# Survey of Active Learning in Science in Saudi Arabian Universities

By

Amal Faleh Alenzi

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Approved by

Christine Guy Schnittka, Chair, Associate Professor of Science Education
James Groccia, Professor Emeritus of Higher Education
Karen McNeal, Associate Professor of Geosciences
Chih-Hsuan Wang, Assistant Professor of Research Methods
Daniel Henry, Director of Auburn Center for Evaluation

Abstract

This dissertation examines Saudi Arabian faculty attitudes toward active learning and their usage of it in STEM classrooms. The objective of this study is to see if there is a relationship between the preexisting beliefs and the implementation of active learning techniques by Saudi instructors in university science subjects. This study was conducted using two pen and paper surveys to determine the pre-existing beliefs of Saudi faculty about active learning practices and their usage of these practices. The first survey, called "Attitudes Toward Active Learning" focuses on examining four separate constructs about the use of active learning techniques, including: institutional support, personal attitudes about the usefulness of active learning, personal attitudes about the ease of use, and instructor ability. The second survey, called "Usage of Active Learning", consists of two parts that focus on the teaching practices commonly used in the active classroom. The first part of the second survey asks faculty about the frequency of usage of certain active learning techniques. The second part had an open-ended question, which asks faculty to describe their teaching style. The findings reveal that the four constructs, "support," "attitude of usefulness," "attitude of ease of use," and "skill" all have a positive and high correlation with the usage of active learning practices, and all significantly predict the use of active learning techniques. Finally, the results of this study could help generate further discussions about the development of and changes in the higher education system in Saudi Arabia.

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# CHAPTER I: THE PROBLEM

## Introduction

Active learning has been given a lot of consideration in recent years (Bonwell & Eison, 1991; Faust & Paulson, 2015; Felder & Brent, 2009). Active learning is an educational method where students are encouraged to interact with the material and other students (Ito & Kawazoe, 2015). This is a different approach from a traditional teaching style where students are taught by lecture alone. In the field of science in particular, active learning is very important for giving students hands-on experience with the topics and materials they are learning. Active learning can lead to an increase in exam scores in science classes over traditional learning and reduce the rate of failure (Freeman et al., 2014). Many countries across the world are encouraging the use of active learning in math and science classes and reducing the amount of traditional lecture-based teaching (Eurydice & European Commission, 2011). Even in developed countries there is much progress still to be made in using active learning, and this is even truer for developing countries. This research study will focus on one country in particular, Saudi Arabia. This country was chosen because of the author's cultural background and interest in improving the Saudi Higher Education curriculum. The goal of this research is to better understand the use of active learning in university science classes in Saudi Arabia, so that active learning can effectively be used in colleges and universities in Saudi Arabia.

## Problem Statement

The traditional lecture has been used as the main format of teaching for nearly 900 years (Freeman et al., 2014). Sometimes that hundreds of students sit in a large lecture hall for over an hour, typically three times a week. During the lecture, students passively learn pre-processed information and then are expected to apply this information on periodic exams (McCarthy & Anderson, 2000). This traditional format however, does not allow students to focus on deep fundamental understandings of the course information (McCarthy & Anderson, 2000). Instead, many students only focus on passing the course and do not critically examine the subject matter for a better understanding (Springer, Stanne, & Donovan, 1999). Due to this surface-deep process, it is likely that students will apply new information only to their short-term memory, where it will soon be forgotten (McCarthy & Anderson, 2000). As a result, the traditional lecture fails to support student-learning objectives. As will be demonstrated through the cited research in this study, active learning techniques have been proven to be effective through countless studies. This paper sets out to research what constructs influence the use of active learning techniques in the classroom, so as to improve the quality of science education in Saudi Arabian universities.

### Engagement and Motivation

There are many flaws related to the use of traditional lectures in science, technology, engineering, and math (STEM) classrooms. One significant weakness of the traditional lecture method is that it often does not engage and motivate students. L.B. Curzon found that student interaction in lecture halls is limited to raising hands for clarification, specifically in larger classrooms, leaving students with few opportunities to comment, question, or provide feedback to the teacher. More often than not, students are ineffectively engaged, and are expected to sit quietly and listen, while perhaps not understanding the material. This inability of students to communicate with each other or their instructor decreases the likelihood of success in terms of a high exam grade or application of the concept to their lives (as cited in Tormey & Henchy, 2008).

**Long-term Memory**

Moreover, another problem that Curzon found is that the knowledge learned in the traditional classroom is not applied to long-term memory. Instead, many students learn the material just well enough to pass the test. Students often find it difficult to focus on and absorb course materials because many students struggle taking notes in a traditional lecture. If students are unable to take coherent notes, then they will struggle to remember the information (as cited in Tormey & Henchy, 2008).

**Higher order thinking**

Likewise, the standard traditional lecture does not allow students proper opportunities to incorporate higher order thinking skills, an integral part of the learning process. The learning process requires students to evaluate and analyze knowledge, and to immediately interact with their understandings of the information as it is constructed. Simply telling students information does not activate higher-order thinking. It is more likely students will forget the information they heard within hours (as cited in Tormey & Henchy, 2008).

**Collaboration and Learning**

Last, the traditional lecture does not give students sufficient chances to work collaboratively with their classmates. Studies show that student exam essay scores are higher when they are able to work collaboratively with their peers prior to the exam, compared to similar students who work independently prior to the exam (Linton, Pangle, Wyatt, Powell, & Sherwood, 2014). Thus, when students are able to discuss course content with their peers, they can learn from each other. In summary, there are numerous reasons why the use of the traditional lecture in STEM classrooms limits student achievement of course learning objectives.

