous studies on interteaching, which have suggested that students perform better on exams following interteaching sessions than lectures (Saville et al., 2005; Saville et al., 2006). The present results are also not consistent with research on the use of collaborative learning in higher education, which has demonstrated the positive impact collaborative learning can have on student learning (Dees, 1991; Griffin & Griffin, 1998; Keeler & Anson, 1995; Springer et al., 1999). The primary reason for this discrepancy may be that the current study did not compare interteaching or collaborative learning to a “traditional” lecture method. It is likely that collaborative learning is often effective because it promotes active responding and immediate/frequent feedback, while traditional lecture courses provide little opportunity for either. Research has shown that students who are active participants in the learning process, as opposed to passive “receivers of information” during lectures, learn more (Prince, 2004; Yoder & Hochevar, 2005). However, active responding and frequent feedback can be achieved via mechanisms other than collaborative learning. When other elements of effective instruction – such as detailed study objectives, frequent practice opportunities, and frequent exams – are combined with traditional lecture, as they were in
the present study, adding collaborative learning may not result in any further benefits. Much of the previous research compared interteaching or collaborative learning only to traditional lecture methods that did not incorporate other elements of effective instruction or opportunities for active student responding.

It should also be noted that mean exam scores for Section 1 are consistently higher than mean exams scores for Section 2 (Figure 1). This may be due to a number of reasons, but two factors are probably most relevant. First, the instructor for Section 1 had more experience teaching this class (5 semesters) than the instructor for Section 2, who was teaching the class for only the second time. Although the lecture slides in both sections were identical to ensure that the content of lectures was very similar for both sections, the more experienced instructor’s teaching behavior may have been shaped to be somewhat more effective. Second, the entry repertoires of students in the two sections may have been substantially different. The demographic survey administered at the beginning of the class showed that students in Section 1 had a higher average GPA (3.24) than students in Section 2 (2.94). This difference in exam scores between sections, however, is irrelevant to the major findings of this study, as no consistent difference between conditions was found for either section.

The mean exam scores for both sections are also relatively high, raising the concern that a ceiling effect may be reducing the variability of scores and limiting our ability to demonstrate a difference between treatment conditions. While this is a legitimate concern for this study, it does seem that there is enough room for improvement for an effect to be observed. As mentioned above, for example, there is a clearly discernable difference between the scores for Section 1 and Section 2. Although this
difference is not related to the impact of the treatment conditions, it does suggest that the scores, particularly for Section 2, are not so high that an improvement could not be detected.

As described previously, conditions were counterbalanced across two sections primarily to control for material difficulty. The data in Figure 1 illustrate the importance of this control, where drops can be observed in mean exam scores for both sections on the same unit exams (e.g., from exam 4 to exam 5). Without counterbalancing, misinterpretations of the effect of each condition may have been made.

Study Behavior

As a process measure, data were collected on four aspects of student study behavior for each unit. Process measures have not been implemented in previous research on interteaching, and may provide valuable information about how interteaching impacts study behavior outside the classroom. For example, it may be argued that the social contingencies in the interteaching classroom are more likely to encourage students to prepare for class (e.g., reading the chapter) than the contingencies operating in lecture courses. In interteaching, being prepared for class is likely reinforced by praise or approval from peers and being able to successfully complete the interteaching activities, while not being prepared is likely punished by criticism or ridicule from peers and inability to successfully complete the interteaching activities. Such contingencies are rarely in effect for traditional lecture courses. This raises the question of whether any positive effects of interteaching are due primarily to learning taking place inside or outside the classroom.
The present study did not reveal any clear differences across conditions for any of the four self-reported study behaviors: looking at the lecture slides, looking at the unit objectives, reading the textbook chapter before the exam, or reading the textbook chapter before the first class of the unit. One might assume that the relatively strict criteria for earning assignment points (80% accuracy required to earn any points at all) would promote better preparation for interteaching, given the time constraints of the sessions. This does not seem to have been the case in this study (see Figures 12 and 13). Students engaged in similar study behaviors for both conditions, though students in Section 1 read more of the lecture slides than students in Section 2, and students in Section 2 generally read the textbook more often than students in Section 1. The reasons for these differences between sections are not clear and are not particularly relevant to the purposes of this study, but may be due to differences in instructor behavior (e.g., one instructor may have emphasized reading the chapter before class more than the other).

Since study behaviors were self-reported, a measure of reliability was obtained by comparing student tracking data from the online course management system (WebCT) to student responses to two of the questions on the study behavior questionnaire (Figures 14-17). The results of this comparison demonstrate some inconsistencies between accessing the materials and reporting the use of the materials on the study behavior questionnaire, particularly for Section 2. While this is a promising way to assess the reliability of the self-report measure, it is not perfect. Some students may have accessed the online materials but not studied them, for example, while other students may have looked at materials accessed or downloaded by classmates. Nevertheless, the use of the
online tracking data collected automatically by most course management systems should be considered an important source of information about student study behavior.

**Social Validity**

Two measures were employed for social validity purposes. The first measure was student assessment of each class session's utility or value. Ratings on this measure were very similar for both conditions, indicating that students generally did not find interteaching class sessions more or less useful than lecture class sessions.

The second measure was the social validity questionnaire administered at the end of the course. This instrument revealed another important difference from previous research on interteaching. Contrary to the findings of Saville et al. (2006), where 58% of the students somewhat preferred interteaching and 15% strongly preferred lecture in Study 1 and 85% of students preferred interteaching and 0% preferred lecture in Study 2, only 12% of students in the current study either somewhat or strongly preferred interteaching, with 77% preferring lecture over interteaching. Several possible reasons for the strong preference for the lecture condition in the present study are described below.

