APPLYING THE LEARNING-BY-TEACHING METHOD IN A CLASSROOM SETTING

by

Savannah Cain

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Thesis Committee:

Dr. Michael Hein, Chair

Dr. Aimee Holt

Dr. Mark Frame

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ABSTRACT

Learning-by-teaching has been shown to be an effective strategy for learning material however, research in the area has been inconsistent. Studies have found that those who prepare to teach or engage in teaching can exhibit increased learning gains, compared to those who simply study material. Learning-by-teaching research has primarily been studied in the lab, and when it has been studied in the classroom, it was done via a computer system. The present study looked to examine if the learning-by-teaching method could lead to increased learning gains in a classroom setting. The effects of learning-by-teaching on learning were examined, as well as if time spent engaging in learning-by-teaching and the quality of output effected learning gains. The results did not indicated that engaging in the learning-by-teaching did not provide greater learning gains than simply studying the material. However, a meaningful difference in means from exam one to exam two was found in one of the conditions, thus providing evidence that learning-by-teaching can be an effective method to use in the classroom.

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CHAPTER I: INTRODUCTION

Overview

Learning has become an institution in most cultures. As the world has become more advanced, learning is not just taking place in the traditional classroom, but it is occurring in the workplace, via the internet, in social groups, etc. Workers are demanding more learning opportunities from their employers, but it is often times overwhelming to determine which of the learning strategies is best for a specific environment. Many different learning strategies have been studied over the years to determine what is the most effective way to not only learn, but teach material. Early research in learning discovered that tutors can show learning gains that are greater than those they are teaching (Allen & Feldman, 1973). Research has continued to investigate this phenomenon, with Cohen, Kulik, and Kulik (1982) completing a meta-analysis that showed tutors outperformed and had more positive attitudes towards learning, when compared to their counterparts who did not act as tutors. The current research looks to better understand the learning-by-teaching phenomenon and the processes that are involved with this learning strategy.

Learning Strategies

It has been determined that there are many different ways to learn. Much research on learning techniques has been done by psychologists (Annis, 1983; Bargh & Schul, 1980; Biswas, Leelawong, Schwartz, Vye, & The Teachable Agents Group at Vanderbilt, 2005; Chase, Chin, Oppezzo, & Schwartz, 2009; Duran, 2017; Fiorella & Mayer, 2016, Hoogerheide, Loyens, & Gog, 2014; Nestojko, Bui, Kornell, Bjork, 2014;). Fiorella and

Mayer (2016) have described learning as a generative activity. Generative learning is described as a learning strategy that involves actively integrating new information learned with existing knowledge (Fiorella & Mayer, 2016). Generative learning states that it does not matter how the information is presented to learners, but rather it matters how the learners try to make sense of the new information they are learning. Fiorella and Mayer (2016) developed the SOI model of generative learning, which states there are three primary cognitive processes in generative learning. The three processes include: the ability to *select* the most relevant information, *organize* the selected information into mental representations that help to make sense of the information, and then *integrate* the new mental representations with existing knowledge (Fiorella & Mayer, 2016). Fiorella and Mayer (2016) describe eight generative learning strategies. The strategies they chose were determined to be generative because each of the strategies motivate learners to make sense of new information by using the SOI model (Fiorella & Mayer, 2016). Prior research on generative learning strategies has demonstrated that the effect is most prominent after time delays (Dunlosky et al., 2013; King, 1994). This is important to recognize because it allows us to understand that these strategies have lasting learning effects.

Learning by summarizing is one of the most basic generative learning strategy (Fiorella & Mayer, 2016). Students generally copy words and phrases from the lesson when asked to write a summary, however an effective summary involves using the SOI method. Students need to select the most relevant information, organize their thoughts, and integrate the new material with their prior knowledge (Fiorella & Mayer, 2016). Although, many students are often required to write summaries, these are often times not

the best strategies to use because most students have never been trained on how to write an effective summary. This strategy is often only helpful when it is for short text passages, that are relatively simple concepts. This would not be an effective strategy to use in physics or chemistry that have many levels of analysis (Fiorella & Mayer, 2016).

A more advanced generative learning strategy is learning by self-explaining (Fiorella & Mayer, 2016). This sounds similar to learning by summarizing, however there are distinct differences between the two strategies. Learning by self-explaining occurs when students explain the content of a lesson to themselves when learning is occurring (Fiorella & Mayer, 2016). This strategy is different from summarizing because it occurs while the learning is in progress. For example, Chi, Bassok, Lewis, Reimann, and Glaser (1989) asked students to think aloud as they studied a physics lesson. These researchers found that students who generated more self-explanations during learning performed better on the follow-up problem solving test. The goal of self-explaining is to have students reflect on their own knowledge, and determine where they have misunderstandings, so that they can repair their mental model of that subject (Fiorella & Mayer, 2016). Instead of discovering what you do not understand after reading the passage, like in learning by summarizing, learning by self-explaining allows the learner to clarify information throughout the learning process (Fiorella & Mayer, 2016). For this reason, this strategy is very effective when complex material is being learned, such as math and science (Fiorella & Mayer, 2016). Just as with learning-by-summarizing, learning by self-explaining has to generally be prompted in order for students to use this strategy, and learning gains are effected by the quality of explanations generated (Fiorella & Mayer, 2016).

Learning-by-teaching is another generative learning strategy and will be the main topic for the current research. It is an approach that is studied to see if students learn more by teaching others (Fiorella & Mayer, 2016). The research regarding the learning-by-teaching model is much more scarce than the previous other two generative learning strategies discussed above (Fiorella & Mayer, 2016). Learning-by-teaching research has largely involved peer tutoring, cooperative learning, and small group discussions to show the effect (Bargh & Schul, 1980; Gregory, Walker, McLaughlin, & Peets, 2011; Fiorella & Mayer, 2016; Fiorella & Mayer, 2013). Very few studies have isolated the learning-by-teaching method to determine what type of learning gains come to the student who is teaching the material (Fiorella & Mayer, 2016). Learning by teaching is different from self-explaining because it involves the process of preparing to teach and interacting with others. The ability to interact with students during the teaching process allows for the student teacher to reflect on their own knowledge and determine where their knowledge may be lacking (Fiorella & Mayer, 2016). Much of the learning-by-teaching literature has tried to determine whether the expectancy of teaching the material is enough, or must one actually teach the material in order to see learning gains (Bargh & Schul, 1980; Fiorella & Mayer, 2013; Muis et al., 2015; Nestojko et al., 2014).

Learning-by-Teaching

Learning-by-teaching is described as “learning new material more deeply through teaching it to others” (Fiorella & Mayer, 2013, p. 281). Research has studied the cognitive benefits of the learning-by-teaching model (Bargh & Schul, 1980; Duran, 2017; Fiorella & Mayer, 2016; Hoogerheide, Deijkers, Loyens, Heijletjes, & Gog, 2016).

Roscoe and Chi (2007) describe two strategies individuals can use when learning-by-teaching. These include reflective knowledge building and knowledge-telling. Reflective knowledge building requires the individual to build upon their prior knowledge by integrating the new material they are teaching someone. Whereas knowledge-telling is summarizing the facts about the new material and presenting that to the learner. Roscoe and Chi (2007) conducted a literature review and determined that when tutors took advantage of the knowledge building technique rather than the knowledge-telling technique their explanations were more effective for the individuals learning from them (tutees).

Bargh and Schul (1980) began research in the learning-by-teaching area by determining if tutors benefit from teaching others. They focused only on preparing to teach the individual, rather than actually teaching the individual the material. They determined that participants who prepared to teach the material scored higher than participants who just studied the material. They concluded that preparing to teach material allows for deeper processing to occur because it requires individuals to increase their organization of the material, while also requiring them to elaborate on what they already know. Even though, the tutor did not interact with another person, there was still effects from preparing to teach the material on learning. Annis (1983) contradicted Bargh and Schul's (1980) results by finding that those who actually taught material outperformed those who prepared to teach but did not actually teach. These results suggested that the act of teaching material may be more beneficial, than preparing to teach the material. However, those who taught in this study interacted with students, while the other conditions did not have the opportunity to interact with students (Annis,

1983). So, we cannot determine whether the results occurred due to teaching or having the opportunity to interact with others during the process.

Other research has contradicted Annis (1983) and has found that if students believe they are studying the material to teach another individual they will outperform those who believe they are studying the material to take a test (Duran, 2017; Hoogerheide, et al., 2016; Nestojko, et al., 2014). Nestojko and colleagues (2014) conducted a study in which students either were told they were going to teach the material or take a test on the material. It is important to note that this was just an expectancy study, which meant that the students in the teaching condition, did not actually teach the material. Instead these students just prepared to teach and then took a free recall test. They found that those who expected to teach produced a greater amount of correct answers on the recall test, and they showed better performance on the short-answer questions (Nestojko et al., 2014).

Hoogerheide and colleagues (2014) investigated whether creating a video to teach material would increase learning. They had three conditions: (a) Test condition (study intention, no video creation); (b) Explanation condition (study intention, explain to others, no video creation); (c) Explanation-Video condition (study intention, explain to others, video creation). Mixed results were found. Contrary to their hypothesis there was no learning difference between the explanation and the video group. This suggests that it does not matter whether an individual actually teaches (creates a video), but all that matters is that a person explains the information as if they were teaching (Hoogerheide et al., 2014). It could be seen that a limitation of this study is that it was conducted in the

lab, so students were forced to explain out loud in the explanation condition. Although, the explanation condition produced similar results to the explanation-video condition one could question if these results could be replicated in a real-world condition. It is unlikely that students would have adhered completely to the explanation conditions requirements if told to complete the assignment as homework. By having students complete a video assignment it ensures that students are applying the learning-by-teaching method. Requiring the completion of a video allows the researchers to evaluate the effort and quality of the students' output. Without documentation, it would be hard for researchers to evaluate the learning-by-teaching method in classrooms, because it could never be known if students used the technique. This is the logic for the proposed study. Hoogerheide and colleagues (2016) expanded on the above research by conducting a study to determine if teaching to a fictitious other on video is more beneficial than teaching to a fictitious other by writing to them. They were unable to show that explaining on a video was more beneficial than explaining it in writing, however, they were able to show that teaching (through writing or video) was more beneficial than restudying the material (Hoogerheide et al., 2016). These results may be more feasible to implement into a curriculum, because technology would not be required for students to write down their teaching method. However, more research needs to be conducted in order to determine if speaking (creating a video) versus writing has longer learning effects.

