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Active Learning: A New Assessment Model that Boost Confidence and Learning While Reducing Test Anxiety

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Abstract—Tests are a source of anxiety and have proved to impact the grades among students. In addition, students do not have the time to prepare for their exams. The ultimate goal of the instructor is to create and offer an environment that reduces the examination stress while maximizes learning in the little time available to the students. The demand on students' available time is a major challenge. Although active learning has been utilized to increase student engagement and ultimately increase learning, it has never been used to reduce the test anxiety, increase learning in relation to available-student-time or attempt to increase learning with respect to available student time. Student time has been recognized as the most precious resource in learning. This paper proposes a mechanism of active learning, when employed can create an environment for less stressful exam taking while boosting and amplifying learning in a limited amount of time. Various pedagogical and psychological theories have been explored to develop this methodology that has been employed in three different semesters. The results have shown that students prefer this less stressful mechanism of testing and improved learning and students have commented that they felt they were on top of the materials being covered in class throughout the year and felt prepared for the final with little or no preparation for the final exam. In addition, students felt reduced stress during the test taking.

Index Terms—Computer science education**,** active learning**,** test anxiety**,** student centered teaching, assessments

I. Introduction

Many student struggle with test taking anxiety; causing assessments to not represent a student's' true abilities. Test anxiety stems from many sources, however, one of the most predominant reasons is a lack of confidence in an individuals' own ability [3]. This lack of confidence typically manifests itself through comparisons to peers, considering the consequences of failure, low expectations for assessment performance, excessive worry over evaluation, feeling unprepared for tests and lowered self-worth [4]. However, research has shown that this worry interferes with performance on assessments. This can be seen in the negative correlation between test anxiety and IQ, academic achievement, problem solving, memory and grades. These deficits were seen in students from all educational levels with test anxiety from third grade to graduate school [5]. When looking specifically at course grades, less than five percent of students with high test anxiety received A's on their assessments and have the lowest marks average among all students [4]. Because of the staggering 16 to 20 percent of students report high levels of test anxiety, with an additional 18 percent reporting moderately high levels of test anxiety, many have attempted to pinpoint the underlying cause, many have tried to pinpoint the source of test anxiety [6]. The first cause identified was the fear of failure; while stress can be motivating, when self-worth is tied to outcomes, failure can become devastating. Poor testing history can create a negative mindset surrounding tests and influence future outcomes. Finally, lack of preparation can leave individuals feeling anxious and overwhelmed [7].

The proposed active learning methodology seeks to address this challenge by fostering an environment that enables students to perform to the best of the abilities on assessments by restructuring the way classes are taught. This methodology combines various aspects of effective classroom management including repetition, group work and is based off the ideas discussed in various engagement and motivational methodologies. Students are first asked to create questions and answers, review all questions and answers created by students, taking a quiz and finally, grading the quiz. Partner learning was also incorporated into various stages of this process. This lecture structure is designed with the goal of keeping students engaged during class time to eliminate anxiety caused by lack of preparation. In addition, the class was

structured with weekly or biweekly tests throughout the semester with the goal of creating low pressure environment where students are tested on topics that are current with the lecture material. As will be discussed, this takes the focus off of memorization and instead helps students gain a comprehensive understanding of the material which in turn raises their test-taking confidence.

II. Background

Active learning has been proposed as a solution for many challenges in the classroom including time management, engagement, motivation and improved comprehension [1, 16, 25, 27]. However, active learning has also showed enormous potential in reducing test anxiety by improving class engagement, maximize learning despite competing demands on students' time, creating opportunities for students to affirm their knowledge prior to the exam and ultimately reducing anxiety surrounding exams [28]. In doing so, it's believed that active learning methodologies can address the three primarily causes of test anxiety which include, fear of failure, poor testing history and lack of preparation.

The bases of active learning stems from the realization that the average attention span of a student is 10 to 15 minutes [28, 29, 30, 31]. This means that a 45-75 minute lecture is often challenging for students, especially when the topic is not of interest. Even if questions are asked during lecture, only those students paying attention will volunteer answers, while unengaged students remain unengaged. It comes as no surprise that engagement increases learning [1, 2]. Active learning engages students through some form of activity other than listening, whether that be problem solving, reading, writing, discussions, role playing or participating in a debate [32]. By increasing students critical thinking skills, a stronger understanding of the concepts can be gained, making active learning a valuable addition to the classroom [1]. To take advantage of the 10-15 minute attention span, a longer lecture could be segmented into smaller "mini" lectures or broken up with discussions that give students the opportunity to think about the topics being covered and apply them to related problems.