First, as mentioned previously, the present study did not compare interteaching to a traditional lecture condition. Instead, the lecture condition in the present study included all of the components of interteaching except for the collaborative learning component. Thus, the results of the social validity questionnaire should not be interpreted as meaning students prefer any type of lecture method to interteaching. Rather, they indicate that the students prefer a well-structured lecture method that includes clear study objectives, frequent practice opportunities, and frequent exams over a similar method that includes briefer lectures and collaborative learning.
Second, the response effort during the interteaching condition of the present study was considerably higher than in previous studies. Saville et al. (2006) awarded “quality points” for students simply engaging in on-task behavior during interteaching discussions or for partners answering the same question correctly on the exam, and students were simply instructed to work through and discuss the prep guides during interteaching. In the present study, however, students were required to complete and turn in an assignment sheet (based on the “prep guide” or unit study objectives) during interteaching, and were awarded points based on the accuracy of their responses. This procedure was used primarily to provide roughly equivalent contingencies between the two conditions for contacting the material on the assignment (i.e., completing the homework assignment for the lecture condition or completing the in-class assignment for the interteaching condition). Although scores on homework assignments did not differ significantly from scores on in-class assignments for either section, students seemed to dislike the in-class assignments much more. For the in-class assignments, less than 10% strongly agreed with the statement that the assignment helped them learn the material, while about 15% either disagreed or strongly disagreed with the statement. For the homework assignments, none of the students strongly disagreed or disagreed that the assignment helped them learn the material, while close to 40% strongly agreed with the statement. In their comments on the feedback forms and social validity questionnaire, some students indicated that they often felt rushed or frustrated during interteaching, and disliked being dependent upon their partner’s preparation and pacing.

Third, a sizable portion of the students seemed to dislike working with other students in general. When asked whether they liked working with other students during
class time in their college classes, nearly half of the students indicated that they did, but approximately 30% of them either reported that they disliked it or strongly disliked it. This distaste for collaboration can be related to the composition of the collaborative pair or group, as high-performing students can have negative attitudes toward participation in heterogeneous groups (e.g., Engelhard & Monsaas, 1989). When low-performing students pair up with high-performing students, pacing becomes an issue. The pair is likely to progress too quickly for one student or too slowly for the other student. This effect seemed evident in the comments of students who expressed frustration with the level of preparedness or competence of their partners.

Finally, students may have expressed a preference for the lecture condition simply due to resistance to change (Dembo & Seli, 2004). Quite a few students said that they did not like interteaching because teaching should involve an instructor delivering lectures, not individual assignments during class. Other students commented that they should not have to teach themselves. These arguments illuminate part of the difficulty in implementing new teaching methods. Students have been exposed to the common lecture method of instruction for years, particularly by the time they reach higher education. When a new method is introduced, especially one that increases the in-class response effort, students may have a hard time adjusting to or accepting the change (Dembo & Seli).

Administrative Issues

Developing and managing an interteaching course can be very labor intensive and time consuming. Although Boyce and Hineline (2002) note that the development of any new course can be resource intensive, managing an interteaching course still seems to
require more effort than a traditional course, particularly for larger classes. A number of teaching assistants are required to adequately assist students during class, someone must keep track of and record quality or assignment points, and the interteaching records (feedback forms in the current study) must be read and used to prepare lectures. Since the brief lectures are based on comments from the interteaching records, it also becomes impossible for the instructor to prepare the lecture very far in advance. If one assigns quality points based on exam questions answered correctly by both interteaching partners (a method not implemented in the current study, but recommended by Boyce and Hineline), grading exams can also become more complex and time consuming. Thus, the time and effort required to manage and maintain an interteaching course may be detrimental to its widespread adoption and should be examined more closely.

**Future Directions**

This study attempted to answer an important question about the role of one of the components of interteaching. The findings of the current study raise a number of issues related to the implementation of interteaching as an instructional method. These issues are all empirical in nature and should be examined further in future studies.

The first issue is one of external validity: would similar results be obtained if the study were replicated in other content areas? The content of a statistics course is quite different from courses that can be considered more “conceptual” in nature, such as a course on the principles of learning. Therefore, it might be assumed that different motivational variables operate in these classes. For example, students may have more interest in the topics covered in an abnormal psychology class compared to an
introductory statistics class, and thus they might contact the material more frequently outside of class and more readily engage in discussion about the material during class.

In addition, the nature of the interteaching sessions and the role of quality or assignment points in relation to them should be studied further. As noted earlier, interteaching sessions in the present study were more structured and required a higher response effort than interteaching sessions in previous research. It is unknown what effect this variation in the nature of the interteaching sessions and quality/assignment points may have had on student learning or attitudes. Zinn and Saville (2007) recently demonstrated that when quality points are implemented in the manner outlined by Boyce and Hineline (2002), they appear to have little effect on exam scores. Additional research on the manner in which quality points are assigned in interteaching and the structure of the collaborative learning sessions is clearly needed.

Another component of interteaching that should be examined in more detail is the interteaching record. The interteaching record allows students to provide the instructor with feedback and a list of topics they found difficult and would like to have covered during the brief lecture in the next class period. This component was implemented via the feedback forms in the current study, but it is not clear whether students benefit from this way of “manding” for information. The impact of this strategy may be minimal, as there are other ways for students to get such information (e.g., interacting with the instructor or TAs via interteaching sessions or via office hours and email), but it may function as a motivative variable (Lloyd et al., 1972).

