 doi:10.20944/preprints201904.0273.v1

Article

Are the Sequential Interactive Effects of Two Active Learning Strategies Synergistic? Using the Socratic Method of Questioning and Ability Based Learning

La Shun L. Carroll[1]

[1] Graduate School of Education, University at Buffalo

1. Introduction

Many students graduate college inadequately prepared even after completing all of the required coursework. In fact, recent research conducted on more than 2,300 undergraduates found that 45 percent of students show no significant improvement in the key measures of critical thinking, complex reasoning and writing by the end of their sophomore years [1] (Arum & Roksa, 2011). These same students are hired by employers who, according to an American Association of Colleges and Universities research survey, find that students feel more prepared than they are [2] (Education.com, 2015).

If students do not fully apply themselves, then they may be considered responsible for the result of being inadequately prepared. Nevertheless, such poor results are more likely a surface level reflection of a deeper systematic problem with the overall course architecture than resting with the students themselves. The group of high-achieving students continues to learn in the very same educational environments as all students. Regardless whether it is their intellectual capacities solely, or in combination with cognitive processes related to approaching learning and particular instructional methodologies implemented, these individuals are the link, and a qualitative strategy of inquiry should provide insight into how to approach the educational process best as a student learner and what steps educators may take to improve it for all students.

Deficiencies in preparation adversely and directly affect students' productivity upon entering the workforce and negatively influences their ability to maintain gainful employment and provide for their families, and inevitably contributes to developing issues concerning their psychological well-being. The development of mental and behavioral health problems in new graduates can be attributed to the predicament in which they find themselves governed by Proposition seven of what has been referred to as the Insecurity Thesis.

As presented in the text by Heery & Salmon [3] (2000), the uncertain or insecure nature of employment conditions not only impose economic costs on employees but psychological costs as well (p. 7). Specifically, as a result of the inadequate academic preparation in this case, the detrimental effect that job insecurity has on the psychological well-being of people includes heightening levels of anxiety, depression, feelings of uselessness, waning self-confidence, and overall dissatisfaction with oneself and one's environment [4] (Nolan, Wichert, & Burchell, 2000). In the event this trend continues, far-reaching effects also have the potential to include stifling societal maintenance and progression indirectly due to diminishing returns, as resources continue to be directed toward an educational process that has not lived up to its full potential.

Despite there being a disproportionate number of students who graduate without adequately learning the subject material in addition to essential skills such as critical thinking and effective

communication, there are a select few who excel academically and are successful learners. To learn the key to success, one must learn from cases of success, which are both necessary and sufficient with regard to the issue of dealing with success and its negation (i.e., cases in which one does not succeed referred to cases of failure).

From the perspective of the researcher as an observer, when one approaches the study of successes regardless of the context in which they occur, it can be argued that while learning from the failures may provide the best opportunities for growth from the perspective of those who actually fail (i.e., what they are doing incorrectly), without cases of success to which to compare there can be no way for those who fail to know what deficiencies they need to correct in order to derive benefit; therefore, for those who fail the study of success is both necessary and sufficient to achieve the goal of learning how to succeed. Nonetheless, from the perspective of those who do succeed and the researcher as observer investigating, the study of successes without including the failures will always be self-sufficient because, while it may be helpful, the comparison to failures is unnecessary to ascertain what works (i.e., results in success) so that those who fail may derive benefit from the research.

If there were an equal number of ways to both succeed and not to succeed, then the probability of achieving success would be fifty percent, which would imply that success is no more determined than chance. Nevertheless, this cannot be the case since successful students regardless of their experience with failure are ultimately significantly more successful than what would be predicted by chance alone, or they are considerably less successful than chance predicts. Furthermore, no matter how many events were attempted with different approaches resulting in repeated failures, although the probability of succeeding for any given student may initially fluctuate or decrease with every trial, once the knowledge of how to succeed is gained after a trial or event, thereafter, success becomes permanent with probability steadily increasing, as each subsequent trial occurs. Therefore, disproportionate yet significantly greater, or fewer, trials of success over time cannot be purely due to a chance occurrence substantiating them as the primary focus of the research.