**Test Scores and retention in STEM fields**

Another major consequence of the traditional lecture is lower test scores. According to a study by researchers at The President's Council of Advisors of Science and Technology (PCAST), modifying a curriculum away from traditional learning methods in STEM subjects could yield a 55% increase in exam scores, and raise student grades by a half letter (Freeman et al., 2014). If STEM students' grades increase, then more students will be able to complete bachelor's degrees in STEM subjects. Specifically, the PCAST recommends that university STEM programs adopt a curriculum based upon active learning practices (Freeman et al., 2014). A study at the University of North Carolina School of Pharmacy found that the use of active learning improved student final exam scores by 2.5% between 2011 and 2012 and by an extra 2.6% in 2013. In total, student exam performance increased from 2011 to 2013 by 5.1% (McLaughlin et al., 2014). A study involving 62 introductory physics courses, which enrolled 6,542 students, found that the use of interactive-engagement methods "can increase mechanics-course effectiveness well beyond that obtained in traditional practice" (Hake, 1998, p.1). As these studies demonstrate, active learning should be the teaching method utilized in STEM subjects.

**Reflection on learning**

The core focus of active learning is student activity and engagement (Prince, 2004). Learning requires for new knowledge to be built upon prior knowledge (Prince, 2004). Accordingly, students must have the opportunity to reflect upon what they have learned using their notes, and have an opportunity to share and reflect their thoughts. In addition, students should be allowed to freely express their thoughts and interact cooperatively with classmates to achieve greater understanding. Active learning acknowledges these learning realities; in it, students do more than listen passively. Instead, greater emphasis is placed on the development of student skills, higher-order thinking, and the exploration of opinions and values, with a focus on motivating students and providing them with immediate instructor feedback (Bonwell & Eison, 1991). Due to its emphasis on interactive learning and discovery, the adoption of active-learning methodologies in STEM classrooms is a logical solution to the problems faced by students listening to traditional lectures.

This research focuses on the implementation of active learning practices in science classes at two Saudi Arabian universities. There is a lack of literature about how Saudi Arabian faculty view active learning or how much they use active learning in their classrooms in Saudi Arabia. This research study aims to determine what faculty opinions on active learning are, and how often they use it. The results of this study will be applicable in further investigations on the use of and implementation of active learning in Saudi universities.

## Research Goals and Questions

The goal of this study is to provide recommendations and to better understand how active learning is used and perceived by faculty members at Saudi universities. Specifically, this research will aim to improve the quality of science instruction at Saudi universities by first determining what faculty actions and opinions are. Through the implementation of active learning methodologies, students will be more able to understand science course information, commit this information to long-term memory, and apply it in their future. An immediate benefit of using active learning techniques is that exam and test scores will likely be higher, one marker of higher student achievement. Also, the learning process will be more relevant to the actual lives of students. Due to these combined factors, the overall quality of education and instruction will be improved for both students and instructors. In summary, this research will emphasize the importance of active learning for faculty at Saudi universities, which could ultimately lead to the application of active learning practices with students.

The research questions that this study addresses are the following:

1. What are the attitudes of Saudi Arabian (SA) university science faculty towards active learning techniques? (Source: Survey 1- Attitudes Toward Active Learning)
2. Which active learning techniques do faculty use in SA? (Source: Survey 2- Usage of Active Learning)
3. What is the relationship between what faculty do in class and their attitudes?

With the answers to these questions, this study will help faculty and those who organize them (such as deans, principals, and department heads) better understand how faculty feel about active learning; they might use this information to determine how the faculty could incorporate active learning into their teaching.

## Context and Significance

Saudi Arabia is a country with 25 universities and many colleges (Saudi Ministry of Education, 2016). The education system provides every citizen with a free education through university, as well as support such as books (Saudi Ministry of Education, 2016). Education is an important aspect of the country, and improving education is part of the long-term plan known as Vision 2030, which outlines objectives and programs for the country (Saudi Vision 2030, 2018). With the importance of education, using the best teaching methods can help the students, the faculty, and promote the government's goals. Active learning is a teaching style that can be readily included in the teaching methods of faculty at Saudi universities. However, before any recommendations can be made, there needs to be more information about whether faculty are aware of active learning, what their perceptions are, and how often they use it. It is also important to know whether the faculty have any common concerns such as active learning taking too much time or not being appropriate for large classes, as these concerns can be addressed through professional development. Knowing their perceptions and what concerns they have, improvements and suggestions can be made to include active learning in science education in the best way possible to lead to better learning results for the students.

This study will investigate the active learning practices at two Saudi universities. For this research, the science faculty at both universities were given surveys to complete.

Questions were related to how often they use active learning, the challenges they face using active learning, and if there are any resources available to them to use active learning in their classes. Using the data from the completed surveys, the information was analyzed and interpreted. The findings of this research highlight the importance of active learning techniques for Saudi university science faculty and administrators. Moreover, this research could have a direct impact on curriculum development and future research on active learning methods in Saudi Arabia.

## Definition of Active Learning Terminology in Science

It is essential in all fields of academia to define key terms and vocabulary. In the fields of science and engineering it is perhaps even more important as in these fields faculty may not always look through the literature from educational research to learn educational terminology (Prince, 2004). Thus, this section will focus on defining the terminology, which will be found throughout this research paper.

Active learning can be defined in a number of different ways. Prince (2004) defines active learning as any instructional method that "engages students in the learning process ... The core elements are student activity and engagement in the learning process" (p.1). Thus, active learning requires students to be engaged in their own learning process in order to be successful. Students should also be active and be a part of the learning, not just bystanders. Similarly, Bonwell and Eison define active learning as anything that "involves students in doing things and thinking about the things they are doing" (1991, p.2). This meta-cognitive approach to learning invokes higher order thinking and allows students to demonstrate mastery of learning objectives (Brame, 2016). By giving students the opportunity to reflect upon the content, share opinions, and relate to one another regarding course information, students can demonstrate to their instructor that they understand the course materials (Prince, 2004). A positive result of this is that instructors know when to move forward with new information.