A former Industrial Organizational Psychology Master's student at Middle Tennessee State University, conducted her thesis on the learning-by-teaching model (Murry, 2018). Murry's study incorporated the learning-by-teaching method and concept

mapping. The goal of the research was to compare and contrast the different generative learning strategies that was discussed by Fiorella and Mayer (2015). Fiorella and Mayer (2015) found that concept mapping, self-explaining, and teaching were effective learning techniques, however, did not assess whether using two generative learning strategies is more effective. Murry (2018) had four conditions: testing, teaching, testing and completing a concept map, and teaching and completing a concept map. Murry (2018) was unable to find support that teaching and concept mapping effected learning and retention scores, when compared to the other conditions. There was also, no support for the hypothesis that creating a concept map and teaching would have stronger effects on learning, compared to when a concept map was not used. These results were surprising, but may be attributed to a few limitations of the study. Murry (2018) acknowledged that sample sizes were small, particularly in the teaching conditions because some students elected not to be recorded. Another potential limitation is that this is material that these students likely did not care to learn. Murry (2018) completed a tradition lab study that had students study the Doppler Effect and then complete their activity based on the condition they were assigned. In the current study, students should be motivated to excel on the assignment, as it is a part of their class grade, and will likely effect their test grades. Murry (2018) also did not examine the content of the videos, which is an aspect that is lacking in the literature. The present study will attempt to examine this and see if higher quality videos, increase the likelihood of learning gains being observed. The goal of the present research is to take a step back from Murry's approach and isolate the learning-by-teaching effect to see if significant results can be obtained.

The learning-by-teaching method has also been shown to be effective outside of the traditional classroom setting. For example, Gregory and colleagues (2011) conducted research with 17 third-year medical students who volunteer to teach their fellow second-year students. The researchers found that the third-year students not only had knowledge gains in the content areas that they prepared to teach and taught, but also saw gains in the information they prepared to teach, but never actually taught. It is also, important to note that there was no difference in the knowledge gains for second-year students if they were taught by a faculty member or a third-year student (Gregory et al., 2011). This is an important implication because it suggests that the learning-by-teaching model could be implemented into organizations, by having fellow co-workers teach each other. Tang, Hernandez, and Adams (2004) conducted a study similar to Gregory and colleagues (2011) that had fourth-year medical students engage in a sociocultural medicine training workshop, where they participated in teaching the material to other students in the program. A survey was given to all students who attended the workshop. The researchers determined that students rated their peer teachers higher than faculty, on factors such as meaningfulness of the course, group work usefulness, and facilitation skills (Tang et al., 2004). Tang and colleagues (2004) also found that peer-teachers reported having a greater understanding of the relations among sociocultural background, health, and medicine, following their teaching experience. This study is important because it not only showed the benefits for the peer-teacher, but also showed the benefits of learning from peers. Cortese (2005) conducted interviews within an organization to determine how learning best occurred on the job. The researchers noted that eight different modes of learning occurred, however learning-by-teaching occurred in one-hundred percent of

those interviews, and was said to the be the most helpful learning tool among the workers (Cortese, 2005). Lee, Mcnamara, Pitt-Catsouphes, and Lee (2014) conducted a survey that determined opportunities to teach and train others was positively related to job satisfaction and engagement. These studies show that that learning-by-teaching method can be implemented in a variety of different situations.

Teachable Agents

Research has begun to determine how Teachable Agents (TAs) can be used in classrooms to help promote the learning of students by teaching someone else through an interactive other (Biswas et al., 2005; Chase, et al., 2009). A TA is described as a computer character that students teach (Chase et al., 2009). A TA is able to learn by using artificial intelligence to learn and reason through what the student is teaching them (Chase et al., 2009). Chase and colleagues (2009) described the two types of interactive computer characters which include: avatars and agents. An avatar is controlled by a human, whereas an agent is controlled by the computer (Chase et al., 2009). Lester et al. (1997) showed that interacting with an agent can increase motivation. The agent did not give any advice to the students, but rather just exhibited behaviors of encouragement. Students ultimately gave high ratings to the agent and wanted to use the agent to help them with their homework. Lester and colleagues (1997) referred to this as the persona effect. The persona effect says that the socialness of the agents helps students to engage (Lester et al., 1997). This suggests that engaging with others while you are teaching may be more beneficial, than previous research above stating just preparing to teach is enough to see the effect.

Avatars have also been shown to have benefits to learning (Chase et al., 2009). Yee and Bailenson (2007) coined the term the proteus effect which is defined as when people learn to take on the attributes of their avatars. Yee and Bailenson (2007) conducted a study where participants were either assigned to a tall or short avatar, and asked to play a negotiation game. People who played as a tall avatar were tougher negotiators. Yee and Bailenson (2007) concluded this occurred because people who had the tall avatar took on the persona/stereotype that height is associated with power and authority. This suggests that learning through a TA could help to boost students confidence, just by creating different characteristics of the persona they are portraying. Finally, there is a hybrid agent/avatar that blends the properties of an agent with an avatar (Chase et al., 2009). A key difference between the others and the hybrid is that the hybrid has the ability to reflect on prior interactions without the human explicitly controlling it (Chase et al., 2009). A TA is considered to be a hybrid agent/avatar. Teachable agents are largely used for educational purposes because they are able to act as an independent social presence, while being able to think and reason through situations (Chase et al., 2009).

Biswas et al. (2005) created the interactive teaching program Betty's Brain to see if teaching a fictious other on a simulated program would benefit students learning. Chase et al. (2009) tested Betty's Brain to determine if there is a protégé effect. The protégé effect is when students make a greater effort to learn the material for the teachable agent rather than trying to learn the material to better themselves (Chase et al., 2009). They determined that students who were interacting with a teachable agent on Betty's Brain software spent more time on the learning activities, such as reading the passage they were

provided. They determined that students are more willing to put effort towards learning for someone else than for themselves. Overall, the teaching agent elicited more motivation for the students to work harder to learn. This research suggests that students may take an assignment more seriously, if they know they are not just learning for themselves, but learning for others (Chase et al., 2009). This supports the learning-by-teaching methodology, that expectancy to teach and effect someone else's learning, promotes higher learning gains for the student who is teaching. However, this study did not determine what the psychological processes were being used by students that elicited this motivation to work harder.

To answer this question, Chase and colleagues (2009) conducted a second experiment that wanted to answer the following question: if students treated their TAs as independent beings, then how do students react when their TA fails. In this experiment, there were two conditions: Avatar condition or TA condition. Before students completed the experiment they were instructed on how the TA software works and how to construct a concept map. In the avatar condition students learned on their own and answered Gameshow questions themselves. In the TA condition students taught their TA and then watched the TA answer the Gameshow questions. Those in the avatar condition were told to "learn the best you can by making this concept map," whereas those in the TA condition were told to "teach your agent the best you can by making this concept map." All students were told to talk out loud throughout the entire process, so that researchers could get a better idea of the psychological processes students were using (Chase et al., 2009). Results showed that those in the TA condition treated their agents as responsible for getting an answer right or wrong. TA students also demonstrated a greater effort

toward learning because they spent significantly more time reading and editing their concept maps. However, there was no difference in learning outcomes found, but they did not find this surprising because of the complexity of the material (Chase et al., 2009). The researchers then coded the comments that students were making throughout the process of the experiment. Based on these comments it was determined that those in the TA condition saw their TA's performance as a reflection of their own knowledge, but viewed the TA as being their own person. Students in the avatar condition did not perceive their avatars as being independent and thus made all attributions to themselves. Those in the TA condition experienced regret when their TA failed to answer a question correctly (Chase et al., 2009).

Current Study

The learning-by-teaching method has been implemented as a formal education tool in Germany and is termed *Lernen durch Lehren* (LdL) ('Learning-by-teaching' in German) by Jean-Pol Martin (Grzega & Schöner, 2008). However, it has not been implemented as a formal educational tool in many other places. This is partially due to the current research being based largely on peer tutoring and lab studies, and not comprehensive of other scenarios the learning-by-teaching method can be applied in. Much of the research conducted has not focused on material that is of interest to the student (Hoogerheide et al. 2014). For example, Hoogerheide and colleagues (2014) conducted a lab experiment where students were instructed to read a passage that discussed when a conclusion logically follows from two premises. While some students may have been interested in this topic, it most likely had no relevance to many students at

the time, as it was not linked to any learning they were doing in their classes. It can also be noted that the delayed post-test occurred only one week after the experiment, and because it was a lab experiment the return rate was so low for the post-test they were unable to report the results. This is very common among the learning-by-teaching literature, and should be addressed in future research.