2. Background

The traditional educational process is designed around learning experiences both inside and outside of the classroom. There are two concepts of learning that are well-established in the literature. Learning may be either a product or a process. Those who view learning as a product measure its relative success or failure based on the observation of results achieved [5] (Carr, 1992). Conversely, others who view learning as a process consider the changes in the behavior of an individual that occur over time as a result [6] (Lachman, 1997). The focus on behavioral changes in this definition is common among traditional behaviorists [7] (Learning-Theories, 2016). Regardless of the concept of learning with which one agrees, the educational system has been established to achieve this end and aims to accomplish it through various instructional methodologies.

3. Literature Research Strategies

The key search terms used were learning, student, theories, instruction, and active learning. The research strategy employed consisted of first utilizing the University at Buffalo Libraries to conduct a general inquiry to obtain an idea of what was available using the terms as mentioned above, as well as google scholar. The author used these initial results to outline a path based on important concepts related to this study from the core understanding of learning. To ensure there was as full a selection of works as possible, a query using the same key terms was conducted on eric.gov, using EndNote, and Questia. The important concepts were used to provide explanations for, and contrast between concepts that were pertinent to the author's research allowed for the development of the context for the framework of this study. Both current literature and seminal works were considered based on relevance to the topic and not solely the date.

Instructional methodology can is the manner in which educators deliver information to their students [8] (University of Tennessee, 2016). Within the context of educational environments, the

choice of instructional delivery of course content may result in either of two forms of learning by the student: Passive and Active.

Passive learning, which is associated with the behaviorist view of learning, is typified by the experience from the perspective of the student who plays no role in the learning process [7] (Learning-Theories, 2016). An example of passive learning occurs in classes taught through traditional lecturing formats where students must sit and listen but are prohibited from discussion amongst themselves and questioning is discouraged. In contrast to this, active learning occurs within the context of educational settings that permit and encourage students to be involved in what they learn by thinking while they are doing the learning [9] (Bonwell & Eison, 1991).

The rationale behind active learning is that by having students participate in the process, the experience becomes more meaningful and personal. Through participation combined with frequent assessments that allow for real-time feedback and adjustments, there is an overall reduction in delay receiving timely input from educators so that they may take corrective measures.

The assessments that occur throughout the learning process are known as formative and may be thought of as helping to shape or "form" the learning of the student with rapid feedback from educators or experts [10] (Carnegie Mellon University, 2008). These structured and non-structured formative assessments that comprise active learning strategies are in contrast to the summative assessments that occur at the culmination of the traditional learning process. Summative assessments aim at gauging the result of the instruction to evaluate what students have learned [10] (Carnegie Mellon University, 2008). Strategies of instruction that incorporate both forms of evaluation in addition to encouraging student cognitive and corporeal engagement are responsible for the beneficial effects observed when employing active learning in educational environments.

The assessments that occur throughout the learning process are known as formative and may be thought of as helping to shape or "form" the learning of the student with rapid feedback from educators or experts [10] (Carnegie Mellon University, 2008). These structured and non-structured formative assessments that comprise active learning strategies are in contrast to the summative assessments that occur at the culmination of the traditional learning process. Summative assessments aim at gauging the result of the instruction to evaluate what students have learned [10] (Carnegie Mellon University, 2008). Strategies of instruction that incorporate both forms of evaluation in addition to encouraging student cognitive and corporeal engagement are responsible for the beneficial effects observed when employing active learning in educational environments.

4. Review of Relevant Literature

Research findings support the conclusion that traditional methods of instruction such as lecturing that result in passive learning are ineffective at sustaining the attention of students. Stuart & Rutherford [11] (1978) note that findings suggest that student concentration dwindles after the first ten to fifteen minutes of a traditional lecture. Such a loss of focus has also been found to negatively impact students' ability to retain information beyond the initial ten minutes of lectures [12] (Thomas, 1978). The author finds that, although it may be ineffective by itself in the traditional format, these findings appear to portray lecturing in a negative light. Nevertheless, the problem is not the lecturing itself; it is the passive learning forced on the students to whom the lecture is given.

In light of the passivity mentioned above students are expected to endure, an attempt to address the need for student engagement in traditional lecture courses has led to research that offered ways to transform the lecture into a more interactive experience. By capitalizing on the strengths of the lecture with minimal to no modification, the strategies that were developed and refined took into consideration what was discovered about concentration and attention span to integrate periodic breaks from lecturing and allow both structured and non-structured student interaction [13] (Rowe, 1980; Mazur, 1997). Although the reduction of lecture time to increase educational outcomes may seem counterintuitive, by reducing the amount of lecturing time in a course, students were ultimately deriving greater benefit by actually coming away learning more. Thus, it seems as though the slightest

addition of an active component in the learning process was positively correlated with gains in student learning. Nevertheless, the student interaction activity was comprised of a combination of different things, which makes defining the individual contributions of each component of the activity problematic.