To understand how active learning methodologies, assist in reducing test anxiety, we will first look at the need for efficiency in the classroom and how active learning methodologies address this need, how teaching styles effect learning styles and how test anxiety is addressed through active learning methodologies.

A. Engaging Students in Limited Time

A constant challenge in the classroom is teaching in a way that motivates students to learn. As student's responsibilities beyond the classroom continue to evolve, teaching styles must adapt to continue to reach students. Active learning strategies enable students to get the most utility out of the time they devote to academics and enable them to succeed in the classroom while also recognizing students' responsibilities as employees, parents, caregivers and the many other roles growing numbers of college students are being asked to take on. Approximately 4 out of 5 college students work at least part time while attending school averaging 19 hours per week [14]. In addition, 33 percent of 4-year degree seeking students attend part time [15] and all students irrespective of age or background, have obligations beyond the classroom. By acknowledging this, faculty can help student succeed without asking them to sacrifice other responsibilities. The suggested active learning methodology acknowledges the other demands on students' time, making such methods more effective. Active learning has been clearly linked to improved understanding of concepts. In a study of student's understanding of basic concepts in physics, understanding increased by a minimum of 45 percent when active learning was employed (from 30 percent understanding with traditional methods to over 75 percent understanding when active learning models were utilized) [25]. This study effectively illustrates the gains that are possible when active learning is incorporated into the classroom.

The suggested active learning methodology uses repetition as a tool to achieving engagement and increasing understanding. By approaching the same ideas from different angles, first reviewing all material and writing the questions, followed by studying all questions, taking the quiz and assessing their performance on the quiz, comprehension is emphasized, as opposed to simply memorization. Comprehension enables students to make associations, elaborations and inferences from the materials which expands understanding [17, 19]. Research shows that with every repeat, students are able to add more information to their current knowledge, thus gaining a more thorough understanding of the topic [18, 20]. However, simply repeating information is not enough; to engage all students, irrespective of their learning style the method by which material is taught must vary to suit all student learning preferences. The proposed methodology recognizes this learning involves reception and processing of information and that individual preferences can make different teaching methods more or less effective [21].

This methodology also utilizes partner learning as a way to improve understanding and memory, recognize personal strengths and weaknesses and assess the understanding of all students, including those with learning disabilities, in the same environment [16, 25]. By creating questions and answers and working in groups during the assessment, students learn from each other's' understanding of concepts [22]. In addition, teaching others have been found to be a valuable way to reaffirm one's own knowledge of a subject. This opportunity also helps students pinpoint topics which they have a firm understanding of and partners can help each other better understand key topics or challenging concepts [23]. Partner learning techniques also make for an inclusive classroom in which all students irrespective of disability, feel confident participating in-class partner assessments that, were they individual, students with disabilities would likely take in a special testing area with extra

resources. The fact that partner learning enables all students to complete assessments in the same environment is a testament to its ability to make assessments a low-stress occurrence. In addition, by creating a more inclusive classroom, all students feel equally knowledgeable which can be a huge confidence booster for students who are used to being singled out during assessments [24]. However, higher confidence in understanding of material was seen in all students. For these reasons, partner learning has been seen as a positive addition to the classroom.

B. Confidently Applying Knowledge

An underlying theme that, in part, determines the effectiveness of a methodology is how much students are understanding material as opposed to simply memorizing to pass assessments. Active learning seeks to increase understanding and in doing so, prevent students from feeling the need memorize. Students, often unconsciously, vary their learning style depending upon the context both in and out of school. In the case of a student, these contextual factors determining their choice of learning approach they choose to use when preparing and studying for the particular course based on their beliefs of how different types of knowledge might be more or less useful for achieving their learning goals [10, 11, 12]. This variability in learning methods is described as surface or deep approaches to learning. Predictably, surface learning is associated with direct recall or materials, concentration on assessment requirements rather than learning objectives and memorization of facts and procedures but a failure to distinguish principles or concepts. On the other hand, in deep learning, course content is related to one's life context, new ideas are integrated with previous knowledge and experience and an underlying desire for intellectual mastery and understanding exists with less focus on assessment requirements [16, 34]. As was suggested earlier, students choose the method of learning that they feel will be most beneficial in achieving their goals. As faculty, the goal should be to align curriculum design with the skills required off deep learning. In doing so, students will gain practical and comprehensive understanding of the material.