A number of students in the present study suggested that lectures could be given on Mondays and interteaching sessions could be conducted on Wednesdays, and
indicated that they would have liked interteaching more if this format would have been used. This format seems appealing, as it would allow students to observe the instructor model the correct responses during lecture on Monday and then have the opportunity to practice and receive immediate feedback on those responses during interteaching on Wednesday. It would be worthwhile to investigate the effectiveness of hybrid formats of this sort.

Finally, the manner in which feedback is delivered to students during interteaching sessions should be examined more closely. It is presumed that part of the value of interteaching sessions is that students are able to obtain immediate feedback on their performance from TAs or the instructor. In this study, however, students frequently did not ask for assistance or feedback during the interteaching sessions. Thus, students often progressed through the in-class assignment and handed it in for grading without any feedback from TAs or the instructor. This may have caused problems for some students who made errors on the assignment that were not corrected before the exam. Developing and evaluating a more thorough and systematic way of providing all students with feedback during interteaching would be valuable.

CONCLUSION

Interteaching has been presented as a feasible alternative to the traditional lecture format (Boyce & Hineline, 2002; Saville et al., 2006), and it may very well be. This study, however, was not able to identify any advantages of interteaching when it is compared to a well-designed lecture class that includes detailed study objectives, practice opportunities, and frequent exams. Interteaching is presented as a combination of several
components, and ideally each of those components should contribute to the effectiveness of the method. For any “package” intervention, component analyses such as this one reveal valuable information about which components are needed and which components may be redundant.

Understanding the role of the “interteach” in interteaching is particularly important because using collaborative learning in a class can be a logistical challenge: a larger classroom may be needed, care must be used in composing the groups, and methods of tracking individual and group performance must be determined. In addition, the use of collaborative learning can drastically change the setting in which most students are used to working. The current study provides little justification for introducing collaborative learning and its challenges into a well-designed lecture course.

Behavior analysis has contributed immensely to education and has enabled teachers and students to achieve their goals in many different settings. The empirical approach of behavior analysis has resulted in extensive research on the development and evaluation of effective and efficient teaching methods (Moran & Malott, 2004). Interteaching is a promising method recently introduced by behavior analysts, but it is in need of further refinement and evaluation to maximize its effectiveness and social validity. This study was an important step toward that end, and it is hoped that future research will result in continuous improvements to interteaching and a better understanding of how its components contribute to its success.
REFERENCES


Appendix A

Demographic Information 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's 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: ________
Appendix B
Course Syllabus
PSYCHOLOGY 3000: STATISTICS FOR THE BEHAVIORAL SCIENCES

WESTERN MICHIGAN UNIVERSITY
COURSE SYLLABUS
SPRING 2007

COURSE INFORMATION

Meeting Time: Mon | Wed | Fri
11:00am – 11:50am

Location: Wood Hall Room 2722

Instructor: Thorhallur (Thor) Flosason
Email: thorhallur.o.flosason@wmich.edu
Phone: (269) 381-1993
Office: Wood Hall Room 1507

Office Hours: Mondays, 11:00-12:00am
Thursdays, 2:00-3:00pm
or by appointment

Teaching Assistant: Thomas Baker
Email:
Phone:
Office: Wood Hall Room 2722

Office Hours: TBA

Teaching Assistant: Jordan Silbert
Email:
Phone:
Office: TBA

Teaching Assistant: Angela Soule
Email:
Phone:
Office: TBA

COURSE OVERVIEW

This course is primarily concerned with the concepts of introductory statistics. Statistics might seem to be a boring subject to some, and some people are scared of the math involved in statistics. Ultimately, however, statistics is not about numbers or formulas or sampling theory – it is about life. Statistics are used to help us determine whether or not something we’ve done was effective, and whether something we’ve observed can be applied to new or different situations or people. If we observe something wonderful or horrible happen to someone, for example, statistics can help us understand how likely that event is to happen to us, our loved ones, or our clients. This kind of knowledge can allow us to plan for the future, achieve our goals more effectively or efficiently, allocate our resources in the best manner possible, and hopefully live better lives. Just try to

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remember that as you learn about all of the painfully boring statistical formulas and concepts.

In this course we will consider in detail various descriptive statistics such as the measures of central tendency and variability, and we will examine distributions of data as they relate to z-scores and probability. Inferential statistics in the form of hypothesis testing with t-tests and the analysis of variance (ANOVA) will be covered, and correlation will be introduced.

**Course Format**

Two different teaching methods will be used for this course. Some units will be taught with a traditional lecture format, and others will be taught with a collaborative learning format called "Interteaching." The Course Calendar indicates which teaching method will be used for each unit. When we use Interteaching, you will receive only a brief lecture (about 10 minutes) and then you will spend the remainder of class time working with a partner to complete an assignment (consisting of statistical problems and other questions) based on that unit's material. At the end of class, you will complete an "Interteaching Record" on which you will rate the quality of your work, identify any topics you found particularly difficult, and list any topics or issues you would like the instructor to address in the next class. When we use lecture, you will be required to complete similar assignments on your own at home. The number of points available for each unit (for attendance, assignments, and exams) is the same regardless of which teaching method we are using.

**Text & Materials**

The following materials will be used for the course, and are available at the WMU and University Bookstores:


**Website**

A course website will be maintained with the following key features:

- Course materials – a variety of materials are available, including the syllabus, PowerPoint slides from lectures, and exam study guides
- Gradebook – all scores and grades will be available online (exam scores will typically be available within 24 hours)

You can access the course website via GoWMU [http://gowmu.wmich.edu] by clicking on the "My E-Learning WebCT Vista" link on your home page. If you have problems accessing or using the course website, check here the WMU elearning website [http://www.wmich.edu/elearning] for help or report a problem using their online form [http://www.wmich.edu/vista/problem-report-form.html].
Because we use the course website and email extensively in this course, you should check the course website and your WMU email address **every day** during the semester to ensure that you do not miss any important announcements.