A review of the literature confirms that employing active learning strategies does produce significant positive effects on learning. Interactive lecturing as a form of active learning has been shown to be significantly more effective in producing learning as an educational outcome [14] (McKeachie et al., 1987). In addition, [15] also found significant gains in conceptual knowledge and increases in problem-solving examination scores compared to traditional lecturing methods of instruction when such strategies are employed. Furthermore, increases in positive student outlook, attitude, and tenacity have been positively correlated with the active engagement of students in small collaborative discussion groups in addition to increases in formative assessment during the learning process when compared to traditional instruction methods (Springer, 1998; Knight & Wood, 2005).

Although progress has been made with respect to representation in the extant literature being more reflective of the types of individual strategies that exist, only the benefits of implementing particular active learning strategies have been reported; there is insufficient data on the cumulative or interactive effects.

There is a consensus among authors responsible for studies published on active learning in that they share similar opinions regarding the shift toward engagement during education. Cross (1987) stated that more learning occurs when students are actively engaged in the process as opposed to passively involved. Cross' remarks are consistent with those who feel that active involvement, either cognitively or physically, is how students learn (Astin, 1985).

The author's interpretation of these remarks is that actively involving students appears to provide meaning on a personal level, which reinforces the importance of the students' participation. Regardless of how many students may be in a particular class, or group, on a personal level, the participation grounds them firmly within the experience. It is such grounding that imparts a deontological aspect to the process in that students feel a sense of duty or obligation to learn, which will compel them to give whatever effort necessary to achieve that end.

Based on the author's review of the literature, there seems to exist a disconnect between what students feel they are supposed to be experiencing in the learning process and what they do experience in traditional classroom environments. For many, old lecturing formats offer no incentive to attend class since the students feel as though they could derive more benefit from the reading own their own than by passively sitting in a lecture hall. This mindset of the students underscores the importance of implementing active learning strategies in the educational environment; doing so not only increases learning but it reinforces classroom attendance by incentivizing it with engagement, personal involvement, and gains in knowledge.

Whether the strategy is simply lecturing less as in the pause procedure (Rowe, 1980), utilizing classroom assessment techniques (CATs) of Angelo and Cross (1993), or incorporating technology to mediate the active learning as in TechoCATs (Lieberman & Creed,), as long as students are engaged by the instructional method of the educator and actively participate while thinking about what they are doing the process will significantly increase learning.

It is difficult to deny that there is a significant increase in student learning as a result of employing instructional methodologies that rely on active learning strategies. Nonetheless, while not outright in opposing active learning, there have been some who are reluctant to incorporate such strategies for a number of reasons each of which may be countered. Although implementation of active learning strategies from the perspective of the educator appears to reduce or limit the amount of total available time to cover required content, this argument does not preclude the use of techniques requiring little if any additional time.

In fact, the pause procedure previously mentioned (Rowe, 1980) has shown that, with a reduction in lecture hours, students were able to increase performance on tests that reflect an increase in learning.

Furthermore, educators opposing the use of active learning by citing barriers to employment such as preparation time, the number of students, or that students will be hesitant to make use these strategies are also unjustified in their reluctance. There are currently available prepared resources for activities to implement (Angelo & Cross, 1993), personal response systems or clickers that are readily available for large lecture classes (MacArthur & Jones, 2008), and students are very receptive to active learning strategies when provided instructions on how to do so.

The author's research has been designed to with the purpose of filling a void that exists in the literature concerning the interactive effects of components along the active learning spectrum. While some of the active learning strategies consist of a conglomeration of techniques aimed at engaging students with the information they learn, others are relatively pure strategies. The importance of these relatively pure strategies is that they allow the researcher to manipulate or observe them separately, which could potentially lead to discovering optimal pairs and ordering that will maximize student learning according to experiments investigating how two or more active learning techniques result in effects from the interaction. The author hypothesizes that the interactive effects of active learning strategies are synergetic; pairing them results in interactive effects that exceed the principal effects of either strategy implemented individually.