Another way of looking at active learning is through the context of how it is presented. For example, Grabinger and Dunlap described Rich Environments for Active Learning (REALs) over 20 years ago as a form of incorporating active learning into instructional settings (1995). The philosophical basis for REALs is that students engage in a continuous and collaborative practice of redefining their understanding of course concepts (Grabinger & Dunlap, 1995). REALs could potentially be utilized at any level or age group at nearly any institution; all it requires is student collaboration and engagement in the learning process (Grabinger & Dunlap, 1995). The main goals of REALs include increasing student responsibility, integrating knowledge with practical application, and promoting "high-level thinking processes" (1995, p.10). By giving students greater responsibility in the learning process, students will feel more connected to the classroom, which creates a more positive learning environment. One final explanation is by Ito and Kawazoe, who define active learning as any process that includes students in the learning process, may it be only during lectures, writing, or reading (2015). In summary, while active learning can be defined in a number of ways, the key characteristics of it are consistent: engagement, involvement, responsibility for learning, use of higher-order thinking skills, and connection to the learning process.

## Evidence that Active Learning Succeeds

There is evidence that active learning improves student learning in many ways. These different outcomes include student engagement and motivation, improved student performance in terms of higher order thinking and test scores, and student satisfaction. In general, the cognitive outcomes for students are higher when active learning is used instead of traditional, passive lectures (Cui, 2013).

**Learning preferences**

One of the reasons active learning is better than traditional learning is that active learning incorporates many different teaching modalities, which allows an instructor to give students with different learning preferences opportunities that match their preferred style (Daouk, Bahous, & Bacha, 2016). One major benefit to this is that instructors are not obligated to use a one-size-fits-all approach to their classes. Instead, classes can be altered according to the needs of students.

**Motivating with technology**

First, there have been many research studies that support the relationship between active learning, positive student engagement and motivation, and ultimately improved test scores. This is in part because when students learn actively they are more attentive. One example of active learning motivating students is using an audience response system (ARS) like "clickers". Students in a class with ARSs reported that they were paying more attention to the lessons in class and achieved higher grades (Cain, Black, & Rohr, 2009).

**Interactivity**

In addition, another study demonstrated improved student grades for classes with high interactive-engagement compared to a traditional classroom as measured by a pre- and post-test (Hake, 1998). The authors of this study defined interactive engagement as the "methods … designed at least in part to promote conceptual understanding through interactive engagement of students in heads-on (always) and hands-on (usually) activities which yield immediate feedback through discussion with peers and/or instructors, all as judged by their literature descriptions (p.2).” Thus, students are the most successful in the learning process when their instructor includes them using interactive activities. The significance of this cannot be overstated; active learning makes students both attentive and engaged, leading to greater success.

**Motivation’s long-term effects**

Another benefit to active learning is that it promotes student motivation. One study that explored active learning in science and math classes found that students who had higher scores on a motivation survey were more likely to become lifelong learners than students who had low motivation scores (Lord, Prince, Stefanou, Stolk, & Chen, 2012). One study found that the use of active learning increased exam grades by half a letter (Freeman et al., 2014). It can be understood from this that when students are motivated in class, they will be more successful learners. As a result, instructors should strive to incorporate active learning principles so that students are encouraged and motivated to learn and achieve higher test scores.

**Higher-order thinking skills**

Another benefit to active learning is that it promotes not just higher exam scores, but also higher order thinking. According to a 2009 study published by the American Society for Cell Biology, restructuring an introductory biology course resulted in higher student satisfaction, engagement, and academic performance (Armbruster, Patel, Johnson, & Weiss, 2009). The study examined the difference in student performance on identical exam questions administered three years in a row, from 2006-2008, in the same course. In the first year, the instructors used traditional teaching methods. In subsequent years, instructors used active learning techniques. The researchers found that the proportion of points on the final exam for questions at higher levels of Bloom's taxonomy (levels 3-4 application and analysis) increased from 15-18% in 2006-2007 to 25% in 2008. Student performance on the final exam increased to 91% in 2008 compared to 86% in 2006 and 85% in 2007 (Armbruster, Patel, Johnson, & Weiss, 2009). These results show an increased academic performance and ability to solve higher-order problems. The results also indicate that a semester of experience with implementing active learning and student-centered pedagogies in 2007 made these approaches more effective in improving student performance in 2008. Thus, active learning practices do much to improve higher order thinking

**Satisfaction**

Lastly, students who use active learning are more satisfied. This is perhaps due to the interactive nature. Students enjoy being able to interact with their peers, and not having to sit still for hours on end. To demonstrate this, the Armbruster study (2009) found that students in active-learning courses had high course satisfaction (Armbruster, Patel, Johnson, & Weiss, 2009). The Armbruster study examined the difference in student satisfaction between traditional methods and active learning techniques. Upon using traditional methods in 2006, 65% of students were satisfied. After implementing active learning techniques in 2007, satisfaction rate jumped to 81%. The next year, while also using active learning techniques, 89% of students were satisfied (Armbruster, Patel, Johnson, & Weiss, 2009). This study demonstrates that students who learn actively are in general more satisfied.

This dissertation will describe the development of, and results from two surveys that will help us better understand the perceptions of active learning by faculty in Saudi Arabian universities. In Chapter 2, a literature review will serve as a background for understanding active learning and its use in universities. Chapter 3 will describe the methods used in this study. Chapter 4 will describe the results of the study. Finally, in Chapter 5 there will be a discussion and conclusions based on the results.