**GRADE**

Your course grade is determined by the total number of points you accumulate on:

- **Exams** (12 weekly exams at 35 points each) = 420.0 points
- **Math Review Quiz** (5 points) = 5.0 points
- **Attendance** (25 classes at 1.5 points each) = 37.5 points
- **Assignments** (25 assignments at 1.5 points each) = 37.5 points

**500.0 TOTAL POINTS**

The course letter grade is related to the point total as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>A</th>
<th>BA</th>
<th>B</th>
<th>CB</th>
<th>C</th>
<th>DC</th>
<th>D</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>Percent</td>
<td>90%</td>
<td>85%</td>
<td>80%</td>
<td>75%</td>
<td>70%</td>
<td>65%</td>
<td>60%</td>
<td>&lt; 60%</td>
</tr>
</tbody>
</table>

**EXAMS**

These will consist mainly of matching, multiple-choice, short-answer essay questions, and computational problems. These questions are directly related to study objectives we will provide online. Please note: The exams may be based on **all** of the study objectives, whether they are discussed during lecture or not (unless I direct you specifically to ignore a particular study objective). For some exams, it will be necessary for you to use certain statistical tables. These tables will be provided for you at the time of the exam.

Exams begin at 11:00am, and you will have until 11:50am to complete the exam. Once one person has completed the exam and left the room, **no one will be allowed to begin the exam**. Therefore, if you consistently arrive late, you run the risk of missing the exam altogether.

**CALCULATORS**

You may use a calculator for the exams, but graphing calculators and other types of calculators that store information are **NOT ACCEPTABLE**. Simple calculators that perform the statistical operations necessary for this class are available at Meijer and other such stores for $5 - $15. You will need a calculator that can calculate square roots. If you have questions about the acceptability of your calculator, show it to me **before the first exam**. The use of unacceptable calculators will be considered cheating (see policy below). Bring your calculator to **every class**, as we will do practice activities that require its use. You will **not** be allowed to use your cell phone as a calculator during exams.
FORMULAS
We will be using several statistical formulas throughout the semester. You will be required to memorize some of the simpler formulas, but more complex formulas will be provided for you during the exams. Formulas to be provided will be announced during lecture. Keep in mind that although some formulas will be provided, you will still need to learn how to use them and know when their use is warranted.

EXAM RETURN
Graded exam answer sheets will usually be returned at the beginning of the following class meeting. Exam scores typically will be available on the course website within 24 hours after the exam is taken. You should always compare your answer sheet grade with the website grade to make sure your grade has been recorded correctly!

EXAM RE-GRADE POLICY
After exams have been graded and returned, you may submit your exam for re-grading if you believe that it was not graded accurately. Re-grade requests must be submitted in writing within one week after the exams have been returned. Your request should identify the question(s) you believe should be re-graded and the reason(s) why you believe more points should be awarded. References to relevant material in your textbook (page and paragraph) or to specific lecture material will make it easier to evaluate your request. Attach your exam answer sheet to your re-grade request. When evaluating a re-grade request, I will review both the test item and my grading criteria.

MATH REVIEW QUIZ
During the first unit, you will be required to complete a Math Review Quiz to assess your basic math skills. This quiz will be similar in content and format to the “Skills Assessment Preview Exam” found in Appendix A of your textbook. To study for this quiz, you should read Appendix A to review and master the material it contains.

ATTENDANCE AND REMEDIAL EXAMS
You will earn 1.5 points for each class you attend, excluding exam days. Assignments will also be distributed or worked on during class.

If you miss a class, you will be responsible for any lecture material presented and any announcements made during class. You will also not be able to receive any credit for the assignment distributed or worked on during that class. Thus, you will essentially lose a total of 3 points for each class you miss: 1.5 attendance points and 1.5 assignment points. There is a strong correlation between class attendance and high exam grades. Very few students earn a good grade in this course without attending class regularly.

If you are absent from an exam for any reason (illness, a family emergency, a funeral, car trouble, oversleeping, etc.) you will receive a score of zero for that exam. In some circumstances, you may arrange with the instructor to take an exam early (before the scheduled class exam). Contact the instructor if you would like to arrange to take an exam early.
Two remedial exams will be given during the semester: one in the middle of the semester and the other at the end of the semester (see Course Calendar below for exact dates). You can use your score on remedial exams to replace missing or low exam scores. The first remedial exam will review material covered in Units 1 through 6, and the remedial exam score can only be used to replace a zero or a low score on Unit Exams 1 through 6. The second remedial exam will review material covered in Units 7 through 12, and that remedial exam can only be used to replace a zero or low score on Unit Exams 7 through 12. If your remedial exam score is lower than your lowest score, it will not be used. In other words, the remedial exam can only help you, not hurt you.

No other makeup exams will be given for any reason—this is a strict and non-negotiable policy, and it is best not to miss any exams. Remember that the remedial exams are cumulative and more difficult than regular unit exams. If you are satisfied with all of your exam scores, you do not have to take the remedial exams.