The research hypothesis is that the interactive effects of the two active learning strategies in the study, the Socratic Method of Questioning and Ability Based Learning, are significantly greater than the sum of the individual main effects. The rationale behind this hypothesis is based on it being highly unlikely that combining two individually positive main effects could result in less of an effect than the sum of the individual effects. The null hypothesis for this study is that there will be no significant difference between the interactive effects of the two active learning strategies in the study and the individual main effects of these strategies.

5. Significance of Study

The importance of this study is that by determining the interactive effects of paired active learning strategies, classroom instruction may be customized to enhance student learning and overall experience. The results will address the stated research problem by assisting educators in implementing specific research supported sequences or complementary active learning strategies, which will have been shown to improve educational outcomes.

By conducting this study, there is the potential to obtain findings that may later be used to combine and customize them to maximize interactive effects related to student learning. Future research can be directed toward optimizing main effects through studying the outcomes of combinatoric course design that implements the most effective pairs of active learning strategies into clusters that may be geared to the subject, gender, content amount, and specific ordering. The author believes that his approach could potentially improve the impact that active engagement has on student learners by guiding subsequent research into the best approach to customization of active learning techniques to increase effectiveness, efficiency, and economy of content delivery in the higher educational setting.

6. Methodological Approach and Rationale

The purpose of the proposed study is to investigate whether there exist interactive effects between two active learning strategies and gender to determine the influence on student learning. The active learning strategies are the independent stimulus variables representing active learning techniques as instructional methods to deliver course content, and the classification variable of gender will allow a determination to be made as to whether or not interactive effects may exist for one and not the other gender. It will be determined whether interactive effects may be employed to augment and adequately prepare students through learning as an educational outcome in a classroom setting for undergraduates enrolled at the university.

Rationale. Despite the fact that individual active learning techniques having been shown to influence learning with respect to their contribution to the process of learning as a whole, it is rarely

 doi:10.20944/preprints201904.0273.v1

the case in the real world setting that only particular techniques can or will be employed during any given educational experience. To increase the ecological aspect of external validity, it would prove beneficial to represent the actual world environment more accurately. A more accurate representation of the natural educational setting and conditions may be accomplished by investigating pairs of active learning strategies at the very least. However, there is a paucity of evidence in the literature directed toward understanding the occurrence of interactive effects of multiple active learning techniques. This proposed research study is aimed at producing evidence of the effects of such interaction among active learning strategies if they exist as the author believes.

7. Research Design and Epistemological Assumptions

This study will be conducted within the context of a research paradigm based on axiology, ontology, and epistemology (Terrell, 2009). From an axiological standpoint, the author views learning, or the acquisition of knowledge, as a process and not merely a product (Lachman, 1997). Learning in any form provides the greatest value to humankind, and it may be transferred in a variety of different manners. The author also assumes that students are choosing to take courses of their own volition and are applying themselves 100% when enrolled. Based on this assumption, the author views both educators and researchers, as being ethically obligated to uphold the principles of beneficence, non-maleficence, the autonomy of participants, and justice in conducting any study.

Ontologically, regardless of whether or not the existence of multiple objective realities can be confirmed, assuming that relatively speaking the reality of the educator is fixed as it exists within the scope of an educational environment, the educator who employs a variety of techniques for multiple students whose realities (i.e., learning style) may differ ensures that the greatest number of students may benefit. Using an analogy, were the author to place a locked gate to a secure area combined with a sign containing the universal warning color red, the written word stop, a figure depiction with a circle around it and line through it, and an audio announcement "Stop, people not allowed," the realities of the color-blind, the illiterate, the deaf, and the dumb, the author has taken multiple possible steps and accounted for the possibility of each to "learn" within the context of their individual realities through my singular reality.

Lastly, concerning epistemology given the nature of learning, the author views his role as a researcher in an active light as far as active participation does not have the potential to detract from or call into question, the validity of the results of the study. The author will participate in the determination of which measurement devices will be utilized, how they will be administered, and designing the experimental and control conditions. Nevertheless, the author will not personally interact with the participants during the studies, which means the author will be conducting research from an etic (i.e., outsiders) perspective. Therefore, in consideration of the author's stances and the overall aim of this study, the format the author will employ to conduct the research will be that of a combined experimental and causal-comparative methodology mixed-factor two-by-two-by-two factorial design.