# CHAPTER II: LITERATURE REVIEW

## Introduction

Active learning is a teaching method that has become more popular in recent times. McKeachie says that it refers to the "experiences in which students are thinking about the subject matter," while they collaborate with their peers and instructor (as cited in McCarthy & Anderson, 2000, p.279). There have been many detailed articles reviewing the research on active learning that include descriptions of what active learning is, why it is a good teaching method, and how a teacher could use it in the classroom (Bonwell & Eison, 1991; Faust & Paulson, 2015; Felder & Brent, 2009). All these studies have reached the same conclusion that active learning, if utilized properly, can be a valuable tool in the classroom.

Active learning is based on student involvement; it proposes that students must do more than just listen (Bonwell & Eison, 1991). Likewise, the learning process requires student problem-solving as they read, write, and discuss the course information. Chickering claims that student freedom in the learning process leads to utilization of higher order thinking skills including analysis, synthesis and evaluation (as cited in Bonwell & Eison, 1991). Accordingly, students must be able to demonstrate understanding through doing things and can reflect upon what they are doing. The evidence from these studies demonstrates that active learning techniques develop student mastery of content (Bonwell & Eison, 1991).

This literature review will cover much of the research about active learning, as well as other teaching methods that are like or make use of active learning, like cooperative learning and collaborative learning. Also, the challenges for active learning, as well as ways to overcome those challenges will also be described. Included in this description will be a list of several popular and effective active learning techniques, such as one-minute papers or group work. Lastly, research on the use of active learning specifically for math and science education will also be reviewed.

## Saudi Higher Education Context

In recent decades, the Saudi higher education system has undergone major changes (Alamri, 2011; Al-Hazimi et al., 2004; Ratyan & Mohammad, 2016; Unruh and Obeidat, 2015). New universities have been started across the country (Ratyan & Mohammad, 2016) and for the first time the higher education system in Saudi Arabia ranks in the top 50 in the world (ranked at number 28) (Rayan & Mohammad, 2016). However, despite this growth in demand and quality, challenges are still present. Many university curriculums, especially those in STEM subjects, still emphasize a pedagogy where knowledge is transmitted from instructor to student through rote memorization and lecture (Unruh & Obediat, 2015). A dramatic result of this is that the education system gives students knowledge, which they are unable to interact with; this is a problem because without the ability to negotiate meaning in content, it is impossible to develop analytical thinking skills (Unruh & Obediat, 2015). The primary part of the curriculum today is made up of lectures and tutorials with limited opportunities to problem solve or to apply the additional information and concepts (Al-Hazimi et al., 2004) As a result, this system of pedagogy yields a phenomenon which could be summarized in three words, passivity of learning. Consequently, faculty opposed to student centered learning demotivates students (Unruh & Obediat, 2015) and decrease the likelihood of long-term learning (Al-Hazimi et al., 2004).

Another challenge, which exists in the Saudi Higher Education context, is that of genders. The Saudi educational context is rooted in a collectivist culture with the separation of males and females in education (Unruh & Obeidat, 2015). In 1960, the first school for the education of women began in Riyadh (Alamri, 2011) and girls and boys have been separated in education since (Baki, 2004). While the number of female university graduates in Saudi Arabia has rapidly grown at a rate of 2.5 times the rate of male graduates in the last decade (Baki, 2004), tremendous challenges still exist in terms of increasing the quality of the education. For example, male instructors are almost always banned from directly teaching female students (Baki, 2004). If a male instructor is assigned to a female class, a video conferencing method is used where teacher and students do not ever actually meet in person (Baki, 2004). Problems associated with the video conferencing method include but are not limited to: 1) difficulty in communication due to classroom noise; 2) extreme boredom due to a lack of opportunities to actively participate; and 3) the inability to have effective classroom discussions (Baki, 2004).

To advance Saudi higher education practices, many have advocated for the usage of non-traditional pedagogy (Unruh & Obeidat, 2014) and a newly refocused educational system, which can accommodate the demands of the private sector workforce (Baki, 2004). First, many scholars in the field of Saudi academics have begun to advocate for the introduction of pedagogy that moves beyond teacher-centered rote memorization (Al-Hazmi et al., 2004; Ratyan & Mohammad, 2016; Unruh & Obeidat, 2014). Specifically, the aim of such a reform should be on making the curriculum more approachable to independent learners and with a renewed focus on problem-based learning (Al-Hazmi et al., 2004). Such an initiative would do much to motivate students and improve the overall quality of education. This would require moving past teacher attitudes such as, “This is how I was taught so it’s good enough for my students” (Unruh & Obeidat, 2014). Next, the higher education system should better prepare students for a career in the private sector (Baki, 2004). This point is well summarized by Baki (2004) who stated, “There’s a need to minimize skill that mismatches between what the education and training systems are producing and the needs of the employers in the public sector” (p.8). By placing greater emphasis on the development of skills towards the public sector, an inevitable increase in research and development will follow which will likely continue to improve the higher education system in Saudi Arabia (Baki, 2004). By improving teaching, learning improves, and citizens are better prepared for the workforce, better prepared to innovate, better prepared to start new companies and work in the government, and most importantly, better prepared to teach the next generation.

## STEM Learning Theory

Traditional pedagogy has received criticism for falling short of learning targets and classroom potential. Many introductory science courses rely on lectures and traditional teaching methods for instruction (Handelsman et al., 2004). There is evidence that improving traditional lectures with active learning techniques and an emphasis on student engagement and scientific discovery increases student performance (Handelsman et al., 2004). Learning through activity rather than through traditional instruction has led to a movement in learner-focused education, where learners are given more control over their own learning (Paraskevas & Wickens, 2003).