From the above research, it can be seen that the learning-by-teaching literature is very scattered in its approach. Some of the research has focused on showing the effect in a lab setting (e.g., Annis, 1983; Bargh & Schul, 1980; Fiorella & Mayer, 2013; Fiorella & Mayer, 2014; Hoogerheide et al., 2016; Hoogerheide et al., 2014; Herberg, Levin, & Saylor, 2012; Nestoiko, et al., 2014), while other research has focused on determining if teaching TAs using computer software can produce increased learning gains (Biswas et al., 2005; Chase et al., 2009; Okita & Schwartz, 2013), and others have taken it a step further to focus on finding learning-by-teaching in the workplace (Gregory et al., 2011; Lee et al., 2014, Tang et al., 2004). With all this is mind, it is important to recognize that there are mixed results within the learning-by-teaching literature. The present research's goal to take a step back and start over. In order to be able to apply the learning-by-teaching model in schools and even the workplace, we must first isolate the effect and see if it can produce results on its own. Much of the current research has tried to determine too many aspects of the learning-by-teaching phenomenon at once, so the current research will isolate the method.

The present research expanded on the learning-by-teaching content above and Murry's (2018) thesis by determining if the opportunity to teach others via video would

increase students' motivation to produce high quality content. Previous research has yet to isolate the learning-by-teaching method, and conduct it in a classroom setting where students are motivated/interested to learn the particular topic. It can also be noted, that most of the previous research was conducted at institutions that are very selective in their application process (Fiorella & Mayer, 2013; Gregory et al., 2011; Herberg, et al., 2012; Nestojko et al., 2014). The current population of students tested allow for a better understanding of if the learning-by-teaching method is generalizable. The current research proposed to better understand the knowledge gains that were associated with the learning-by-teaching method, as well as the lasting effects of those gains. For the following study, learning gains were assessed by comparing pre-video exam scores to post-video exam scores. This lead to the following hypotheses:

Hypothesis 1a. Students that engaged in the learning-by-teaching method for Content A (Taylor-Russel tables) exhibited higher learning gains related to Content A (Taylor-Russel tables) than those that did not.

Hypothesis 1b. Students that engaged in the learning-by-teaching method for Content B (Training ROI) exhibited higher learning gains related to Content B (Training ROI) than those that did not.

Hypothesis 2. Students who created high quality videos exhibited higher learning gains when compared to students who created low quality videos. A high-quality video will be determined by setting a cut-off score on the behaviorally anchored rating scales (BARS).

Hypothesis 3. Students who spent more time making their videos will exhibited higher learning gains when compared to students who spent significantly less time making their videos.

CHAPTER II: METHODOLOGY

Participants

The participants for this study were 49 undergraduate students from the Fall 2019 Introduction to Industrial-Organizational Psychology class, at Middle Tennessee State University. All students completed one of the two learning-by-teaching topics that were randomly assigned to them. The learning-by-teaching method was a part of the class and required participation to get a grade for that portion of the class. Each learning-by-teaching group acted as the control group for the other learning-by-teaching group. Students were tested on both topics after the manipulation.

Materials and Measures

The learning-by-teaching exercise was completed on either the Taylor-Russell Tables (TRT) or Training Return on Investment (ROI). All students were presented with information in class on Taylor Russell tables (Appendix A) and Training ROI (Appendix B). Students completed a homework assignment on Taylor Russell tables (Appendix C) and Training ROI (Appendix D). Each homework assignment was worth 10 points. For the Taylor Russell tables assignment, students were given a work-related scenario and were asked to apply a Taylor Russell table to determine if the selection test was worth implementing. For the Training ROI assignment, students was given a work-related scenario and they was asked to evaluate the successfulness of a recently implemented training program.

Test questions on Taylor Russell tables and Training ROI were provided by the professor. There were multiple choice questions and short-answer application questions.

The same multiple choices test questions and short-answer questions were used on exam 1 and exam 2. The researcher's do not believe a practicing effect occurred because the tests were taken approximately 5 weeks a part. Each test had 10 points worth of Taylor Russell table questions, and 10 points worth of Training ROI questions.

For the main manipulation of the study, students were given a homework assignment that instructed them to study their assigned topic (Taylor Russell tables or Training ROI) as if they were going to teach the material to another student that had no familiarity with the topic. Students were then told to video record a lecture of them teaching their assigned topic. A brief description of the assignment was provided to students that discussed general guidelines that should be followed (Appendix E). Students filled out a time-log (Appendix F), that described how much time they spent on the learning-by-teaching assignment. At the completion of the assignment, students filled out a short survey that will assess their motivation and engagement with the assignment (Appendix G).

The videos were then coded by two graduate students from the Psychology department who were e independent from the study. Behaviorally anchored rating scales (BARS) were used, so that consistency among the raters can be ensured. The BARS were developed after the students hadcreated their videos, because these rating scales were not used or seen by the students. This allowed the researchers to tailor the BARS to what the students hadcreated. If there wasa disagreement between the raters, the student researcher madethe final decision on the rating that wasgiven for that video. The BARS

for Taylor-Russell tables and Training ROI can be found in Appendix H and Appendix I, respectively

Students were then given a second homework assignment on both Taylor Russel tables (Appendix J) and Training ROI (Appendix K). Each of these homework assignments were worth 10 points. Students werethen given a second exam that included questions on both Taylor Russell tables and Training ROI. The second exam, like the first, hadthe same of Taylor Russell table questions and Training ROI questions. Students then were given a third exam that included the same questions on both Taylor Russel tables and Training ROI. The third exam wasnot required, but allowed us to capture missing data for students who did not take the second exam.

Procedure

Before data collection began, approval for the study was provided by the Institutional Review Board at Middle Tennessee State University. The learning-by-teaching method was incorporated into the Introduction to Industrial-Organizational Psychology classes' curriculum for the semester.

In the experimental study, students were asked to read and sign a consent form describing the research study, and to provide their consent to use their class grades in the analysis. All students were presented with information in class on Taylor Russell tables. Students then completed a 10 point homework assignment on the application of Taylor Russell tables. All students were presented with information in class on Training ROI. Students then completed a 10 point homework assignment on the application of Training ROI. After completion of both homework assignments students took an exam that had

questions relating to both Taylor-Russel tables and Training ROI. The results from these questions provided a baseline score for each student on their knowledge of each topic.

After exam 1, students were randomly assigned to one of two conditions: teaching Taylor-Russell tables (Content A) or teaching Training ROI (Content B). The two conditions were determined to be similar in difficulty. A meeting with the researchers determined that in previous years, students struggled the most with both of these topics. These topics were chosen, in hope that students would gain a new strategy in order to succeed in understanding these two topics. Students were given approximately 3weeks to complete the homework assignment of creating a video of themselves teaching the material they were assigned. Students were told to use the book assigned for the class, the homework assignment completed on the topic, and notes they had taken in class to complete the assignment. Students were instructed to fill out at time-log. This allowed the researchers to determine how much time each student had spent on the assignment. When turning in their video, students were instructed to fill out a post-experimental survey, that assessed their motivation and engagement in the assignment.

After completion of the video assignment, students were given a second homework assignment on Taylor-Russell tables. If the student performs better on this second homework pertaining to Taylor-Russell tables, then it replaced the grade they received on the first homework assignment. After completion of this homework assignment, students were given a second homework assignment on Training ROI. As with the Taylor-Russell tables assignment, if the students performs better on this second homework assignment on Training ROI, it replaced the grade they received on the first

assignment. This was an additional way in which the researchers assessed if a learning gain was made by the manipulation. Approximately 5 weeks after the first exam, students were given a second exam that included questions on both Taylor Russell tables and Training ROI. Then, approximately 1 week later, students had the option to take a third exam that included questions on both Taylor Russell tables and Training ROI. The third exam was not required, but allowed the researchers to capture missing data for students who did not take the second exam.

After the final exam, students were thanked for their participation. After the class had been completed students received an email from the researcher debriefing them on the purpose of the study.

CHAPTER III: RESULTS

Preliminary Analyses

The total sample size was 49 participants, with $n = 25$ in condition one, $n = 24$ in condition two. A total of 17 participants were not included in the final analysis. One participant from condition two was a graduate student and was thus excluded from the analysis. Two participants in condition one and 1 participant in condition 2 did not provide consent to use their grades in the analysis. Six participants in condition one and 7 participants in condition two did not turn in learning-by-teaching videos. Table 1 below shows the descriptive statistics for each set of test questions on exam 1 and exam 2.

Table 1
Descriptive statistics based on test questions for exam 1 and exam 2

	N	*M*	*SD*
TRT Exam 1	46	13.59	4.07
TRT Exam 2	42	16.33	6.68
ROI Exam 1	46	16.70	2.92
ROI Exam 2	42	17.31	3.20

Primary Analyses

Hypothesis 1a stated that students who engage in the learning-by-teaching method for Taylor-Russell tables will exhibit higher learning gains related to Taylor-Russell tables than those who did not. A two-way RM ANOVA with learning-by-teaching group condition as between-subjects factor (TRT and ROI) and TRT exam scores (exam 1 and exam 2) as within-subjects factor was used to predict the learning gains of students who taught TRT. A familywise alpha of .05 was used. The interaction between learning-by-teaching group and TRT exam scores was not significant, Wilk's F (1, 30) = 2.36, p = .135. The learning gains of students who taught TRT did differ between exam 1 and exam 2, Wilk's F (1, 30) = 18.85, $p < .001$. However, as shown in Table 2 the means from exam 1 to exam 2 are over two points higher for the TRT group than the Training ROI group, suggesting that the relationship is headed in the correct direction. A two point difference for a student on an exam is a meaningful difference. There was not a significant effect for learning-by-teaching group, F (1, 30) = 0.66, p = .42.