Research Design Rationale. There are four aspects concerning the content of courses and curricula associated with student learning, which affect students' educational outcomes: 1) manageability, 2) relevance, 3) sufficiency, and 4) instructional methodology. Considering each of the four aspects is critical to the overall outcome of student learning and may together be nearly as crucial to the success of educational outcomes as the students themselves. Nevertheless, they are not of equal importance to one another. In fact, a meta-analysis has recently shown that aside from what the student brings to the educational experience, the educator accounts for the most variance in learning (Hattie, 2015).

Although Hattie (2015) believes that the method of teaching may likely be less critical than any attributes of the instruction in the method (p. 8), The author does not make a distinction between such attributes of the teaching within a method and the method employing the teaching that has the attributes. It is the educator's instructional methodology comprised of his or her attitudes, expectations, and behaviors that the author interprets as providing a buffer for course content and influences student

learning by compensating for accidental or intentional excesses resulting from any of the remaining three aspects of course content.

Specifically, active learning strategies and techniques possess the attributes that have been very effective in educational settings. However, the literature contains many articles on the main effects of these active learning techniques; little to nothing has been done on the interactive effects. It is for this reason that the proposed study will be that of a combined experimental and causal-comparative methodology mixed-factor two-by-two-by-two factorial design true experiment: Active learning strategy 1 (used or not), active strategy 2 (used or not) and gender (male and female).

8. Definition of Terms

Instructional methodology integrates the manageable, relevant, and sufficient amount of subject content and determines the most effective, efficient, and economical modes of transferring the information to the students (University of Tennessee, 2016). Active learning strategies will be defined as any instruction that involves students in doing things that get them to think about what they are doing (Bonwell & Eison, 1991). Learning is viewed as a process by the author that incorporates a product and will be defined as a relatively permanent alteration in one's behavior resulting from previous experience (Lachman, 1997).

Participants and Sampling Procedures

The total number of participants in the experiment will be ninety-six and be comprised of four groups of twenty-four students each. Each group will consist of twelve male and twelve female students with equal proportions among the groups matched based on pretest performance. The participants in the study will be selected from among second and third-year undergraduate students in attendance at the University at Buffalo enrolled in a physical sciences course by stratified sampling to obtain as representative a sample of the population as possible (Keppel, 1991). Upon being selected, the individuals in the participant pool will be randomly assigned to groups with the participants proportioned for gender in each of the four groups, as well as matched according to pre-test performance levels with respect to gender.

Rationale. Randomization of participant selection and the sampling assignment was chosen to minimize bias. Moreover, randomization will allow the findings to be attributed to systematic effects, and examine the causal relationship between the independent and dependent variables. Furthermore, such procedures also enhance the external validity and population validity.

To be able to detect any differences when they truly exist, the power of the experiment will be maximized. Although getting a false negative may be considered preferable to getting a false positive, erring in favor of such type 2s negatively impacts the power of the experiment. Therefore, in addition to efforts made to minimize errors in sampling and measurement, using a large enough sample, as well as the decision to use parametric tests to analyze the data that will be obtained, the additional step of relaxing the alpha (Martella, 2013) was taken.

The desired effect of increasing the alpha level (i.e., relaxing) does mean that more type 1 errors (i.e., false positives) are likely to occur if the null hypothesis is true and differences occur by chance. Nevertheless, relaxing the alpha results in the reduction of type 2 errors (i.e., false negatives), which has the benefit of increasing ability to detect systematic variance when it is present and not due to chance. In light of this, the selected alpha (level of statistical significance) for the experiment was set at 0.10.

The random assignment to the groups will be done to ensure that there is no systematic bias influencing the results, which allows any observed differences to be attributed to the intervention (Kepple, 1991; Martella, 2013). All data obtained from participants will be anonymized to ensure that ethical and privacy considerations have been addressed.

9. Location and Setting for Study

Ideally, arrangements for this study to be conducted will be made at an undergraduate university in a classroom setting during an introductory physical science course in which each student is enrolled. Nevertheless, modifications may be made to accommodate available time and resources.