Research by Gilbert, Osborne, and Fensham (1982) shows that children are not passive learners. Findings from many other studies have shown that students enter science courses with many preconceived ideas, which are at discord with scientific views and theories. As a result, since the 1980s there has been significant attention on investigating students' conceptions about the natural world. Research shows that students' conceptions about science and the nature of science are limited and naïve (Duit & Treagust, 2003). Research on conceptual change theory has been included in many other theoretical frameworks in recent decades (Duit & Treagust, 2003). A mixture of Piagetian ideas, which focus on the process of cognitive development, along with basic frameworks of cognitive psychology and constructivist ideas form a multi-perspective explanation of the process of learning (Duit & Treagust, 2003). In recent years, conceptual change has become synonymous with constructivist perspectives in science education (Duit, 1999) According to the constructivist learning principle, learning is an active process, which requires students to work actively to "construct or reconstruct their knowledge networks" (Dolmans, Degrave, Wolfhagen, & van der Vleuten, 2005, p.732). Effective learning occurs when learners are active and can activate prior knowledge. This process leads to deeper learning and better understanding of how to use the knowledge (Dolmans et al., 2005).

Conceptual change has been defined in many ways. Duit and Treagust (2003) define it as "where the pre-instructional conceptual structures of the learners have to be fundamentally structured to allow understanding of the intended knowledge, that is, the acquisition of science concept" (p.3). Thus, conceptual change refers to the development of ideas and the interaction of prior knowledge with new concepts. Conceptual change is the path a student takes from a naïve conception to a scientific one.

Largely responsible for improvements to the quality of science education in the 80s and 90s, conceptual change approaches have been under continuous development and refinement (Duit & Treagust, 2003). The push to improve scientific education was driven by concerns in the late 20th century over declining scores on the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) tests (Duit & Treagust, 2003). As a result, scientific quality development projects were instituted with the goals of: 1) redesigning science curriculums; 2) increasing the frequency of learning tasks and experiments, and the introduction of new teaching strategies; 3) focusing on means to engage and interest students; and 4) putting principles of conceptual change and constructivism into practice (Duit & Treagust, 2003). One of the main reasons that conceptual change was adopted, as a principle theory in science education is the results of the many studies, which show it as a more effective means of teaching compared to traditional methods (Duit & Treagust, 2003).

## Active Learning Theory

The practice of active learning continues to grow in popularity, however it is difficult to precisely say when the active learning movement began. John Dewey, a famous American researcher, advocated for active learning early in 1929 when he promoted the idea that learning involves interacting with the real world (Dewey, 1929). What Dewey was saying here is that there is a significant difference between knowing and doing. According to Dewey, “We are so accustomed to the separation of knowledge from doing and making that we fail to recognize how it controls our conceptions of mind, or consciousness, and on reflective inquiry” (p.22). Dewey here examines how the process of learning cannot be separated into passive and active learning. Instead, learning requires active participation in the process and usage of ideas into first-hand real world uses (Hiebert et al., 1996). Dewey, a strong believer in the power of scientific research methods for the analysis of problems, advocated for a methodical approach to problem solving (Hiebert et al., 1996). His three-step process could be simplified to: 1) identifying problems; 2) studying those problems through active engagement; and 3) reaching conclusions to those problems (Hiebert et al., 1996). Unfortunately, this simple yet logical approach to problem solving is often overlooked in the traditional lecture. Often, conclusions are reached for students prior to their having been given sufficient opportunity to consider problems themselves. As a result, students are denied chances to engage in higher-order thinking skills.

Another important person in Active Learning theory is Lev Vygotsky, the educational researcher who is known for his creation of the Sociocultural Theory of Development. According to this theory, “learning takes place when students solve problems beyond their current developmental level with the support of their instructor or their peers” (1978). Thus, Vygotsky states that learning requires problem-solving and social interaction between peers (Cambridge International, 2015). Thus, in summary active learning is a social practice, which requires application of ideas into real-world scenarios and where students can solve challenging problems.

## Active Learning Techniques

Many research studies have focused on creating new and refining old active learning techniques. According to Bonwell and Eison (as cited in McCarthy & Anderson, 2000) all these strategies focus on elements of: 1) student participation; 2) student involvement; 3) student motivation; and 4) content relevancy. The benefits of active learning go beyond grades and superficial learning (Bonwell and Eison, 1991; Moore, Fowler, & Watson, 2007). Many studies have found that active learning techniques lead to a more stimulating and enjoyable classroom for students, resulting in higher overall student satisfaction (McCarthy & Anderson, 2000). Compared to the traditional lecture format, active learning practices improve student understanding of course materials and concepts. The active learning activities that are described below were selected due to their research proven ability to improve student learning through an emphasis on student interaction and higher order thinking skills.

### Problem-Based Learning

Over the course of the past thirty years, researchers have perfected Problem-Based Learning (PBL) methods (Savery, 2006). Referring to a student-centered approach where students complete research, incorporate theory and practice, and employ knowledge and skills to develop solutions to a problem, PBL focuses on solving problems that could have multiple correct answers (Savery, 2006). While there are many different possible definitions of PBL, the characteristics considered to be essential are using a problem as the origin of learning and using group work as a tool for interaction (Dolmans et al, 2005). Problem solving is especially important because when students are presented with a new problem, they discover information that they do not already know along with the information that they still need to learn (Dolmans et al, 2005). Consequently, problems are effective tools to link prior knowledge with new knowledge (Dolmans et al, 2005). Another important aspect of PBL is collaborative learning. Students must work together to combine knowledge and reach conclusions, all while enhancing their collaborative abilities (Dolmans et al, 2005).

PBL methods have been proven to improve student learning satisfaction and classroom attendance (Dolmans et al, 2005; Vernon & Blake, 1993). According to one research study did a five meta-analysis on 35 separate studies, there were not any studies that did not show the benefits of PBL (Vernon & Blake, 1993). One study, which was used in this meta-analysis, found that the usage of PBL methods led to an increase from 65% to 90% in student attendance (Vernon & Blake, 1993).