ASSIGNMENTS

Each class you will be given an assignment to complete (25 total assignments across the course of the semester). When we are using Interteaching, you will complete the assignment in class with a partner. When we are using lecture, you will complete the assignment at home and turn it in at the next class meeting. Each assignment is worth up to 1.5 points. To earn any points at all for the assignment, you must answer 80% of the questions correctly. Here is the breakdown on how assignment points are earned:

- < 80% correct = 0.0 points
- 80-85% correct = 0.5 point
- 85-95% correct = 1.0 point
- 95-100% correct = 1.5 points

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. Incompletes are only given when a student who is passing 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 illness). Contact the instructor as soon as possible if you believe you need (and are eligible) to take an Incomplete for the course.

ACADEMIC DISHONESTY

You are responsible for making yourself aware of and understanding the policies and procedures in the Undergraduate Catalog (pp. 274-276) that pertain to Academic Honesty. These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity, and computer misuse. In this course cheating includes, but is not limited to, using your notes or the textbook during the exam, looking at another student’s exam answers, and using an unacceptable calculator during an exam.

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. **Any student found to be responsible for the act of academic dishonesty will be given a failing grade in the course and may be suspended or expelled from the university.**

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**EMERGENCY CLASS CANCELLATION**

In the event that classes are officially canceled (due to weather, rioting, rip in the space-time continuum, etc.), the following schedule will be automatically in effect:

1. If the class day canceled is a day on which an exam was scheduled, the exam will be given on the first class day when classes resume.
2. If the day canceled is a lecture day immediately prior to an exam day, the exam will be given on the first class day when classes resume.

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**AMERICANS WITH DISABILITIES ACT**

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 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 Disabled Student Services on campus, get a note from them outlining any special attention you may need, and bring that to me as soon as possible. I will make every effort to provide any accommodations necessary.

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**SUCCESS IN THE COURSE**

To be successful in this course, you should:

1. Buy the textbook, study guide, and an acceptable calculator right away.
2. Read the relevant text material **before** coming to class and come prepared with any questions you have about the material.
3. Review and master the information and skills identified in the exam study objectives each week.
4. Re-do every online self-quiz until you achieve a perfect score.
5. Do the practice problems in the textbook and study guide for each unit, and any extra-credit assignments provided.
6. Contact the instructor or TA whenever you have questions about material (either via phone, email, or office hours) or feel that you are struggling in the course!
7. Check your WMU email account and the course website every day for important course announcements.
The class will meet every Monday, Wednesday, and Friday from 11:00am to 11:50am as outlined below. This schedule is subject to change at the instructor's discretion.

<table>
<thead>
<tr>
<th>Class Format</th>
<th>Mondays</th>
<th>Wednesdays</th>
<th>Fridays</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interteaching</strong></td>
<td>January 8 Course Overview</td>
<td>January 10 UNIT 1 Lecture (Ch. 1 &amp; 2)</td>
<td>January 12 UNIT 1 Lecture (Ch. 1 &amp; 2)</td>
</tr>
<tr>
<td><strong>Interteaching</strong></td>
<td>January 15 MLK Day – No Classes!</td>
<td>January 17 UNIT 1 Lecture (Ch. 1 &amp; 2)</td>
<td>January 19 UNIT 1 Exam</td>
</tr>
<tr>
<td><strong>Lecture</strong></td>
<td>January 22 UNIT 2 Lecture (Ch. 3)</td>
<td>January 24 UNIT 2 Lecture (Ch. 3)</td>
<td>January 26 UNIT 2 Exam</td>
</tr>
<tr>
<td><strong>Lecture</strong></td>
<td>January 29 UNIT 3 Lecture (Ch. 4)</td>
<td>January 31 UNIT 3 Lecture (Ch. 4)</td>
<td>February 2 UNIT 3 Exam</td>
</tr>
<tr>
<td><strong>Interteaching</strong></td>
<td>February 5 UNIT 4 Lecture (Ch. 5)</td>
<td>February 7 UNIT 4 Lecture (Ch. 5)</td>
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<td><strong>Lecture</strong></td>
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<td>February 14 UNIT 5 Lecture (Ch. 6)</td>
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<td>February 21 UNIT 6 Lecture (Ch. 7)</td>
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<td><strong>Lecture</strong></td>
<td>February 26 Remedial Exam Review</td>
<td>February 28 Remedial Exam 1</td>
<td>March 2 Spirit Day – No Classes!</td>
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<td>March 7 Spring Break – No Classes!</td>
<td>March 9 Spring Break – No Classes!</td>
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<td>April 4 UNIT 10 Lecture (Ch. 11)</td>
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Remedial Exam 2*  
Monday, April 23  
10:15am – 12:15am

*this exam is given during our final exam time
## Units

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<tr>
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<tr>
<td>Unit 1</td>
<td>Chapter 1 - Introduction to Statistics and Chapter 2 – Frequency Distributions</td>
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<td>Unit 2</td>
<td>Chapter 3 - Central Tendency</td>
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<td>Unit 3</td>
<td>Chapter 4 - Variability</td>
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<td>Unit 4</td>
<td>Chapter 5 – z-Scores</td>
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<td>Chapters 6 – Probability</td>
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<td>Chapter 7 - Probability and Samples</td>
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<td>Unit 7</td>
<td>Chapter 8 - Introduction to Hypothesis Testing</td>
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<td>Chapter 10 – The t Test for Two Independent Samples</td>
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<tr>
<td>Unit 10</td>
<td>Chapter 11 – The t Test for Two Related Samples (NOTE: Skip chapter 12!)</td>
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<tr>
<td>Unit 11</td>
<td>Chapter 13 - Introduction to Analysis of Variance (NOTE: Skip chapter 14!)</td>
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<td>Unit 12</td>
<td>Chapter 15 – Correlation and Regression</td>
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Appendix C

Sample Study Objectives
Unit 5 – objectives

Reminder: The answers to the odd-numbered problems are located at the end of the text. If you have trouble with any even-numbered problems, ask about them during lecture or come to office hours.