Rationale. The higher education classroom environment is suitable for the site of the experiment because it is where the intervention occurs in the natural setting. Generalizability of any significant findings will be straightforward since the conditions in the experiment closely resemble that of the real-world. Separation into groups is essential to distinguish interventional influences from one another and avoid threats to internal validity that could potentially result in similarities within or between individuals. The educators and researchers involved in the study will be calibrated for the task involving the pretest, implementation of stimulus variable(s), and post-test assessment evaluation.

Double-blinding of both evaluators and participants involved will be done. Double-blinding will ensure that the findings are not influenced by bias and do not to threaten the validity of results. By providing all experimental educators an equivalent number (i.e., two) of interventional technique stimulus variables none of them will know which are experimental versus control. Furthermore, student participants in all four groups will be provided equally desirable alternatives as interventions to neutralize any resentful demoralization that could result in similarities between or within individuals.

10. Data Sources/Materials/Measures

There will be two independent (i.e., stimulus) variables that were chosen from available active learning strategies in the literature. One will be the Socratic method of questioning, and the other will be ability-based learning assessment as teaching.

The Socratic method of question attempts to stimulate metacognition, which is often referred to as cognitive awareness where one thinks about thinking (Zhao, 2014). Metacognition makes the students reflect on their thought process, analyze their assumptions, and question their evidence (Gleason, 2011). Ability-based learning uses frequent evaluation and feedback from peers, educators, or experts that become part of the learning process (Gleason, 2011). This strategy involves: clearly explaining ability outcomes of teaching, ample opportunities to practice developing ability outcomes, specific performance criteria are indicated, so students know what is expected to be a good performance, and lastly students receive assessment and feedback with clear indications so that they may correct deficiencies and increase performance during the next assessment.

Rationale. Each active learning technique has been shown to influence learning as separate main effects. However, there were no experiments located in the literature designed to investigate the existence of interactive effects of active learning strategies. This study will be conducted to fill the gap in the literature in an effort to determine the presence of interactive effects between active learning strategies on the dependent variable of student learning.

There will be four groups in total, and each group of participants will be exposed to equally desirable strategies. The first group will consist of control instructional strategies which are basic lecturing. The second group will have one active learning strategy employed with the control strategy. The third group will have the other active learning strategy used with the control strategy. The fourth group will have both active learning strategies employed.

Given the population from which the sample will be selected is likely heterogeneous for certain variables, there is a potential these could influence the outcome of the study. To account for this possibility within each group, there will be ten randomly selected and assigned participants using a stratified random sampling procedure to stratify for gender and pretest performance. Every effort to assign ethnic representation equally to each of the groups will be made as well. All participants will take a pretest assessment so that threats to internal validity based on pretesting should not be the result of this.

Data will be obtained from both pretest and posttest measurements using the same previously established reliable and valid measurement device. The device that we will use is called Learning for

Mastery: A Formative Evaluation Quiz to Test Your Knowledge of Bloom's Concept and consists of a twenty-item quiz. The instrument is an assessment measure to facilitate learning based on Benjamin S. Bloom's Learning for Mastery, which measures students' knowledge of Bloom's concepts and is contained in the Handbook on Formative and Summative Evaluation of Student Learning (Educational Testing Services, 2000). The device is described as being used for higher education, college students, diagnostic testing, pretest-posttest assessment, learning activities, which makes the adoption of this measurement instrument appropriate for this research design and purpose.

11. Data Gathering Procedures/Procedures

Data gathering will be done both pre-intervention and post-intervention. The assessments will be anonymized with gender as the only information needed for equal gender assignment to groups. Gender will be revealed after both scoring by machine, and visual inspection is completed to eliminate bias. The stimulus variables will be implemented and a posttest assessment administered. Again, machine scoring will be followed by visual inspection. Then statistical analysis will be performed.

Rationale. The measurement device will be administered to the participants first to obtain pretest performance data. The anonymized results will then be obtained by using a scantron or similar type of response card. While there are computer-based assessment tools that may be more efficient, the ability to have a machine and human scoring and verification is desirable since each alone may make errors. Each of the evaluators will review all of the participants' answers on the score cards to make sure that the machine correctly read the responses and scored them appropriately. The results will be ranked into three relative levels and gender: high, medium, and low with male and female.