Table 2

Descriptive statistics based on TRT questions for exam 1 and exam 2

				95% CI	
Condition	TRT Questions	*n*	*M*	Lower Bound	Upper Bound
ROI	Exam 1	17	13.77	11.83	15.70
	Exam 2	17	15.71	13.42	17.99
TRT	Exam 1	15	13.80	11.74	15.86
	Exam 2	15	17.87	15.43	20.30

Table 3
RM ANOVA within-subjects effects for TRT group

Effect	*df*	Error	*Wilk's F*	*p*
Exam Scores	1	30	18.85	.00
Exam Scores * Group	1	30	2.36	.14

Table 4
RM ANOVA between-subjects effects for TRT group

Effect	Mean Square	*F*	*p*
TRT	19.22	0.66	.42

Hypothesis 1b stated that students who engage in the learning-by-teaching method for ROI will exhibit higher learning gains related to ROI than those who did not. A two-way RM ANOVA with learning-by-teaching group condition as between-subjects factor (TRT and ROI) and ROI exam scores (exam 1 and exam 2) as within-subjects factor was used to predict the learning gains of students who taught ROI. A familywise alpha of .05 was used. The interaction between learning-by-teaching group and ROI exam scores was not significant, Wilk's F (1, 30) = 0.12, p = .73. The learning gains of students who taught ROI did not differ by exam 1 or exam 2, Wilk's F (1, 30) = 1.01, p = .32. There was not a significant effect for learning-by-teaching group, F (1, 30) = 0.04, p = .85.

Table 5
Descriptive statistics based on ROI questions for exam 1 and exam 2

				95% CI	
Condition	ROI Questions	*n*	*M*	Lower Bound	Upper Bound
ROI	Exam 1	17	16.24	14.96	18.10
	Exam 2	17	17.35	15.67	19.03
TRT	Exam 1	15	16.93	15.26	18.61
	Exam 2	15	17.33	15.54	19.12

Table 6
RM ANOVA within-subjects effects for ROI group

Effect	*df*	Error	*Wilk's F*	*p*
Exam Scores	1	30	1.01	.32
Exam Scores * Group	1	30	0.12	.73

Table 7
RM ANOVA between-subjects effects for ROI group

Effect	Mean Square	*F*	*p*
ROI	0.59	0.03	.85

Hypothesis 3 stated that students who created high quality videos would exhibit higher learning gains when compared to students who created low quality videos. This was not tested for the ROI condition, because it was found that the learning-by-teaching method did not impact exam scores. This hypothesis was tested for the TRT condition, because the exam score means were meaningfully different, even though they were not significantly different. This hypothesis was tested by doing a two-way RM ANCOVA. The quality of video did not effect scores on TRT exam questions, F (1, 29) = 0.82, p = .37.

Table 8
RM ANCOVA for TRT groups' video quality

Effect	Mean Square	*F*	*p*
Exam Scores * Video Quality	6.27	0.82	.37
Exam Scores * Group	2.12	0.28	.60

Hypothesis 4 stated that students who spent more time making their videos would exhibit higher learning gains compared to those who spent less time making their video. Just as above, this was not tested for the ROI condition, because it was found that the learning-by-teaching method did not impact exam scores. This hypothesis was tested for the TRT condition, because the exam score means were meaningfully different, even though they were not significantly different. This hypothesis was tested by doing a two-way RM ANCOVA. The more time a student spent working on their video did not lead to differences in learning gains, F (1, 25) = 0.02, p = .88.

Table 9
RM ANCOVA for TRT groups' video hours

Effect	Mean Square	*F*	*p*
Exam Scores * Video Hours	0.19	0.02	.88
Exam Scores * Group	1.28	0.15	.70

CHAPTER IV: DISCUSSION

Summary of Findings

The purpose of the current research was to examine whether the learning-by-teaching method could help students learn in a classroom setting. Previous research on the learning-by-teaching method was primarily done in lab settings. There have been studies that have looked at learning-by-teaching in the classroom, but these studies have focused on training avatars. All of the hypotheses tested in this study were not supported. However, for those in the TRT condition the means from TRT exam one questions from TRT exam two questions were over four points away from each, suggesting that the relationship was headed in the right direction. This is a promising finding because four points to students on an exam is a meaningful difference. Although, the relationship was not statistically significant, it should be considered a meaningful difference that should be explored further.

There are several possible reasons for the lack of significance for the hypotheses in this study. First, there was a lot of attrition in this study, which may not have allowed for an effect to be detected. Additionally, it seems that the conditions were not equal in difficulty. On exam one students scored approximately 16.5 points on ROI questions, yet only scored 13.8 points on the TRT questions. This suggests that students may have already grasped the ROI concept even before they were instructed to teach it. This could explain why a learning gain was not found for the ROI condition.

Hypothesis 3 and 4 may not have been supported for a variety of reasons. Hypothesis 3 may have not been supported because it may not matter how well a student

can convey on video how well they learned the material, but all that may matter is that they engage in the learning-by-teaching method. Additionally, hypothesis 4 may not have been supported because as long as a student engages in the learning-by-teaching method in some compacity it may not matter how long. Roscoe and Chi (2007) found that students who engaged in knowledge building while using the learning-by-teaching method had greater learning gains compared to those who used knowledge-telling. It seems that as long as you engage in knowledge building, it may not matter how long a person spends using the learning-by-teaching technique.

Limitations and Future Directions

Although insights were discovered from the present study, there are a number of limitations that should be discussed. First, the sample size was small. This occurred for multiple reasons. One reason this occurred was that a class was the subject pool, so the researchers were tied to how many people were enrolled in the class. Some students dropped out of the class mid-semester and others did not turn in the assignment, thus bringing the subject pool down again. Additionally, not all students completed the required parts of the assignment. For example, a large number of students did not complete the post-assignment survey and thus the researchers were not able to assess the motivation of individuals.

Additionally, it seems that the TRT condition and Training ROI condition were not equal in difficulty. It seems that students were able to grasp the Training ROI material before even completing the learning-by-teaching method. On exam one students scored approximately 16.5 points on ROI questions, yet only scored 13.8 points on the TRT

questions. These mean differences suggest that the TRT material was much harder. This suggests that the learning-by-teaching method may be most effective when working in complex subject matters. Future research should explore this further to determine if complexity of material changes how the learning-by-teaching method is applied.

The present study had students use the learning-by-teaching method on material that they had already learned in class by their professor. This could have been a limitation because some students may have grasped the material before engaging in the learning-by-teaching method. A direction for future research would be to have students complete the learning-by-teaching method on material that has not been taught to them by the professor beforehand. Chase and colleagues (2009) found the protégé effect that says students make a greater effort to learn the material for the teachable agent rather than trying to learn the material to better themselves. Future research should incorporate this protégé effect. This could be done by telling students that the videos they create will be shared with students from the other condition. For example, those in the Condition A would learn the Condition B content from those who created videos in Condition B. Those in the Condition B would learn the Condition A content from those who created videos Condition A. Results may be obtained this way, because students may be more willing to learn the material for someone else rather than for themselves.

Future research should also consider looking into if interacting with a person while applying the learning-by-teaching method brings about greater results. Annis's (1983) study had students who were using the learning-by-teaching method interact with students. This research was not able to determine whether the results occurred due to

teaching or having the opportunity to interact with others during the process. This would have great implications because it would make it much easier to implement the learning-by-teaching method into the classroom. If it can be found that actually interacting with an individual while teaching brings learning gains, then teachers would be able to implement the learning-by-teaching method into everyday classes.

Future research should forgo assessing the quality of teaching and how long students spend preparing to teach. From the current research it seems that just having students engage in the learning-by-teaching method with complex materials can bring about learning gains. This has great implications because it suggests that future research does not need to look at how students prepare to teach, but rather if they properly engaged in the learning-by-teaching method.

Conclusion

The learning-by-teaching research has displayed that it is a useful technique for students to use, although it is still not fully understood. This research provided greater insight into how the learning-by-teaching method can be integrated and applied in a classroom setting. Although, all hypothesis were not supported by the research, there were some promising conclusions that were made. The increased means from exam one to exam two for the TRT condition, suggest that meaningful differences can occur when engaging in the learning-by-teaching method. Overall, a four point difference occurred which is very much meaningful to students because that can be the difference between letter grades. The limitations of the current study may have prohibited statistically significant results from being obtained in both the Training ROI and TRT conditions.

It seems that the learning-by-teaching method may not be appropriate in all situations, but rather is only beneficial when discussing complex topics. Future research should determine how difficult a topic must be in order to engage the learning-by-teaching method. Additionally, research should continue to determine the settings in which the learning-by-teaching method is best applied, such as formal educational programs and in job training programs. Most research has shown the merits of using the learning-by-teaching method in controlled settings, such as labs, however the current study expanded upon this research by trying to find effects in the classroom. Though more research is needed on the use of the learning-by-teaching method in the classroom, the current research has shown that benefits can be observed.