There are several key components to a PBL lesson. First, students must be responsible for their own learning (Savery, 2006). This autonomy over the learning process leads to higher student motivation and participation. Next, students encounter "ill-structured" problems, or those without a clear answer, where they must think critically to develop potential solutions (Savery, 2006). This "ill-structure" of problems is like the real world because many of the issues students will face in life will not have a clear-cut answer (Savery, 2006). Finally, PBL is interdisciplinary and incorporates a wide range of knowledge relevant to the problem (Savery, 2006). An added benefit to this is that students are able to each bring their own unique knowledge to the group and discuss their expertise and experiences on the issue. At the end of the lesson, students create a final analysis where they examine what they have learned and examine the most relevant and essential materials and knowledge they learned (Savery, 2006). Ultimately, this metacognitive reflection process promotes student introspection on learning, leading to long-term acquisition of concepts (Savery, 2006).

**Cooperative Learning**

Cooperative learning involves using groups to accomplish individual goals. The groups can be the whole class or smaller groups of students as well. Bonwell and Eison provide the following definition of the goals of cooperative learning: “The goals of cooperative learning are twofold: to enhance students' learning and to develop students' social skills like decision making, conflict management, and communication” (1991, p.43). Cooperative learning is an essential part of what Grabinger and Dunlap call a “rich environment for active learning,” which is an ideal set of principles for maximizing student learning (1995, p.26).

Cooperative learning strategies include active-review sessions, work at the blackboard, concept mapping, visual lists, role playing, panel discussions, debates, games, and jigsaw group projects (Faust & Paulson, 1998). In the book *Cooperative Learning in Higher Education* (Millis, 2012), the author suggests that cooperative learning can improve learning experiences for students over lecture alone. Several instructors, like Paulson (1999), have seen that cooperative learning leads to higher pass rates in their own courses, when compared to classes that do not use cooperative activities. The students also score higher in the lab sections as well. As to why cooperative learning is so beneficial, Slavin (1996) presents main reasons from several perspectives: 1) motivational perspective; 2) social cohesion perspective; 3) developmental perspective; and 4) cognitive elaboration. The motivational perspective describes the reasons that a group would work together, which include, for example, the idea that students will work hard to help each other so that the group gets a good grade. The social cohesion perspective is similar, except the reason that students will work together in this perspective is because they want to help their classmates succeed. The development perspective states that students will learn the most when they are interacting with peers in similar zones of development. The last perspective, cognitive elaboration, states that students learn the most when they are having opportunities to discuss the material and teaching it to others.

When there are a group of students who are supposed to work cooperatively, there are a few recommendations for how to best structure the group. Smith (1996) suggests five recommendations which include: maintaining positive interdependence in the group, having face-to-face interactions, having individual accountability, making use of teamwork skills, and last, allowing for group processing. Maintaining positive interdependence means that students will depend on one another, which could be for the eventual grade or possibly how they use shared resources. Face-to-face interaction will require having the students interact in person for more quality experiences. Individual accountability means that the instructor ensures that every student in a group has some responsibility so that all students get some experience out of the work. Teamwork skills include any group skills like coordination, decision-making, and other skills that rely on working together effectively. Lastly, group processing involves having the group think about and reflect on how well they work together as a group and what changes they could make to better work together.

For a professor who is looking to use group learning, Smith (1996) also presents a list of suggestions for key ideas to design and run a group work activity. These suggestions include specifying the objective for the lesson so there is a goal, making detailed decisions about making the groups to best match that objective, explaining the task to the students in detail and how they can work well together, monitoring how things are going while the project is underway, and evaluating students both in how well they individually did as well as the group's overall performance.

A meta-analysis by Springer, Stanne, & Donovan, analyzed 39 research studies to examine the effect of small groups on learning science, mathematics, engineering, and technology. Each of the studies in the meta-analysis aimed to mirror the work force, in which employees work collaboratively and cooperatively, encouraging communication and accountability. The researchers define collaboration as an unstructured process, which requires students to "negotiate goals, define problems, develop procedures," and work together to derive answers to problems (Springer, Stanne, & Donovan, 1999, p.24). The meta-analysis had a strict code for which sources did and did not qualify. These criteria included studies which were about undergraduates in science, mathematics, engineering, or technology classes at accredited colleges or universities in North America, studies that involved small-group work, whether it was inside or outside of class, studies that took place in classrooms and not in labs, studies that were in 1980 or later, and studies that included statistical information including sample sizes (Springer, Stanne, & Donovan, 1999). In addition, the meta-analysis reached out to several researchers in the field for recommendations on relevant research to include. Sources were found from multiple sites including ERIC, Educational Index, PsycLIT, Dissertation Abstracts International, Medline, CΓNAHL (nursing and allied health), and ASEE (American Society for Engineering Education). The meta-analysis revealed that small group learning has a positive effect on undergraduates in STEM courses (Springer, Stanne, & Donovan, 1999). The study also showed an increase in levels of achievement, measured by exam and standardized test scores, and an increase in attitude, measured by self-esteem and motivation. All scores rose regardless of race or sex.

**Critical Dialogue Skills: The Socratic Method and The Fishbowl Discussion**

The use of dialogue as a tool in education has a long history, which dates back to the early Greek civilization (Oyler & Romanelli, 2014), and it can take many forms (Marchel, 2007). Schein said that critical dialogue refers to continuous "collective inquiry into the processes, assumptions, and certainties that comprise everyday life" (as cited in Marchel, 2007, p.2). Critical dialogue is an effective practice because it combines self-analysis, or the consideration of one's own personal bias, and peer collaboration (Marchel, 2007). The works of Vygotsky and Bakhtin support the importance of critical dialogue as an effective tool in cognitive development, as both researchers emphasized the importance of social interaction in the learning process (Marchel, 2007).