The participants will then be randomly assigned to one of the four groups on the basis of their scores on the measurement instrument stratifying for gender, which will allow for equal representation for all groups and potentially discern effects based on them as well as gender. Each of the four groups is exposed to conditions within the context of the course material to be taught such that neither the calibrated instructors nor any of the participants know what results are experimental ones of interest. Measurement instruments are then administered to obtain posttest data for the dependent variable of student learning from all four groups. The posttest is collected, the scantron cards will be scanned, and all evaluators will visually inspect the anonymized scoring. The posttest performance results of the groups on the posttest are compared and analyzed using tests of statistical significance.

12. Analysis Procedures and Scoring

Descriptive statistics will be provided including mean, standard deviation, and range. Due to the pretest-posttest control group design of this study, analysis of co-variance (ANCOVA) will be used to analyze the data.

Rationale. ANCOVA was selected because we need to determine whether a difference between two or more groups on an individual variable can be at least partly explained by differences that may exist in the groups on another variable (Martella, 2013). Utilizing ANCOVA will allow the pretest assessment scores to be treated as a covariate when comparing the posttest scores of the groups and statistically controls for any real differences between the pretest of the control and experimental groups. ANCOVA is the most powerful in that it improves the likelihood of the researchers detecting the effects of the independent variables if they do not occur by chance alone (Martella, 2013). The results will be interpreted concerning whether or not we rejected or failed to reject the null hypothesis based on the level of significance chosen. If results were not what was expected, explain possibilities that explain why or if threats to validity may have caused them. Lastly, the author will discuss whether the results can be generalized the results to the population and what are the potential implications of such an ability to generalize. All data obtained from participants will be anonymized.

 doi:10.20944/preprints201904.0273.v1

13. The Procedure

The measurement device will be administered to the participants first to procure anonymous pre-test performance data. The participants will be randomly assigned to one of the four groups by their scores on the measurement instrument stratifying for gender. Each of the four groups is exposed to conditions such that neither the calibrated instructors nor any of the participants know what results are experimental ones of interest. Measurement instruments are used to obtain posttest data for the dependent variable from all four groups. The performance results of the groups on the posttest are compared and analyzed using tests of statistical significance.

Rationale. The pre-test with post-test control group design was chosen to assess the impact of the stimulus variable as an intervention. The stratified random sampling and assignment were done to allow the detection of the causal relationship to be determined if it in fact exists. Moreover, anonymization of the procedure, the double-blinding, and the calibration minimize evaluator bias, threats to validity, and increases competence in the administration of assessments and implementation of the independent variables.

14. Data Analysis

Descriptive statistics will be provided including mean, standard deviation, and range. Also, analysis of covariance (ANCOVA) will be utilized to analyze the results to be interpreted.

Rationale. Due to the pretest-posttest control group design of this study, analysis of co-variance (ANCOVA) will be used to analyze the data because we need to determine whether a difference between two or more groups on a certain variable can be at least partly explained by differences that may exist in the groups on another variable (Martella, 2013). Utilizing ANCOVA will allow the pretest assessment scores to be treated as a covariate when comparing the posttest scores of the groups and statistically controls for any existing differences between the pretest of the control and experimental groups.

ANCOVA is the most powerful in that it improves the likelihood of the researchers detecting the effects of the independent variables if they do not occur by chance alone (Martella, 2013). The results will be interpreted with regard to whether or not we rejected or failed to reject the null hypothesis based on the level of significance chosen. If results were not what was expected, explain possibilities that explain why or if threats to validity may have caused them. Lastly, The author will explain the ability to generalize the results to the population and what are the potential implications of such an ability to generalize. All data obtained from participants will be anonymized.

15. Establishing Trustworthiness/Inter-rater Agreement/Inter-rater Reliability

Although inter-rater agreement and reliability are not applicable due to the quantitative paradigm of this research study, the establishment of trustworthiness of the evaluators is paramount. Without trustworthy assessments or interventions, there is no way to make any meaningful inferences from the findings. The can be no external validity without prior internal validity, which is why The author value trustworthiness so highly.

The author intends to establish and reinforce the integrity of the evaluators by blinding to minimize the opportunity for trustworthiness to be a factor. Any attempt to intentionally or accidentally sabotage the findings will be significantly reduced since the evaluators will be calibrated to deliver interventions will not know which of them is experimental. Furthermore, although this quantitative nature of the rating renders interpreting scores on assessments impossible, any biases that the evaluators may bring will be neutralized by anonymizing participants assessments so that during the scoring process participants cannot be unfavorably targeted or have their results altered by raters. In this manner, an unscrupulous evaluator would have a ten percent probability of sabotaging the students that he or she wanted, and the participants are all equally likely to be affected by such behavior.