Through the deep learning techniques utilized in this methodology, students gain confidence in their knowledge and their ability to perform on tests. Because deep learning focuses on learning goals, rather than knowledge needed to pass an assessment, students gain a more complete and detailed understanding of the subject. Deep learning also encourages students to grow their knowledge by making connections and inferences about the material, all of which have been shown to increase understanding of the material and in turn, student confidence [34]. Along with incorporating such activities aimed at increasing understanding, the proposed methodology also aims to address confidence issues surrounding assessment by providing daily self-assessments. These short quizzes serve to affirm student's understanding of topics and increase confidence in test-taking ability. Variation in confidence accounts for approximately 14 percent variance in academic performance and 12 percent variance in persistence [9]. Academic confidence is a construct of self-beliefs, motivation and academic achievement [8]. For this reason, interventions that address these areas, have proven successful in increasing students' confidence.

C. Addressing Stressors

While assessment plays a necessary role in assuring that the required skills have been acquired, the way assessments are structured plays a large role in how students prepare for class, study and in extent, learn the material. In addition, they can be a cause of anxiety for many students [16, 33]. As mentioned earlier, three major sources of test anxiety are fear of failure, poor testing history and lack of preparation. This methodology proposes addressing these stressors through the use of active learning techniques. To address the fear of failure and poor test taking history, this methodology turns to repetition; students complete frequent ungraded assessments to help them assess their own learning, maintain motivation and grow confidence in their abilities [18, 27]. Active learning addresses lack of preparation by utilizing the class time in a way the requires less outside of class preparation for class and tests alike. These factors make active learning an effective tool to indirectly decrease anxiety surrounding tests. As the proposed active learning methodology is evaluated, a key focus will be how these stressors are addressed through the techniques employed.

III. METHODS

This model that takes into consideration the three major stressors, fear of failure, poor testing history and lack of preparation, was developed and tested in three semesters. The model was tailored to create an atmosphere where students worked with a partner that made the students feel they were not alone but had a partner they could rely on. In addition, the model/tool was implemented weekly so the students had limited content to prepare for, besides this content being freshly learnt in the class. To help boost students' confidence, the students were asked to create the questions along with the solutions. In doing so the students learnt the material without them realizing it. This also made the students feel empowered as they were playing the role of the instructor. During the test the students were again partnered with the peer they worked with in creating the questions and were even allowed to talk during the test. This reduced the stress of the students and made them feel like they were having a discussion. The main premise of this model is based on the theory of repetition that helped students learn. Hence the students also had to grade their peer's tests, creating another level of repetition for learning and also empowering them, thereby boosting their confidence.

Thus we focused on ways to not only increase learning by repetition but also reducing stress in test taking by encouraging team/pair work and collaborative learning.

A. Class Set-Up

The model was implemented in four classes, an upper-level computer science database management systems course, a mid-level database concepts course, another mid-level computer architecture course and a civil engineering course. The lectures were twice a week in two of the classes and thrice a week in the other two classes. The study was conducted for three consecutive weeks in two of the classes then implement for the entire semester in the other two classes. The class time was split into two, with two thirds of the time spent on traditional lecture combined with a varied set of active learning activities while the rest of the third of the class time was devoted to implementing the model described in this paper.

To enhance learning by reducing test anxiety the model focuses on self-learning and self-evaluation their learning. This model proposes four stages that can be administered by the instructor or a teaching assistant. In this study the instructor administered most of the tests except for one where the instructor was at a conference.

The questions created by the students in this model are specific to the topics covered in the class for the week. The testing is conducted weekly and the questions created each week are shared with the students so they have access to these questions for the final cumulative exam. In essence the students are creating questions for their final cumulative exam. The instructor would choose fifty percent of the questions for the final from the questions created by the students during the weekly tests.

Technology used to support the model: Google-docs was chosen to support this model. The choice of the technology was based on the features such as *shared, collaborative, accessible, and instant updating* software. The purpose of the *shared* software is so that the students are able to see the questions created by all the students in the class. The collaborative feature is required so that the students are able to *collaboratively* work in the same document. The *accessible* feature of the support is required so that the students have access to the questions irrespective of the machine, or platform they are using. Lastly the *instant updating* feature is required so that the students are able to see the questions as they are being typed by the classmates. A new Google-doc created by the instructor for each unique test and shared with all the students. The only content displayed to the students initially is the list of topics covered in the test so there is no confusion among the students. These google docs are left shared for the students so the students can prepare for cumulative final.