Bold letters in Study Objectives indicate where to look in the Gravetter & Wallnau book for the material in a given study objective. The first letter refers to page number, and the second number refers to paragraph number. If a page starts with a paragraph continued from the previous page, the first new paragraph on the new page is #1.

Chapter 6:

1. In Chapter 6, you are beginning to make the transition from descriptive statistics to inferential statistics. Recall the goal of inferential statistics. The transition into inferential statistics is possible because frequencies or proportions in a population or sample can be translated into probabilities. Defining the relationships between the sample and the population is then possible.

2. The explanation of how probability serves to connect samples and populations and eventually leads to inferential statistics is a good one; it will aid your understanding of the purpose of this unit. Read it, but there will be no exam questions over this material.

3. Learn the definition of probability. You may use the fraction shown on page 131. Read 131,2 to 132,0; be able to calculate probabilities in simple examples like these for the exam.

4. Make certain you are familiar with the notation system for probability. Note how the text restates a probability problem as a proportion problem. Probabilities may be expressed as (a) fractions, (b) decimals, or (c) percentages. Note that the terminology of samples and populations will not change the basic definition of probability.

5. What is the probability for (a) an outcome that will never happen? (b) an outcome that will always happen?

6. Learn the two requirements of random sampling. Read about the interesting consequences of these two requirements (132,3 to 133,1); however, there will be no exam questions over these consequences.

7. Know how to compute the probability of an outcome from a frequency distribution table. Example 6.1, pages 133-134

8. Examine Figure 6.4 on page 135- a normal distribution after a z-score transformation. Learn this important point: Any normal distribution, regardless of its mean and standard deviation, will translate to a normal distribution with a mean of zero and a standard deviation of one when the X scores are converted to z-scores. This will make it possible to answer probability questions. Example 6.2, pages 136-137, will give you an idea of the type of questions we will be dealing with.
9. Understand and master the use of the unit normal table. A complete unit normal table is provided in Appendix B on pages A23-A26 in the back of the text. Pay attention to the column headings. This requires that you correctly identify the area under the distribution that you are evaluating. You must be very careful to interpret the questions correctly. Also remember the unit normal table only lists one half of the values for a normal distribution. However, due to the symmetrical shape of the normal distribution, this is not a problem. Further, due to this symmetry you could imagine negative signs in front of every z-score in the table (in other words, use the table the same with positive and negative z-scores). 137.1 to 138.0

10. An important word before you begin computations: I strongly recommend that you sketch the distribution, locate the mean, and shade in the proportion or area of the graph which you will attempt to identify for each problem. This habit may limit careless errors students frequently make on exams.

11. For the exam, you should be able to perform the following types of computations:

(a) finding proportions/probabilities for specific z-score values. Examples 6.3A-C, pages 138-139
(b) finding the z-score that corresponds to a specific proportion. Examples 6.4A-B, pages 140-141
(c) finding probabilities/proportions for specific raw scores (X values). Example 6.5, pages 142-143
(d) finding proportions/probabilities located between two scores. Example 6.6, pages 143-144
(e) finding scores corresponding to specific proportions/probabilities. Example 6.7, pages 144-145.

END CHAPTER SIX OBJECTIVES
Appendix D

Sample Assignment
Show all calculations were relevant!

1. What is the difference between independent-measures designs and repeated-measures designs?

2. For the following data, calculate the value of $M_D$ and $SS$

<table>
<thead>
<tr>
<th>Participant</th>
<th>Score before treatment</th>
<th>Score after treatment</th>
<th>D</th>
<th>D^2</th>
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<tr>
<td>A</td>
<td>8</td>
<td>10</td>
<td></td>
<td></td>
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<td>E</td>
<td>7</td>
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</tr>
</tbody>
</table>

3. A researcher would like to conduct a study comparing two treatment conditions with 30 individuals measured in each treatment.
   a. How many subjects would be needed if the researcher uses independent-measures design?
   b. How many subjects would be needed if the researcher uses a repeated measures design?
   c. How many subjects would be needed if the researcher uses a matched-subjects design?
4. What information does the D score for each subject in a sample provide?

5. What is it called when the effects of one treatment influence the scores in a second treatment?

6. For the following data, calculate df, M_D, and SS

<table>
<thead>
<tr>
<th>Participant</th>
<th>First treatment</th>
<th>Second treatment</th>
<th>D</th>
<th>D^2</th>
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<tbody>
<tr>
<td>A</td>
<td>6</td>
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<tr>
<td>E</td>
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</tr>
</tbody>
</table>

7. A psychologist conducts a study on the effectiveness of a new reading program. The control group consists of n = 4 students who are provided with regular reading instruction. Another sample of n = 4 students receive the new program. The subjects in the experimental group are matched one-to-one with subjects in the control group, based on their reading achievement scores from the previous year. Based on the data below, would you conclude that the special program has a significant effect on reading scores? (state the hypothesis, and include df, the critical region, MD, SS, the t-value, your decision to retain or reject H0, and if you reject H0 calculate Cohen's d). Use a two-tailed test with alpha = .05

<table>
<thead>
<tr>
<th>Pair</th>
<th>Control</th>
<th>Experimental</th>
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<tbody>
<tr>
<td>A</td>
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<td>12</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>C</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>D</td>
<td>18</td>
<td>20</td>
</tr>
</tbody>
</table>
1. A repeated-measures study obtains two sets of data from one sample by measuring each individual twice, but an independent-measures study uses two separate samples to obtain two sets of data (1 point)