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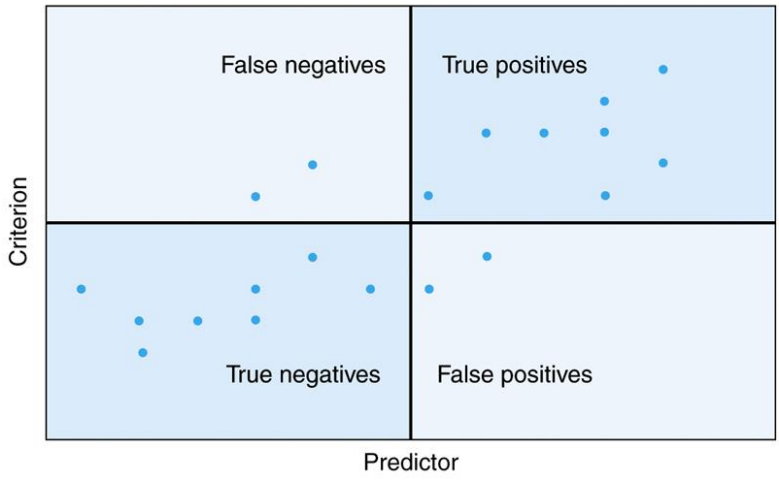
APPENDICES

APPENDIX A: Taylor-Russell Tables Class Content

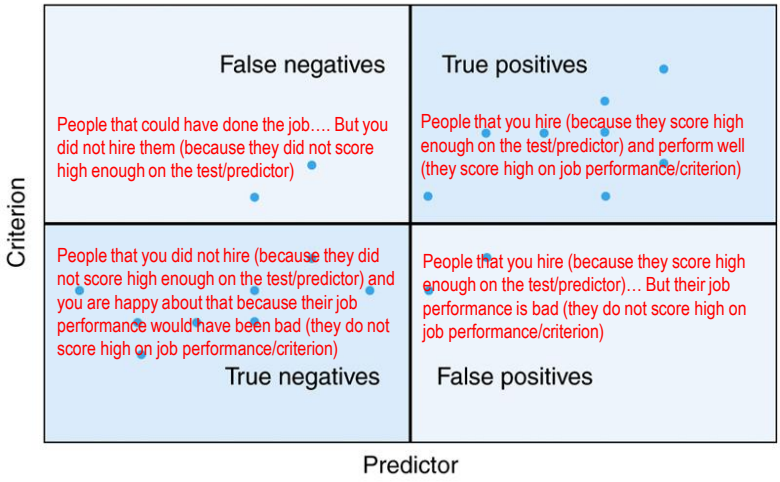
Utility

- Value of selection system to the organization
- Utility is maximized by
  - 1. Baserate for success—should be 50%
  - 2. Selection ratio (hired/applicants)—should be low
  - 3. Validity of selection device—should be high
- Valid predictors increase true positives and reduce false positives
- Must determine if benefits to organization outweigh costs of the selection devices

Utility Example



Utility Example



Common Utility Methods

Taylor-Russell Tables

Proportion of Correct Decisions

The Brogden-Cronbach-Gleser Model

63

Utility Analysis
Taylor-Russell Tables

- Estimates the percentage of future employees that will be successful
- Three components
  - Validity
  - Base rate (successful employees ÷ total employees)
  - Selection ratio (hired ÷ applicants)

64

Taylor-Russell Example

- Suppose we have
  - a test validity of .40
  - a selection ratio of .30
  - a base rate of .50
- Using the Taylor-Russell Tables what percentage of future employees would be successful?

65

Base Rate

Selection Ratio

r.	.05	.10	.20	.30	.40	.50	.60	.70	.80	.90	.95
50% .00	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50
.10	.58	.57	.56	.55	.54	.53	.53	.52	.51	.51	.50
.20	.67	.64	.61	.59	.58	.56	.55	.54	.53	.52	.51
.30	.74	.71	.67	.64	.62	.60	.58	.56	.54	.52	.51
.40	.82	.78	.73	.69	.66	.63	.61	.58	.56	.53	.52
.50	.88	.84	.76	.74	.70	.67	.63	.60	.57	.54	.52
.60	.94	.90	.84	.79	.75	.70	.66	.62	.59	.54	.52
.70	.98	.95	.90	.85	.80	.75	.70	.65	.60	.55	.53
.80	1.0	.99	.95	.90	.85	.80	.73	.67	.61	.55	.53
.90	1.0	1.0	.99	.97	.92	.86	.78	.70	.62	.56	.53

Validity Coefficient

66

1.	Selection Ratio	.30
	Base rate	.50
	Validity	.40
	% of future successful employees	.69

67

Taylor-Russell Example

- Suppose we have
  - a test validity of .35
  - a selection ratio of .40
  - a base rate of .70
- Using the Taylor-Russell Tables what percentage of future employees would be successful?

68

Base Rate 70%

Selection Ratio

Validity Coefficient

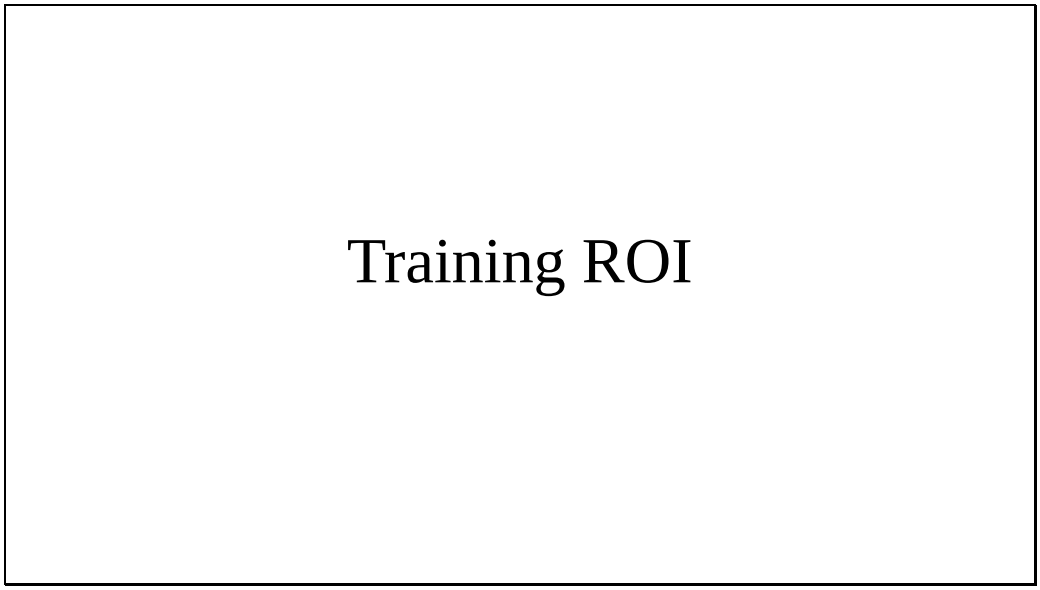
r.	.05	.10	.20	.30	.40	.50	.60	.70	.80	.90	.95
.00	.70	.70	.70	.70	.70	.70	.70	.70	.70	.70	.70
.10	.77	.76	.75	.74	.73	.73	.72	.72	.71	.71	.70
.20	.83	.81	.79	.78	.77	.76	.75	.74	.73	.73	.71
.30	.88	.86	.84	.82	.80	.78	.77	.75	.74	.74	.71
.40	.93	.91	.88	.85	.83	.81	.79	.77	.75	.75	.72
.50	.96	.94	.91	.89	.87	.84	.82	.80	.77	.77	.72
.60	.98	.97	.95	.92	.90	.87	.85	.82	.79	.79	.73
.70	1.0	.99	.97	.96	.93	.91	.88	.84	.80	.80	.73
.80	1.0	1.0	.99	.98	.97	.94	.91	.87	.82	.82	.73
.90	1.0	1.0	1.0	1.0	.99	.98	.95	.91	.85	.85	.74

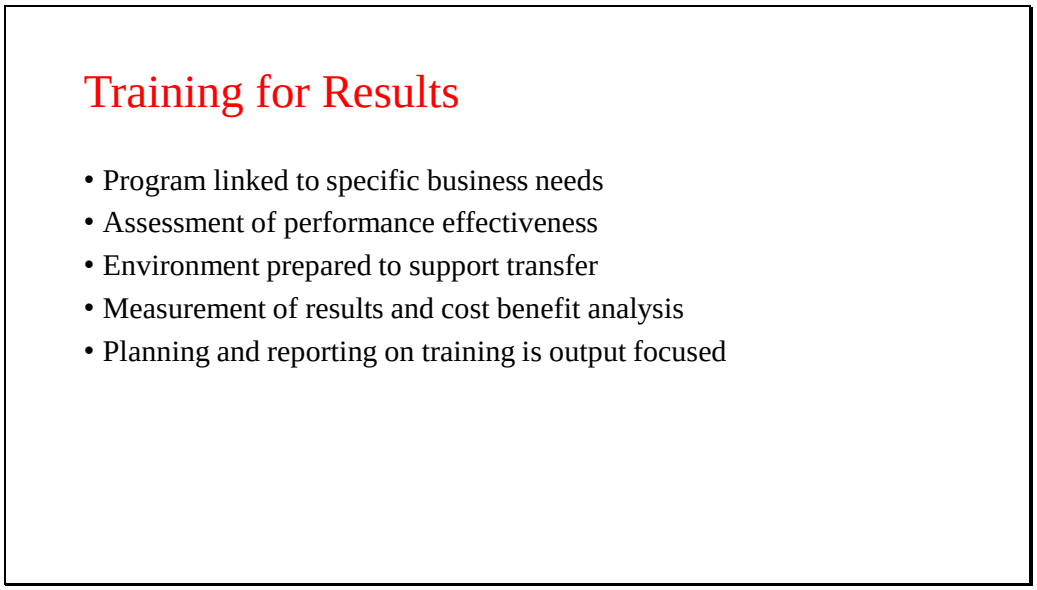
69

2.	Selection Ratio	.40
	Base rate	.70
	Validity	.35
	% of future successful employees	.80 (round r down) .83 (round r up)

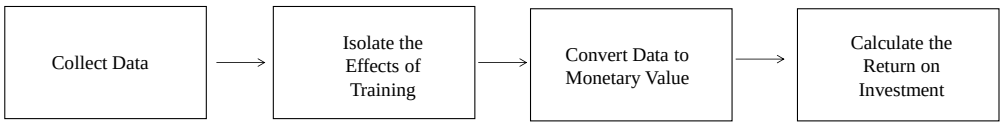
70

APPENDIX B: Training ROI Class Content





Return on Investment (ROI)



Data Collection Methods

- Follow-up questionnaires/surveys
- Observe employees on the job
- Monitor performance data
- Interview employees

Isolate the Effects of Training

- Participant Estimate of Impact
- Supervisors Estimate of Impact
- Trend Line Analysis
  - Anticipate performance based on historical data
- Experimental Design
  - Use control groups
  - Random Selection

Convert Data to Monetary Value

- Determine what the intangible benefits may be
  - Interpersonal Skills
  - Team Development
  - Morale
  - Stress Reduction
  - Increased Satisfaction

Calculating Training ROI

- ROI (%) = $\frac{\text{Program Benefits} - \text{Program Costs}}{\text{Program Costs}}$ x 100

- Program Costs
  - Salaries/Benefits (Facilitators and Participants)
  - Program materials and fees
  - Travel/Lodging/Meals
  - Facilities
  - Design and Development of Program

Example: Calculating Training ROI

- Each customer service rep. will attend training for 2 days. Each customer service rep. makes 12/hour and will be at training each day for 8 hours.
- Training materials cost $50 per employee
- The trainer makes 25/hour and will be training 8 hours/day.
- After training customer service representatives receive over 5 less complaints per day. This is estimated to save the company $500 per employee.