Format of the test: The format chosen for this model was short answer and multiple choice questions so that they could be tested on not only on the concepts and theories with the multiple choice questions but also analytical, mathematical and logical problems with the short answer questions. The students were required to put their names next to the questions they create. The rules identified by the instructor for the creation of the questions are- i) No question could be repeated ii) Questions had to be based on the topics covered in class iii) The students could use the internet, textbook, or any knowledge learned from the instructor's lecture iv) The instructor would review the questions and highlight any questions that are incorrect, repeated or too easy to and had to be recreated by the students.

B. Our model

In an attempt to create a model that can replicate our study we propose the following steps:

Step 1 - Test development phase - Under the supervision of the instructor or the teaching assistant each student along with a partner will create 2 to 3 questions along with the answers in the google doc. As the students type in their questions they are able to see each other's questions. This is important so they do not repeat any questions.

Step 2 - Learning phase will require 15 to 20 minutes – Once the questions have been created the students are given 15 to 20 minutes to study the questions and answers created earlier. The students can continue to work in pairs and are permitted to talk and discuss questions with each other.

Step 3 - Testing phase will require 5 to 10 minutes - The students are asked to close their computers or mobile devices in order to take the test. The instructor will choose a set of questions from the set created by the students. The students take the test with their partner and are allowed to talk and discuss the questions amongst themselves. If it happens that there are fewer than 10 students then consider not pairing the students, instead the students can work individually during the entire process.

Step 4 - Grading phase will require 5 minutes – lastly the students grade their neighbors test. The instructor may choose to use this grade towards the final grade or not. The grades were counted towards the final grade for the students by the instructor in this paper. These tests were 20% of the final grade for the entire course.

This model creates an illusion of the real world where the students will work in collaboration with their colleagues on solving real life problems. The pairing of students helps boost students confidence and reduce stress of testing.

C. Subjects

The subjects were students from two different database classes. One was a 4000 level class for the computer science students while the other was a 3000 level course for the computer information systems students. The combined students were 30 but only 20 of them completed the survey.

The subjects were students from the computer architecture course. The combined students were 31 but only 20 of them completed the survey.

IV. Data Analysis

To evaluate the effectiveness of Active Learning in decreasing test anxiety, students were asked a series of questions regarding how the previously described active learning methodology prepared them for assessments in comparison to other teaching methodologies trialed with the group throughout the course. The questions were developed within three broad subheadings: learning preferences, assessment preferences and future suggestions. The goal with this breakdown was to get a picture of both the ideal class structure for learning as well as the ideal assessment environment. We asked about future suggestions to gage students' satisfaction with the options they were given throughout the semester and to evaluate possible missing aspects that could further improve the learning environment for students.

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A. How do you learn best?

After being exposed to various learning methodologies throughout the course, students were asked to identify their preferred learning methodology. Students rated each method on a scale from 1-5 where 1 is "not effective", 2 is "somewhat effective", 3 is "average effective", 4 is "moderately effective" and 5 is "highly effective". The methods included an in class activity, PowerPoint lecture (denoted by pp in figures), partner quiz on current material and writing questions regarding current material. These methodologies span the spectrum from the very passive student role seen in lecture-based methods to the very self-determined learning encouraged in when students wrote their own questions on a subject.

One challenge encountered when evaluating student responses was a strong leftward skew among all responses as can be seen in figure 1. Across all categories, students reported generally positive results in response to all learning methodologies. While this is good in that very view methods were completely ineffective, it leads to the challenge of gaging each method's effectiveness in comparison to other methods.

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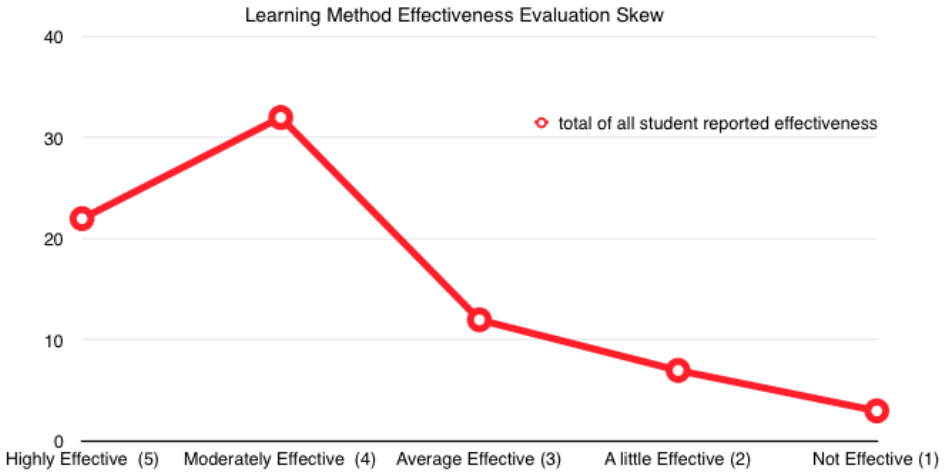