Critical dialogue is often an instructor-directed questioning process where students are required to think both as a group and individually. One of the most notable instructor-led questioning methods is the Socratic method of questioning, which encourages students to develop original thoughts based on higher-order questioning (Paraskevas & Wickens, 2003; Tofade, Elsner, & Haines, 2013). Through the use of a "Socratic Seminar," questions are the primary tool for teaching (Paraskevas & Wickens, 2003). Socratic questioning is effective because it highlights limitations to knowledge and motivates learning (Paraskevas & Wickens, 2003). Moreover, the structured discourse of the Socratic method not only connects learning to personal experiences, it also engages learners on an emotional level (Paraskevas & Wickens, 2003).

According to a 2014 study published in the American Journal of Pharmaceutical Education, students prefer to learn using Socratic questioning (Oyler & Romanelli, 2014). The study examined 74 upper-level medical students; one group received information through traditional didactic lecture methods and the other group learned through Socratic methods. At the end, students were given a 7-item survey to assess their preferences. With a sample size of 30 students, (30% of the students in the class), a majority stated that they preferred the Socratic method for learning rather than the didactic approach (Oyler & Romanelli, 2014).

An example of a student-led method of critical dialogue is the fishbowl technique. The fishbowl activity begins by dividing a class into two equal groups (Kramer & Korn, 1996). One group is the inside group, which is tasked with problem solving and discussion. The other group is on the outside of the inside group and they observe the dialogue. This group is responsible for taking notes as the inside group interacts (Kramer & Korn, 1996). Moreover, the outside group has a unique job of helping those in the inside when they begin to struggle with a problem (Miller & Benz, 2008). As a result, the outside group serves as a sort of quality control for classroom discussion. Students who are engaged in a fishbowl activity are more likely to discuss and comment on their methodological thought process, thus promoting higher order thinking (Miller & Benz, 2008). The fishbowl technique is an effective way to encourage peer collaboration, improve student performance on a variety of academic tasks, sharpen student analytical skills, encourage cooperation, and help students build their knowledge of research (Miller

& Benz, 2008). All these factors help build a positive classroom environment and promote student collaboration (Miller & Benz, 2008). The numerous benefits associated with the fishbowl technique make it as an interesting method for promoting collaboration between students.

**Writing-to-Learn**

Writing-to-learn (WTL), or the use of writing to improve student scientific writing, has been proven to enhance student knowledge and cognitive development in STEM subjects. Despite this, WTL practices are not commonly used (Reynolds et al., 2012). One of the primary benefits of writing is that it makes thinking visible, which allows for greater reflection (Reynolds et al., 2012). As a result, the WTL process gives students the opportunity for greater metacognitive awareness, or “knowing about knowing” (Reynolds et al., 2012). This allows for learners to revisit their ideas and to expand on prior knowledge, create new relationships with the information, uncover self-explanations, and review understanding and comprehension (Reynolds et al., 2012). Langer (1986) said that writing helps students think about their background knowledge, thus thinking about their thinking. Langer went on to add, “metacognitive awareness may make writing a particularly effective tool for writing to learn” (1986).

Writing to Learn methods have been proven in STEM subjects. Kirkpatrick and Pittendrigh (1984) found that writing tasks benefited average and under-performing students the most, and that almost 90% of students reported that WTL methods improved their understanding of physics material. Strenski (1984) developed a WTL classroom technique where students wrote paragraphs using isolated bits of facts and information.

He later found that this technique helped his students link new knowledge to prior knowledge (Strenski, 1984).

Linton, Pangle, Wyatt, Powell, & Sherwood (2014) examined the effect of practice writing and discussion, both active learning techniques, on exam scores. The researchers examined three different active learning teaching methods in an introductory biology course: discussion, writing, and discussion + writing (Linton, et al., 2014). Students actively involved with in-class writing showed the largest increase of scores on exams. The writing, although time consuming, allowed students to consider what they had learned and develop new questions. Meanwhile, in-class discussions did not result in a significant increase in test scores. The discussion, though seemingly not providing a significant increase in learning, must still be valued in the classroom setting because of its ability to refine conceptual understanding (Linton et al., 2014).

**Audience Response Systems**

The traditional lecture provides students with few opportunities to respond and participate in class. Often, only the most knowledgeable students are willing to participate in class (Graham, Tripp, Seawright, & Joeckel, 2007). As a result, many instructors seek whole-class activities, which can help students contribute to the class and be challenged. One approach to the challenges associated with the traditional lecture is the use of an Audience Response System (ARS). ARS refers to a technology where students can respond electronically to in class questions using a device (Graham et al., 2007). Instructors have successfully used ARSs in classes with just 15 students all the way to 200 students, and ARSs have been linked to higher student satisfaction by promoting collaboration and engagement (Laxman, 2011). Thus, ARS technology is an attractive technique for instructors to better facilitate and grow their students' knowledge.


*Figure 1.* Audience response hardware from Turning Technologies: Student transmitter (left) and instructor receiver (right).