1. How much does the training cost?
2. What are the calculated program benefits per employee?
3. What is the calculated ROI (%) per employee?
4. Should this training continue?

APPENDIX C: Taylor-Russell Tables Homework #1

PSY 3320 Fall 2019 – Integrative Assignment # 1 Part 2

The sales person for the Make Employees Great Again (MEGA) Consulting firm is trying to sell *O 'Patrick's Food and Sprits* their MEGA-Select test for hiring employees. As the Director of Human Resources for a *O 'Patrick's Food and Sprits* the decision to use or not to use the MEGA-Select test is yours to make. Through your research, you have determined that the MEGA-Select test does measure job relevant characteristics for servers and wait staff as well as supervisors at *O 'Patrick's Food and Sprits*. From what you have read you know that the MEGA-Select test is valid. If you decided to use the test, you would use it to hire **Servers/Wait staff** and **Supervisors**.

Based upon your research, you have determined that 50% of your current **Servers/Wait staff** perform the job well and that 70% of the current **Supervisors** perform the job well. Last year *O 'Patrick's Food and Sprits* hired 80% of the **Servers/Wait staff** that applied for the position and hired 5% of the **Supervisors** that applied for the position.

MEGA Consulting states that the MEGA-Select test has a validity of r = 0.40 for all restaurant related positions. As previously noted your independent analysis and research supports their claim. You have been asked to determine what impact using such a test would have on *O 'Patrick's Food and Sprits* in terms of increasing the number (percentage) of productive employees.

*Note: the MEGA-Select test would cost three times as much as the test that is currently being used to select hire **Servers/Wait staff** and **Supervisors** employees at O 'Patrick's Food and Sprits.*

Using the Taylor-Russell tables below, make a recommendation and answer the associated questions (on the next page):

Base rate of 50%		Selection Ratio										
		.05	.10	.20	.30	.40	.50	.60	.70	.80	.90	.95
MEGA Select Validity	.00	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50
	.10	.58	.57	.56	.55	.54	.53	.53	.52	.51	.51	.50
	.20	.67	.64	.61	.59	.58	.56	.55	.54	.53	.52	.51
	.30	.74	.71	.67	.64	.62	.60	.58	.56	.54	.52	.51
	.40	.82	.78	.73	.69	.66	.63	.61	.58	.56	.53	.52
	.50	.88	.84	.76	.74	.70	.67	.63	.60	.57	.54	.52
	.60	.94	.90	.84	.79	.75	.70	.66	.62	.59	.54	.52
	.70	.98	.95	.90	.85	.80	.75	.70	.65	.60	.55	.53
	.80	1.0	.99	.95	.90	.85	.80	.73	.67	.61	.55	.53
	.90	1.0	1.0	.99	.97	.92	.86	.78	.70	.62	.56	.53

Base rate of 70%		Selection Ratio										
		.05	.10	.20	.30	.40	.50	.60	.70	.80	.90	.95
MEGA Select Validity	.00	.70	70	.70	.70	.70	.70	.70	70	.70	.70	.70
	.10	.77	.76	.75	.74	.73	.73	.72	.72	.71	.71	.70
	.20	.83	.81	.79	.78	.77	.76	.75	.74	.73	.73	.71
	.30	.88	.86	.84	.82	.80	.78	.77	.75	.74	.74	.71
	.40	.93	.91	.88	.85	.83	.81	.79	.77	.75	.75	.72
	.50	.96	.94	.91	.89	.87	.84	.82	.80	.77	.77	.72
	.60	.98	.97	.95	.92	.90	.87	.85	.82	.79	.79	.73
	.70	1.0	.99	.97	.96	.93	.91	.88	.84	.80	.80	.73
	.80	1.0	1.0	.99	.98	.97	.94	.91	.87	.82	.82	.73
	.90	1.0	1.0	1.0	1.0	.99	.98	.95	.91	.85	.85	.74

The previous page contains information Regarding the MEGA Select test. Based upon the information provided, what recommendations would you make regarding the: **a)** Using the MEGA Select test for hiring **Servers/Wait staff** at *O 'Patrick's Food and Sprits*? **b)** Using the MEGA Select test for hiring **Supervisors** *O 'Patrick's Food and Sprits*?

3a) Should *O 'Patrick's Food and Sprits* use the MEGA Select test for hiring **Servers/Wait staff**? Yes or No _____

3b) Explain your answer above and be sure to specify what, specifically, you would you expect in terms of increasing the percentage of productive **Servers/Wait staff** at *O 'Patrick's Food and Sprits* using the MEGA Select test?

4a) Should *O 'Patrick's Food and Sprits* use the MEGA Select test for hiring **Supervisors**? Yes or No _____

4b) Explain your answer above and be sure to specify what, specifically, you would you expect in terms of increasing the percentage of productive **Supervisors** at *O 'Patrick's Food and Sprits* using the MEGA Select test?

APPENDIX D: Training ROI Homework #1

Homework #5 Training Return on Investment

Student Name **M#**

- **Illegible and/or unintelligible responses will not be graded.**
- **Students are NOT permitted to work together on Homework assignments and evidence of doing so will be reported as an act of academic dishonesty.**

For the following assignment, pretend that you are the regional HR Manager at Smart-Shop, a national retail chain. You are responsible for all of the Human resource Functions and activities in your Region.

Smart-Shop has gotten complaints from customers that it is taking way too long to resolve their problems when they call the customer service department. The training department decided to conducted a training to help speed up the decision-making skills of Smart-Shop's customer service representatives.

Each customer service representative will attended the training for 2 days. Each employee attending training makes $13/hour and will be at training for 8 hours each day. It will cost approximately $500 per employee to put on the training each day.

After the competition of training the company notices a decrease in time it takes to resolve a customer complaint. It has been evaluated that the training benefit for each employee is $2,000.

$$\text{ROI (\%)} = \frac{\text{Program Benefits} - \text{Program Costs}}{\text{Program Costs}} \times 100$$

a. How much does it cost to send one customer service representative to training?
_____

b. What are the calculated program benefits per employee?
_____

c. What is the calculated ROI (%) for this training program?
_____

d. Should Smart-Shop continue this using this training for their customer service representatives? Explain.

APPENDIX E: Learning-by-Teaching Video Assignment

Learning-by-teaching is described as "learning new material more deeply through teaching it to others" (Fiorella & Mayer, 2013, p. 281). The goal of this assignment is to have you utilize the learning-by-teaching strategy to help you to learn concepts in this class.

Instructions

You will study this material using your lecture notes, homework assignments, assigned readings, etc. You will then create a video of yourself teaching the material. You should act as if you are teaching the material to someone who is just being introduced to this topic. This person has no prior knowledge of the topic, so you will want to explain things in detail. You may use visual aids (PowerPoint, whiteboard, etc.) while you are teaching, but please make sure that it is visible in the video. You will be required to fill out a time-log for this assignment. Each time you spend time working on the assignment, you will fill out your time-log. An example of how to fill out your time-log has been provided for you. Before turning in the assignment, you will complete the post-assignment survey.

General Guidelines

- Create a video of yourself teaching the material to another student who has no prior knowledge on the topic
- The video should be between 5-10 minutes
- You should use materials provided in class (lecture notes, homework assignment, etc.) and your book to complete this assignment

- You will need to fill out the time-log that has been provided to you. Each time you spend time working on this assignment you will need to document on your time-log the amount of time you spent working on it.
- After completing the assignment you will fill out the post-assignment survey
- Once completed you will upload your video, time-log, and post-assignment survey to D2L via dropbox.

APPENDIX F: Learning-by-Teaching Video Assignment Time-Log

The first few lines are given as examples

Date	Time spent on assignment	Description of items worked on
10/21	10:00 AM – 10:45 PM	Reviewed class notes and homework assignment, and started to write ideas for a lesson plan
10/23	6:00 PM – 6:30 PM	Created an outline for how information should be presented
10/26	2:00 PM – 4:00 PM	Began rehearsing the presentation of the material

APPENDIX G: Post-Experiment Survey Engagement and Motivation Survey

1. The learning-by-teaching video homework assignment was engaging

1	2	3	4	5
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

2. I was motivated to learn the material using the learning-by-teaching method

1	2	3	4	5
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

3. I would use the learning-by-teaching method again to study for a test

1	2	3	4	5
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

4. Creating a video was not an engaging homework assignment

1	2	3	4	5
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

5. I was motivated to create the best possible video

1	2	3	4	5
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

6. It was easy to stay focused on the task

1	2	3	4	5
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

APPENDIX H: Taylor Russell Table (TRT) Video Evaluation Form

Student Name: _____

Total Length of the Video: _____

Definition of TRT:

1	2	3	4	5
The presenter did not mention that TRTs are used to determine the number of future successful employees on the job if a particular selection method is used.		The presenter explained that TRTs can be used to determine how likely employees will be successful on the job if a particular selection method is used. The presenter failed to emphasize that TRTs are looking at the success of future employees.		The presenter explained that TRTs can be used to determine how likely future employees will be successful on the job if a particular selection method is used. The presenter clearly emphasized that it is regarding the success of future employees and not current employees.