16. Limitations to Methodology

The pretest–posttest control group design of this study controls for the following threats to internal validity: history, maturation, testing, instrumentation, statistical regression, selection, mortality, and selection by maturation interaction, which threaten the internal validity that potentially cause changes in the results of the experimental group (Martella, 2013). Although experimental treatment diffusion, compensatory rivalry by the control group, compensatory equalization of treatments, and resentful demoralization of the control group all have the potential to threaten the internal validity by causing changes in the performance of the control group, because the design gives the control groups an equally desirable intervention threats to internal validity that result in similarities within or between individuals was a concern.

The threats to external validity that are controlled for include multiple treatment interferences, novelty and disruption effects, the Hawthorne effect, pretest sensitization, and posttest sensitization. Novelty, disruption effects, and the Hawthorne effect are not concerns as threats to the external validity since the design provides an equivalent alternative intervention in all groups. Pretest sensitization should not pose a threat since the pre-test does not have a powerful effect on the experimental intervention that would favor the experimental groups more than the control groups. The design of this study makes novelty, disruption, Hawthorne, and sensitization effects of little concern or equally likely to occur for all participants, which means that it is highly unlikely for one of the groups but not all having results threatened.

Of all of the threats to external validity that are applicable ecologically, the interaction of time of measurement and treatment effects would always be a concern. The extent to which the effects of the independent variable on the dependent variable will maintain through time cannot completely be controlled for will multiple posttest measurements at various points in time. Doing so will introduce the potential for many of the other threats to influence the results at subsequent points in time. The only way to mitigate those potential threats would be to keep participants in the groups indefinitely barring access to the outside world, which is unethical.

References

1. Arum, R.; Roksa, J. *Academically adrift: Limited learning on college campuses*; University of Chicago Press: Chicago, IL, 2011.
2. Success, F.S.C.L.C., 2015.
3. The Insecure Workforce; Routledge: London, 2000.
4. Nolan, J.P.; Wichert, I.C.; Burchell, B.J. 9: Job Insecurity, Psychological Well-Being and Family. *Public Administration Quarterly* **2000**, *35*, 181–203.
5. Carr, D. Education, Learning and Understanding: the process and the product. *Journal of Philosophy of Education* **1992**, *26*, 215–225.
6. Lachman, S.J. Learning is a Process: Toward an Improved Definition of Learning. *The Journal of Psychology* **1997**, *131*, 477–480.
7. Theories, B.L., 2007.
8. of Tennessee, U. Instructional Methods, 2016.
9. Bonwell, C.; Eison, J. Active learning: Creating excitement in the classroom. *ASHE-ERIC Higher Education Report* **1991**, *1*.
10. Formative vs Summative Assessment -. *Eberly Center* **0**.
11. Stuart, J.; Rutherford, R.J. Medical student concentration during lectures. *The Lancet* **1978**, *2*, 514–516.
12. Thomas, E.J. The Variation of Memory with Time for Information Appearing During a Lecture. *Studies in Adult Education* **1972**, *4*, 57–62.
13. Mazur, E. Confessions of a converted lecturer. *Waterloo University, Www. Youtube. Com/watch* **2009**.
14. McKeachie, W.J.; Others, A. Teaching and Learning in the. *College Classroom. A Review of the Research Literature* **1987**.
15. Hake, R.R. Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics* **1998**, *66*, 64–74.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 24 April 2019 doi:10.20944/preprints201904.0273.v1

Author biography

La Shun L. Carroll La Shun L. Carroll obtained his Ed.M. from the University at Buffalo Graduate School of Education after earning his Doctorate, Cum Laude from the University at Buffalo School of Dental Medicine. Dr. Carroll obtained his B.A., graduating Magna Cum Laude, majoring in Philosophy from Baruch College. His publications include "Theoretical Biomimetics: A biological design-driven concept for creative problem-solving as applied to the optimal sequencing of active learning techniques in educational theory" in Multidisciplinary Journal for Education, Social and Technological Sciences (October 2017), and “A Comprehensive Definition of Technology from an Ethological Perspective” (MDPI, 2017). Research interests include metaphysics, logic, science, technology, and education. Dr. Carroll was an Adjunct Professor at Saint Michael’s College.