2. $M_D = 4$ (1 point), $SS = 54$ (1 point)

3. a. 60 subjects (1 point)
   b. 30 subjects (1 point)
   c. 60 subjects (1 point)

4. It provides an indication of how much difference there is between the two treatments (1 point)

5. Carry-over effects (1 point)

6. $df = 4$ (1 point). $M_D = 1.2$ (1 point), $SS = 2.8$

7. $H_0: \mu_D = 0$ (1 point)
   $H_1: \mu_D \neq 0$ (1 point)
   $df = 3$ (1 point)
   Critical region: +/- 3.182 (1 point)
   $M_D = 4$ (1 point)
   $SS = 48$ (1 point)
   $t = 2$ (1 point)
   Fail to reject $H_0$ (1 point)

Total points: 18
Appendix E

Feedback Form for Lecture
Feedback Form – Lecture

Student:

Today’s lecture was valuable/helpful (circle one):

- Strongly Agree
- Disagree
- Neutral
- Agree
- Strongly Agree

What topics in the lecture were difficult, and why?

Comments or suggestions?
Appendix F

Feedback Form for Interteaching
Feedback Form – Interteaching

PSY 3000
Statistics for the Behavioral Sciences

March 14, 2007
Unit 7

Students:

Duration of session: _______ Sufficient time: YES NO

Items on assignment completed: ______ out of _______

Today’s interteaching session was valuable/helpful (circle one):

Strongly Agree
Disagree Neutral Agree Strongly Agree

What items on the assignment were difficult, and why?

What topics would you like to have clarified in next class?

Comments or suggestions?
Appendix G

Study Behavior Questionnaire
Please circle an answer for each of the questions below.

<table>
<thead>
<tr>
<th>Question</th>
<th>Not at All</th>
<th>Part of Them</th>
<th>Most of Them</th>
<th>All of Them</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you look at the lecture notes (posted online) for this unit?</td>
<td>Not at all</td>
<td>Part of them</td>
<td>Most of them</td>
<td>All of them</td>
</tr>
<tr>
<td>Did you look at the study objectives for this unit?</td>
<td>Not at all</td>
<td>Part of them</td>
<td>Most of them</td>
<td>All of them</td>
</tr>
<tr>
<td>Did you read the chapter for this unit?</td>
<td>Not at all</td>
<td>Part of it</td>
<td>Most of it</td>
<td>All of it</td>
</tr>
<tr>
<td>Did you read the chapter before coming to class on Monday?</td>
<td>Not at all</td>
<td>Part of it</td>
<td>Most of it</td>
<td>All of it</td>
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<tr>
<td>Did you seek any help from a TA or the instructor outside of class (email, phone, meeting) for this unit?</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you study for this unit with friends or other students (e.g., a study group)?</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
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</table>
Appendix H

Social Validity Questionnaire
<table>
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<tr>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
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<tr>
<td>Overall, do you feel you learned more with interteaching or with lecture?</td>
<td></td>
<td></td>
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<tr>
<td>How good was your instructor at lecturing?</td>
<td>very bad</td>
<td>bad</td>
<td>neither good nor bad</td>
<td>good</td>
<td>very good</td>
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<tr>
<td>For units taught with interteaching, the in-class assignments helped me learn the material</td>
<td>strongly disagree</td>
<td>disagree</td>
<td>neutral</td>
<td>agree</td>
<td>strongly agree</td>
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<tr>
<td>For units taught with lecture, the homework assignments helped me learn the material</td>
<td>strongly disagree</td>
<td>disagree</td>
<td>neutral</td>
<td>agree</td>
<td>strongly agree</td>
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<td>In your college classes in general, how much do you like working with other students during class time?</td>
<td>strongly dislike it</td>
<td>dislike it</td>
<td>neutral</td>
<td>like it</td>
<td>like it a lot</td>
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<td>Overall, which teaching method did you prefer?</td>
<td>strongly prefer interteaching</td>
<td>somewhat prefer interteaching</td>
<td>no preference</td>
<td>somewhat prefer lecture</td>
<td>strongly prefer lecture</td>
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<td>If you preferred one method over the other, why did you prefer that method?</td>
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Appendix I

Sample Interobserver Agreement Sheet
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</table>
Total agreements:  
Total disagreements:  

**Formula:**

\[
\text{IOA} = \frac{\text{Agreements}}{\text{Agreements} + \text{Disagreements}} \times 100
\]

Signatures:

Grader 1:

Grader 2:

IOA calculation:

**Directions for using the IOA sheet**

For each item on the answer key, there is a corresponding number on this assignment sheet. Using the answer key, circle the number for each item that indicates points earned for that item.
Appendix J

Student Comments
Social Validity Questionnaire

Numbers in parenthesis indicate the student's preference:
1. Strongly prefer interteaching
2. Somewhat prefer interteaching
3. No preference
4. Somewhat prefer lecture
5. Strongly prefer lecture

Section 1

Student #1: (5) "Lecture, everything was more clear cut and I understand the material better with explanations in lecture."

Student #2: (2) "Interteaching allowed me to better grasp the concepts; if I had any questions about the assignment I was able to get direct assistance."

Student #3: (3) "Neither. Both had good + bad."

Student #4: (3) "No one is going to read before class. So you end up with kids who don't know anything. Monday lecture, Wednesday elaborate (sic) add more material and interteach. Fri test."

Student #5: (3) "I liked the combination of both."

Student #6: (4) "Lecture is more thorough with such a hard topic as stats."

Student #7: (4) "I felt rushed to finish the assignment with interteaching."