Definition of Utility Analysis:

1	2	3	4	5
The presenter failed to mention that TRT is a type of utility analysis.		The presenter stated that TRT is a type of utility analysis, however did not acknowledge that there are other ways to perform a utility analysis. The presenter explained that utility analysis can be used in selection to assess how successful the selection too being implemented will be at selecting qualified employees.		The presenter stated that TRT is one type of utility analysis, and acknowledges (does not need to explain the others) that there are other ways to perform a utility analysis. The presenter explained that utility analysis can be used in selection to assess how successful the selection tool being implemented will be at selecting qualified employees. The presenter mentioned that the organization must consider the costs and benefits to using a selection test after the utility analysis is performed.

Components of TRT:

1	2	3	4	5
The presenter failed to mention that the components needed to perform a utility analysis using TRT are validity, base rate, and selection ratio.		The presenter mentioned that the components needed to perform a utility analysis using TRT are validity, base rate, and selection ratio. The presenter briefly described what validity, base rate, and selection ratio are, however did not provide a solid example of any of them.		The presenter mentioned that the components needed to perform a utility analysis using TRT are validity, base rate, and selection ratio. The presenter described in detail validity, base rate, and selection ratio and provided an example of all three.

Demonstration:

1	2	3	4	5
The presenter did not provided a demonstration on how to use a TRT.		The presenter provided one demonstration on how to use a TRT. The demonstration included a visual of a TRT. The presenter walked through how to plug in the validity, base rate, and selection ratio into the TRT.		The presenter provided multiple demonstrations on how to use TRT (one example where not beneficial to use and one when it is beneficial to use) The demonstration included a visual of a TRT. The presenter walked through how to plug in the validity, base rate, and selection ratio into the TRT for each example.

Clarity of Presentation:

1	2	3	4	5
For the majority of the video it was hard to understand what the presenter was saying There were many distractions during the video (people in the background, noise, etc.)		For the majority of the video it was easy to hear and understand the presenter There were a few distractions during the video (people in the background, noise, etc.)		The presenter spoke clearly and was easy to understand throughout the entire video. No distractions occurred in the background of the video

Presentation Aids:

1	2	3	4	5
No visual aid was used		The presenter used a visual aid The visual aid was clear to see The presenter seemed distracted by the visual aid (i.e. read directly off the PowerPoint slides.)		The presenter used visual aids that enhanced the watchers understanding of the concept described The visual aid was clear to see The presenter was not distracted by the visual aid (i.e. did not read directly from PowerPoint slides.)

Video Quality:

1	2	3	4	5
It was hard to see the presenter/visual aid in the video because it was so blurry. The sounds effects made it so that I could not hear what the presenter was saying.		The video was blurry at times. It was almost always easy to see the presenter/visual aid in the video. The sound was clear for the majority of the video.		The video was never blurry. The presenter/visual aid was clear throughout the entire video. The sound was clear for the entirety of video.

Total Video Score:

APPENDIX I: Training ROI Video Evaluation Form

Student Name: _____

Total Length of the Video: _____

Definition of Training ROI:

1	2	3	4	5
The presenter did not define ROI as being a percentage of how much you earn or lose on an investment.		The presenter explained that ROI is the percentage of how much you earn or lose on an investment. The presenter mentioned that Training ROI is type utility analysis, but failed to explain that a utility analysis uses a tool (such as ROI) to look an organizations gains and losses pertaining to a specified intervention (such as training).		The presenter explained that ROI is the percentage of how much you earn or lose on an investment. The presenter mentioned that Training ROI is type utility analysis, and explained that a utility analysis uses a tool (such as RIO) to look an organizations gains and losses pertaining to a specified intervention (such as training).

Steps to Calculating Training ROI:

1	2	3	4	5
The presenter failed to mention that the steps taken to calculate training ROI, which include: 1. Collect data 2. Isolate training effects 3. Convert data to monetary value 4. Calculate ROI		The presenter mentioned that the steps needed to calculate Training ROI include: 1. Collect data 2. Isolate training effects 3. Convert data to monetary value 4. Calculate ROI The presenter briefly described what each step was, however did not		The presenter mentioned that the steps needed to calculate Training ROI include: 1. Collect data 2. Isolate training effects 3. Convert data to monetary value 4. Calculate ROI The presenter described in detail all four steps and provided an example of all four. For example: 1. Collecting data can be done using surveys,

		provide a solid example of any of them.		interviews, focus groups, etc. 2. Isolate training effects can be done using estimate of impact, trend line analysis, experiment design 3. Convert data to monetary value can be done by accessing intangible benefits such as higher job satisfaction, higher levels of teamwork, etc. 4. Calculate ROI can be done by accessing the costs and benefits of the training

Calculating ROI:

1	2	3	4	5
The presenter did not provide the formula for calculating Training ROI.		The presenter provided the formula for calculating Training ROI. ROI (%) = $\frac{Program\ Benfits - Program\ Costs}{Program\ Costs}$ x 100 The presenter describes program benefits as the monetary gains for the organization that came from the training. The presenter describes program costs as the costs associated with training employees. The presenter fails to provide examples of benefits and costs.		The presenter provided the formula for calculating Training ROI. ROI (%) = $\frac{Program\ Benfits - Program\ Costs}{Program\ Costs}$ x 100 The presenter describes program benefits as the monetary gains for the organization that came from the training. The presenter describes program costs as the costs associated with training employees. The presenter provides an example of program benefits (i.e. the organization increased sales by $1,200 per employee).

				The presenter provides an example of program costs (i.e. paying the trainer, meals, lodging, training materials).

Demonstration:

1	2	3	4	5
The presenter did not provided a demonstration on how to calculate Training ROI.		The presenter provided one demonstration on how to calculate Training ROI. The presenter walked through how to plug in program costs and program benefits into the equation. The presenter only explained Training ROI as being effective if a positive value was reached. The presenter failed to mention that a 100% ROI means that for every 1 dollar invested, you gain 1 dollar back (another percentage can be used in the example. Such as 85% means that for every 1 dollar invested, you gain 85 cents back).		The presenter provided multiple demonstrations on how to calculate Training ROI. The presenter walked through how to plug in program costs and program benefits into the equation for each demonstration. The presenter explained Training ROI as being effective if a positive value was reached, but the organization found the return to be valuable. The presenter explained that a 100% ROI means that for every 1 dollar invested, you gain 1 dollar back (another percentage can be used in the example. Such as 85% means that for every 1 dollar invested, you gain 85 cents back).

Clarity of Presentation:

1	2	3	4	5
For the majority of the video it was hard to understand what the presenter was saying		For the majority of the video it was easy to hear and understand the presenter		The presenter spoke clearly and was easy to understand throughout the entire video.

There were many distractions during the video (people in the background, noise, etc.)		There were a few distractions during the video (people in the background, noise, etc.)		No distractions occurred in the background of the video

Presentation Aids:

1	2	3	4	5
No visual aid was used		The presenter used a visual aid such as a PowerPoint. The visual aid was clear to see The presenter seemed distracted by the visual aid (i.e. read directly off the PowerPoint slides.)		The presenter used a visual aid such as a PowerPoint. The visual aid was clear to see The presenter was not distracted by the visual aid (i.e. did not read directly from PowerPoint slides.)

Video Quality:

1	2	3		5
It was hard to see the presenter/visual aid in the video because it was so blurry. The sounds effects made it so that I could not hear what the presenter was saying.		The video was blurry at times. It was almost always easy to see the presenter/visual aid in the video. The sound was clear for the majority of the video.		The video was never blurry. The presenter/visual aid was clear throughout the entire video. The sound was clear for the entirety of video.

Total Video Score:

APPENDIX J: Taylor-Russell Tables Homework #2

Homework #5 Utility Analysis

Submit (via D2L Dropbox) one document that contains:

a) **An correct answer (Yes or No) to questions 1a and 2a**
b) **A full, complete and accurate answer to questions 1b and 2b**

Students are NOT permitted to work together on Homework assignments and evidence of doing so will be reported as an act of academic dishonesty.

For this assignment, pretend that you are the Director of Human Resources at Han Solo Coffee Company. The sales person for the Make Employees Great Again (MEGA) Consulting firm is trying to sell Han Solo Coffee Company their MEGA-Select test for hiring employees. Through your research, you have determined that the MEGA-Select test does measure job relevant characteristics for Baristas as well as Supervisors at Han Solo Coffee Company. From what you have read, you know that the MEGA-Select test is valid. If you decided to use the test, you would use it to hire **Baristas** and **Supervisors**.

Based upon your research, you have determined that 50% of your current **Baristas** perform the job well and that 70% of the current **Supervisors** perform the job well. Last year Han Solo Coffee Company hired % of the people that applied for **Baristas** positions and hired 5% of the people that applied for **Supervisors** positions at Han Solo Coffee Company.

MEGA Consulting states that the MEGA-Select test has a validity of r = 0.40 for all coffee shop positions. As previously noted your independent analysis and research supports their claim. You have been asked to determine what impact using such a test would have on Han Solo Coffee Company in terms of increasing the number (percentage) of productive employees.

IMPORTANT Note: the MEGA-Select test costs three times as much as the test that is currently being used to hire **Baristas** and **Supervisors** at Han Solo Coffee Company.