Fig.1. Leftward skew in students' responses.

To address this, we calculated an average for each rating which is represented in figure 2 by the red trend line. Using this we can see how each method compared in ratings at each level. Using this, we can see how each method compares to the average.

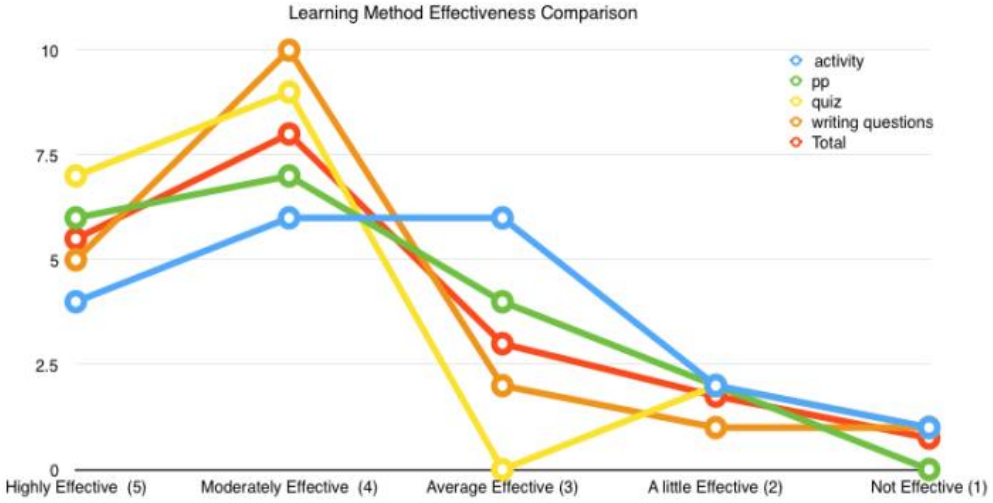

Fig.2. Comparison of methodologies.

The effectiveness of PowerPoint lectures most consistently follows the average trend line (denoted "Total" in figure 2). From there we see two methodologies, partner quizzes and writing topical questions, that are noticeably higher in "highly effective" and "moderately effective" ratings while also ranking much lower in "Average effectiveness", "a little effective" and "not effective" categories. This suggests that these two methodologies are the most positively accepted by students. Finally, the incorporation of class activities stands out for a few reasons; first, the trend line has the least change between and secondly, is the only methodology to follow different shape graph, compared to the other trends that follow a similar path. However, it creates a rough bell curve and because of this, it's' possible that this methodology is very hit and miss and on average, only achieves average effectiveness. From this data we have come to the conclusion that partner quizzes and writing questions are the most effective learning methodologies.

B. Assessment Preferences

In addition to learning preferences, students were also asked specifically about their assessment preferences. Results are shown in figure 3. These responses show that all but 1 student reported benefiting from partner assessments to some degree. At first glance, the data in figure 3 looks rather, however, student comments from the end of survey add some enlightening details to this questions. Students reported that they "liked having a partner when they encountered an unfamiliar idea." However, the fact that they are not relying on each other a high amount also shows developing self-reliance and confidence. Students generally saw partners as a "safety net" in the case that a concept was unfamiliar.