Student #8: (4) "Because sometimes you get paired with someone who is not prepared and it's frustrating when you need their input."

Student #9: (4) "With interteaching, sometimes I relied on the other person. They were wrong ½ of the time."

Student #10: (4) "I preferred interteaching a bit more because I was able to apply what I learned immediately instead of doing the homework before class, like this morning. (This student actually preferred lecture, according to his rating)"

Student #11: (4) "I somewhat preferred lecture because it gave me more time to complete homework assignments."

Student #12: (4) "I just seemed to get better grades on the lecture assignments, rather than interteaching assigns. Usually, two minds work better than one, but not in this case for me."
Student #13: (4) "I preferred lecture because if I did not understand the material and my partner did they would just do the assignment to get it done instead of helping me understand, whereas with lecture I could go over it on my own and actually understand it."

Student #13: (4) "Interteaching did not help me learn sometimes if the other student was writing (have both partners turn a sheet in."

Student #15: (4) "The instructor was great at teaching the material through lecture."

Student #16: (5) "More time to concentrate + learn with homework rather than interteaching."

Student #17: (5) "Lecture allows me to absorb more material. Taking homework home also allows me to work at my own pace and take my time with the material."

Student #18: (5) "I felt that with interteaching was rushing the material and I felt rushed to finish the assignments in class. With lecture I was able to take my time completing and understanding the material better at home."

Student #19: (5) "I preferred lecture because I learned the material better and didn’t have to work at someone else’s pace."

Student #20: (5) "I wrote you a letter about my thoughts on interteaching that I hope you received."

Student #21: (5) "I hate working with other people. It seemed like the interteaching assignments were a tad more difficult."

Student #22: (5) "I felt too rushed in interteaching so I was not confident in my work. I had to teach the material to myself at home."

Student #23: (5) "I didn’t like interteaching because I like to be able to look at the assignment and go over them to make sure I understand what I am doing."

Student #24: (5) "Because it allowed me to review the material on my own and understand it rather that speed through problems w/o grasping them."

Student #25: (5) "You teach well and your assignments are good teaching tools... I feel like interteaching could be good if you didn’t do a good job at lecturing and making homework."

Student #26: (5) "Interteaching was frustrating because one person usually did all of the work. I hate depending on other people to know the info."
Student #27: (5) “I’m so used to lecturing already that when you take away the majority of what I’d be learning that day just to work with someone, it just didn’t work. Plus, I’m not very good at reading and reviewing notes before class.”

Student #28: (5) “With interteaching everybody tried to rush through and get out early. When I had homework I could take it home, look it over and work on in at my pace and strategies and could understand the material better. Also with interteaching, one student would do the work and the others generally would not.”

Section 2

Student #1: (1) “Because it made me learn it and focus. Any questions I had I could ask during class.”

Student #2: (1) “I understood the material more during interteaching and the assignments were more helpful because I knew I did them right.”

Student #3: (1) “I thought it was helpful to talk out the material with others. Helped me learn better.”

Student #4: (2) “I like working with a partner and not having homework.”

Student #5: (2) “I liked being able to compare and discuss answers.”

Student #6: (2) “Working with others helped me learn the materials faster.”

Student #7: (3) No comment

Student #8: (3) “I think either one has its benefits to me.”

Student #9: (3) No comment

Student #10: (4) “I liked the combination of both, but full lecture is nice so we learn all materials.”

Student #11: (4) “I preferred lecture because I tend to learn the material mostly from HW and + when I do the HW by myself I make sure I know how to do all of it myself.”

Student #12: (4) No comment

Student #13: (4) No comment

Student #14: (4) “I didn’t like working with a different person each class time, but if you let us reuse partners I would have liked it.”
Student #15: (4) "Lecture because I just to better taking my time and teaching myself."

Student #16: (4) "I would like to see lecture on Monday, interteaching on Wednesday, and testing on Friday."

Student #17: (4) "Going back to homework allows me to revisit the formulas and makes me do the work again."

Student #18: (4) "I could take more time on something I didn’t understand and look it up in the book for lecture homework. With interteaching I felt rushed."

Student #19: (5) "I like the lecture for the fact that you have HW to look over and use at home for study purposes. Having the HW on-hand helps to see what will be on the test better than interteaching."

Student #20: (5) "With lecture more material was covered in class and I had time to do the homework on my own at home that way I figured out all the answers on my own."

Student #21: (5) "If I do it myself I have more time to think through the problems more."

Student #22: (23) "The lecture method allow one to take homework home and not feel rushed to finish it."

Student #23: (5) "The one thing I liked about interteaching was that there was time provided in-class for practice. However, I often felt I was doing all of the explaining or and it often took too much time when I could have done it much faster on my own."

Student #24: (5) "For learning, take home assignments are much more effective. Problems generally are more (illegible), and you can take all the time necessary to grasp a concept if needed. However, it is very nice to be able to interact with students via interteaching."

Student #25: (5) "I preferred lecture because I learned better when I took the homework home and had it to review."

Student #26: (5) "In lecture there is more time to go over information, ask questions, we take the homework home and have time to ingest what we are doing. It is rushed, not enough time in 50 minutes for it. Personally I didn’t like interteaching because if you work with a person who equally does not understand the work it doesn’t help. If we were to do lecture on 1 day then interteaching on the other"
Appendix K

HSIRB Approval Letter
Date: November 29, 2006

To: Eric Fox, Principal Investigator
Thorhallur Flosason, Student Investigator for thesis

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number: 06-11-20

This letter will serve as confirmation that your research project entitled “The Role of the Intereach in Inte.teaching” 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: November 29, 2007