Using the Taylor-Russell tables below, make a recommendation and answer the associated questions (on the next page):

Base rate of 50%		Selection Ratio										
		.05	.10	.20	.30	.40	.50	.60	.70	.80	.90	.95
MEGA Select Validity	.00	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50
	.10	.58	.57	.56	.55	.54	.53	.53	.52	.51	.51	.50
	.20	.67	.64	.61	.59	.58	.56	.55	.54	.53	.52	.51
	.30	.74	.71	.67	.64	.62	.60	.58	.56	.54	.52	.51
	.40	.82	.78	.73	.69	.66	.63	.61	.58	.56	.53	.52
	.50	.88	.84	.76	.74	.70	.67	.63	.60	.57	.54	.52
	.60	.94	.90	.84	.79	.75	.70	.66	.62	.59	.54	.52
	.70	.98	.95	.90	.85	.80	.75	.70	.65	.60	.55	.53
	.80	1.0	.99	.95	.90	.85	.80	.73	.67	.61	.55	.53

	.90	1.0	1.0	.99	.97	.92	.86	.78	.70	.62	.56	.53

Base rate of 70%		**Selection Ratio**										
		.05	**.10**	**.20**	**.30**	**.40**	**.50**	**.60**	**.70**	**.80**	**.90**	**.95**
MEGA Select Validity	**.00**	.70	70	.70	.70	.70	.70	.70	70	.70	.70	.70
	.10	.77	.76	.75	.74	.73	.73	.72	.72	.71	.71	.70
	.20	.83	.81	.79	.78	.77	.76	.75	.74	.73	.73	.71
	.30	.88	.86	.84	.82	.80	.78	.77	.75	.74	.74	.71
	.40	.93	.91	.88	.85	.83	.81	.79	.77	.75	.75	.72
	.50	.96	.94	.91	.89	.87	.84	.82	.80	.77	.77	.72
	.60	.98	.97	.95	.92	.90	.87	.85	.82	.79	.79	.73
	.70	1.0	.99	.97	.96	.93	.91	.88	.84	.80	.80	.73
	.80	1.0	1.0	.99	.98	.97	.94	.91	.87	.82	.82	.73
	.90	1.0	1.0	1.0	1.0	.99	.98	.95	.91	.85	.85	.74

The previous page contains information Regarding the MEGA Select test. Based upon the information provided, what recommendations would you make regarding the: **a)** Using the MEGA Select test for hiring **Baristas** at Han Solo Coffee Company?
b) Using the MEGA Select test for hiring **Supervisors** at Han Solo Coffee Company?

1a) Should Han Solo Coffee Company use the MEGA Select test for hiring **Baristas**? Yes or No

_____

1b) Explain your answer above and be sure to specify what, specifically, you would you expect in terms of increasing the percentage of productive **Baristas** at Han Solo Coffee Company using the MEGA Select test?

2a) Should Han Solo Coffee Company use the MEGA Select test for hiring **Supervisors**? Yes or No _____

2b) Explain your answer above and be sure to specify what, specifically, you would you expect in terms of increasing the percentage of productive **Supervisors** at Han Solo Coffee Company using the MEGA Select test?

APPENDIX K: Training ROI Homework #2

Homework #5 Return on Investment

Student Name **M#**

- **Illegible and/or unintelligible responses will not be graded.**
- **Students are NOT permitted to work together on Homework assignments and evidence of doing so will be reported as an act of academic dishonesty.**

For the following assignment, pretend that you are the regional HR Manager at Food-To-Go, a national fast-food chain. You are responsible for all of the Human resource Functions and activities in your Region.

Food-To-GO has gotten complaints from customers that it is taking way too long to receive their order when they go through the drive-thru. The training department decided to conducted a training to help speed up the delivery of drive-thru orders.

Each grill cook will attended training for 3 days. Each employee attending training makes $13/hour and will be at training for 8 hours each day. The training department will supply each employee with $200 worth of food to practice during training for each day of training. Additional training materials will cost approximately $400 per employee for the entire 3 days of training.

After the competition of training the company notices a decrease in the time it takes to get each customer their food in the drive-thru. The average wait time decreased from 3 minutes to 2 minutes and 40 seconds. It has been evaluated that the training benefit for each employee is worth $600. The training also, helped to reduce errors made by the kitchen each day, resulting in a savings of $200 per employee.

$$\text{ROI (\%)} = \frac{\text{Program Benefits} - \text{Program Costs}}{\text{Program Costs}} \text{ x } 100$$

e. How much does it cost to send one grill cook to training?

_____

f. What are the calculated program benefits per employee?

_____

g. What is the calculated ROI (%) for this training program?

_____

h. Should Smart-Shop continue this using this training for their customer service representatives? Explain.

APPENDIX L: IRB Approval

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

IRBF016: INFORMED CONSENT

(Use this consent template when recruiting adult participants not considered as "vulnerable")

A. INFORMATION AND DISCLOSURE SECTION
(Participant Copy)

Primary Investigator(s)	Savannah Cain	**Student** ☒
Contact information	(608) 921-9485; snc4p@mtmail.mtsu.edu	
Department Institution	Psychology	
Faculty Advisor	Michael Hein Department Psychology	
Study Title	APPLYING THE LEARNING-BY-TEACHING METHOD IN A CLASSROOM SETTING	
IRB ID	**20-2050** **Expiration: 08/31/2020**	**Approval: 11/04/2019**

The following information is provided to inform you about the research project and your participation in it. Please read this disclosure carefully and feel free to ask any questions you may have about this study and the information given below. You must be given an opportunity to ask questions, and your questions must be answered. Also, you must receive a signed copy of this disclosure.

Your participation in this research study is voluntary. You are also free to withdraw from this study at any time. In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study.

For additional information about giving consent or your rights as a participant in this study, please feel free to contact the Middle Tennessee State University (MTSU) Office of Compliance (Tel 615-494-8918 or send your emails to irb_information@mtsu.edu. Please visit www.mtsu.edu/irb for general information on MTSU's research participant protection policies.

Please read this section and sign Section B if you wish to enroll in this study. The researcher will provide you with a copy of this disclosure form for you to keep for your future reference.

1. **Purpose of the study:** You are being asked to participate in this research study because the learning-by-teaching model has been shown to increase learning gains in students. The learning-by-teaching model has mostly been conducted in a lab setting, so the present research attempts to see if it still produces significant results in a classroom setting.

2. **Classification of procedures to be followed and approximate duration of the study:**
   - ☒ **2.1** ***Educational Tests***
   - ☐ 2.2 ***Behavioral Evaluation***
   - ☐ 2.3 ***Psychological intervention or procedures***
   - ☐ 2.4 ***Physical Evaluation or Procedures***
   - ☐ 2.5 ***Medical Evaluation or Clinical Research***
   - ☐ ***2.6 OTHER***

3. **What are procedures we intend on doing in this study?**
   You will be asked to complete a homework assignment for class that will involve you video recording yourself teaching an assigned topic.

4. **What will you be asked to do in this study?**
   You will be asked to video record yourself teaching material.

5. **What are we planning to do with the data collected using your participation?**
   We plan to use your video homework assignment grade, your homework grades on your Training ROI and Taylor-Russell tables, and your exam question scores that relate to Training ROI and Taylor-Russell tables.

6. **What are the expected results of this study and how will they be disseminated?**
   The researchers anticipate that whichever material a student teaches (Training ROI or Taylor Russell tables), that the student will perform better on the exam questions pertaining to the topic they taught (Training ROI or Taylor Russell tables). The researchers will evaluate each students exam scores in order to determine if they did better on either Training ROI or Taylor Russell tables material.

7. **What are your expected costs to you, your effort and your time commitment?**
   Your time commitment will be no more than you usually spend on homework/studying in this class.

8. **What are the potential discomforts, inconveniences, and/or possible risks that can be reasonably expected as a result of participation in this study?**
   There are little to no risks involved with this study. The homework assignments you are completing are usually a part of the class regardless of this study being completed. The only additional homework assignment that you will have to complete is the video assignment, which is being implemented into the course specifically for this research.

9. **How will you be compensated for your participation?**
   You will not be compensated for your participation

10. **What are the anticipated benefits from this study?**
    a. **The benefits to science and humankind that may result from this research:** This research benefits science because to the researchers' knowledge the learning-by-teaching method has not been studied in a classroom setting. All previous research on learning-by-teaching has been conducted in a lab setting or having students training an avatar. This research will further develop researcher's understanding of this technique and if it could eventually be implemented into school curriculums and the workplace.
    b. **The direct benefits to you which you may not receive outside the context of this research:** The direct benefits to participants is that they will have the opportunity to learn a new study technique that may be effective to use in future classes

11. **Will you be compensated for any study-related injuries?**
    You will not be compensated for any study-related injuries.

12. **Circumstances under which the researcher may withdraw you from this study:**
    Your data may be withdrawn from the study if you are missing more than 2 pieces of important data, such as an exam or homework score.

13. **What happens if you choose to withdraw your participation?**
    You will still need to complete the assignment as it is being used for the class. However, you data will not be included for the study.

14. **Can you stop the participation any time after initially agreeing to give consent/assent?**
    You may withdraw from participation at anytime.

15. **Contact Information.** If you should have any questions about this research study or possibly injury, please feel free to contact Savannah Cain by telephone 608-921-9485 or by email snc4p@mtmail.mtsu.edu OR my faculty advisor, Michael Hein, at michael.hein@mtsu.edu. For

additional information about giving consent of your rights as a participant in this study, to discuss problems, concerns and questions, or to offer input, please feel free to contact the MTSU IRB by email: compliance@mtsu.edu or by telephone (615) 494 8918.

16. **Confidentiality.** All efforts, within reason, will be made to keep the personal information in your child's research record private but total privacy cannot be promised. Your information may be shared with MTSU or the government, such as the Middle Tennessee State University Institutional Review Board, Federal Government Office for Human Research Protections, *if* you or someone else is in danger or if we are required to do so by law.

You do not have to do anything if you decide not to participate. If you wish to enroll, then enter your name and age in the attached Section B document and sign in the space provided. Return Section B to the investigator and retain this information sheet for your future use.

Consent obtained by:

_____ _____

Researcher's Signature Name and Title Date