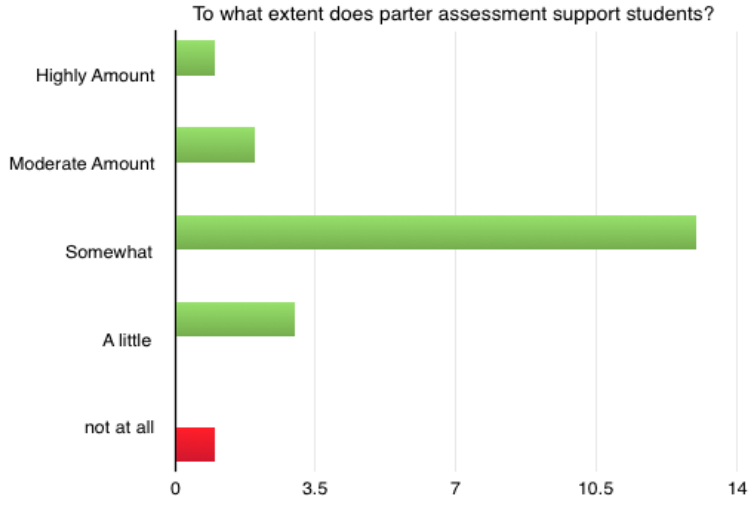

Fig.3. Support from partner learning.

Students were also asked if they liked having the daily practice quizzes graded. Students generally responded that daily quizzes should not be graded as this can be seen as a "test-run" to assess how well they know the material. This falls back on the idea of deep learning encouraging focus on learning objectives whereas shallow learning empathizing the assessment criteria. Student's preferred ungraded tests so they could focus on learning the concepts, rather than concerning themselves with "what will be on the test?" However, graded assessments add value by motivating student participation. While this still remains a debatable area, the effectiveness of active learning was acknowledged by students and faculty alike; while at first tentative with the such frequent of assessments, students soon warmed up to the idea as they found it prepared them for assessments, so much so that students commented on how little they needed to study for graded exams in these courses.

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C. *Future Suggestions*

When asked what they would suggest for future classes, majority of students suggested the same amount of active learning. Students reported that they preferred writing their own questions for in-class quizzes and being able to work with a partner. While students did not want a completely active learning based classroom in which students prepared by watching a lecture before class, students responded with concerns, nearly all expressed interest in some active learning component to future courses. When looking particularly at assessment recommendations, students supported continued daily quizzes as a way to prepare themselves for graded exams. They also spoke highly of the ability to utilize partners during these in class quizzes as being able to discuss was beneficial to learning.

V. Conclusions

The motivation behind this paper was to develop a methodology that can be used to help reduce test anxiety, in an attempt to improve performance of students in tests. It is important that we continually strive to find ways to help students succeed in classrooms. Because more than ⅓ of students experience moderate or severe anxiety surrounding tests, every effort to alleviate this anxiety should be made [6]. When doing a simple search online of "test anxiety" numerous links appear with information on how students can contain the physiological, psychological and behavioral effects. However, we believe that test anxiety should be combatted as a team. Instructors play a large role in the way student's approach exams and the perceived levels of anxiety. In addition, it has been shown that lectures can be structured that better prepare students.

Most importantly, this methodology stresses that students are not alone. They are supported by classmates every step of the way, from writing questions, reviewing material and taking the quiz. By learning together, students reported less anxiety about answering incorrectly. Being able to collaborate with fellow students also empowers students to recognize the areas they do excel in and teach others. As was mentioned earlier and is apparent in figure 3, for majority of the time, students will be able to answer questions independently, however, only one student reported not benefiting at all from partner learning. Similarly, only one student reported depending on their partner to a high degree. This suggests that while they are primarily independent, they benefit from working with a partner on the most advanced topics. In addition, this methodology more accurately mimics what students will experience in the workforce. Very rarely in the workforce will students face a problem alone. By integrating collaboration into the classroom, students are better prepared for the work environment they will experience upon entering the workforce. While assessments are a necessary part of education, the way students are prepared for assessments as well as the way assessments are administered play a key role in how much anxiety is associated with the experience.

Future work could evaluate attitudes towards active learning over time to evaluate how student's openness to these methods and assessment confidence change over time. At the end of the semester when this survey was taken, students were acclimated to the active learning methodologies, however there was hesitation at the beginning of the semester. Likewise, confidence levels have changed over the course of the semester. Students were visibly more confident in their abilities as semester continued. However, being able to quantitatively back up these observations is a key goal for the future.

One of the underlying goals from this study was to achieve deep learning by focusing on learning objectives

rather than assessment objectives. This gives students a comprehensive knowledge that can be applied to various situations from tests, to a future position in the workforce [35]. On the other hand, shallow learning is so concentrated on assessments, it removes all ability to apply knowledge to practical situations. In doing so, assessments become less of the focus. This ability of students to apply their learning to daily quizzes without the worry of being graded enables them to gain confidence in their knowledge and increase comfort with testing environments.

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