ARS technology can improve student-learning experiences by improving student test scores and by encouraging student collaboration, and engagement. First, due to the interactive aspect of ARS systems, students can participate more in class, thus raising test scores (Laxman, 2011). In one study, Mazur saw considerable improvement in student test scores from the beginning to end of the semester for students who used ARSs over those who did not (as cited in Laxman, 2011). Reay, Bao, Warnakulasooriya, and Baugh (2005) also had a similar finding when they observed that students who used ARS devices did better on the same exam questions than students who did not use ARS devices (as cited in Laxman, 2011). Another benefit of using ARS devices is that students can work in a more collaborative environment (Graham et al., 2007). By working together to answer questions, students can communicate in-small groups and discuss misconceptions about the material (Graham et al., 2007). Also, students who are not likely to participate can become more involved. For many students, the fear of failing in front of the class can be overwhelming; this is especially true for female learners and students from other cultures (Graham et al., 2007). Because ARS technology allows students to provide anonymous in-class answers, students are able to make their voices heard without the fear of embarrassing themselves. Finally, ARSs encourage students to be more engaged. Overall, ARSs provide students with greater class enjoyment because they allow the instructor to communicate with students and to have greater awareness of student understanding of concepts (Graham et al., 2007). This allows instructors to help students if they are struggling. As a result, ARSs are an effective tool to enhance the quality of STEM education.

The success of ARS systems in class is widely accepted. A study from Brigham Young University in 2006 demonstrated that students who used ARS technology in class felt that it strongly enhanced their learning experiences. Students from across 10 different courses were asked 14 different questions on the effectiveness of ARS technology (Graham et al, 2007). The students overwhelmingly responded that they felt the use of the ARS "clicker" was an effective learning device (Graham et al., 2007). Another study on ARS systems at a public regional institution in the Midwest found that ARS systems increase student participation. Participants attended two lectures (Stowell et al., 2007). The first lecture was a traditional 30-minute lecture with hand-raising allowed. The second utilized ARS systems (Stowell & Nelson, 2007). After each of the two lectures, students were given surveys to assess their "enjoyment, hope, pride, anger, anxiety, shame, hopelessness, and boredom" (Stowell & Nelson, 2007). The students responded with greater positive emotion with clickers and they participated more with clickers. The findings of this study clearly show that ARS technology can be used as a good source in teaching to promote participation and positive emotions.

## The Jigsaw Method

In the jigsaw method, students participate in at least two groups to learn and share information. Students are initially presented the information in their first group. The group works together to fully understand the information and answer any provided questions. Then, new groups are formed with at least one individual from each original group. In these new groups, students teach each other the information they learned previously, while compiling any relevant data and conclusions from the second group's members.

The jigsaw method is ideally suited for courses which require problem-solving skills (Ghaith & El-Malak, 2004). Through this method, students can creatively learn new content in a relaxed and feedback-rich context, all while utilizing higher order thinking skills (Ghaith & El-Malak, 2004). Research shows that the jigsaw method successfully reinforces learning abilities such as "positive interdependence" and "individual accountability" (Ghaith & El-Malak, 2004).

In addition, the jigsaw method has been proven to improve student academic performance and to promote higher order thinking skills. In a 2014 study, students were briefed about the material and the learning platform of Google+ (Huang, Liao, Huang, & Chen, 2014). After being introduced to the topic, the students in the control group learned the material individually, while the experimental group participated in a jigsaw learning activity. The findings from the study showed that the jigsaw method helps students acquire, share, and organize the information they are given (Huang et al., 2014). In another 2014 study, researchers examined the usage of the jigsaw method with medical students at Duke University. Students were arranged into small groups (Buhr, Heflin, White, & Pinheiro, 2014). After learning the principles, students were rearranged into new groups where they taught the other students about the content from their original group (Buhr et al., 2014). At the end of the study, students took a knowledge test. The results of this test showed that students understood the information well (Buhr et al., 2014). Finally, in Ghaith & El-Malak 's 2004 jigsaw study he found that the jigsaw method had a statistically significant impact on higher order thinking skills. According to the research, the jigsaw method works well with students and is demonstrated to be an effective way to teach students additional content. This reveals a bigger picture that active learning through the jigsaw method can better help students to reach course goals.

**The Flipped Classroom**

Another active learning technique is the flipped classroom. Diane Lending (Gan Kok Siew et al., 2014), a professor at James Madison University, defines the Flipped Classroom as "changing the classroom model from a traditional lecture-based classroom followed by homework to a model where content delivery is done at home before an active learning experience in the classroom" (p.115).

By assigning material for students to read, watch, or listen to before class, the instructor is given more time in class to answer questions and engage students in activities. In a study by Enfield (2013), instructors developed video lectures. Daily quizzes were given to make sure students watched the instructional videos, and actively engaged the students during class time. End of class surveys showed high approval of the flipped classroom by the students, with most considering the videos to be very helpful and somewhat engaging. In fact, 63% of students found it helpful, 95% found it appropriately challenging, and 95% found it somewhat or very engaging (Enfield, 2013). The technique aims to encourage students to confidently learn relevant material outside of the classroom, while feeling supported in the classroom (Enfield, 2013).

An example of the flipped classroom method in action can be found at the University of Michigan math department, which has been teaching a flipped version of its calculus courses since the 1990s (Berrett, 2012). Every summer, faculty members receive an intense weeklong training course and occasional follow up meetings throughout the semester from more-experienced instructors (Berrett, 2012). Students are expected to do their reading and review outside of class and to come to class prepared to discuss the information. The instructor gives a brief lecture and then students are asked to explain their understanding of the reading and complete problems on the board. As students demonstrate their understanding, the instructor circles the room to see if every student is learning the material. “Students are learning how to think, and we’re learning what they’re struggling with,” said Karen Rhea, the director of the introductory mathematics program. Students at the University of Michigan’s flipped course are divided into 60 small sections of introductory math courses such as calculus, with a maximum number of students capped at 32 (Berrett, 2012). In 2008, the students were given concept inventories when the course started and then again after it had finished (Berrett, 2012). Students showed learning progress almost twice as high as those who attended traditional lectures at other institutions and took the same test (Berrett, 2012). In fact, the students who scored the lowest had relatively similar scores to students at other schools who learned from traditional lectures (Berrett, 2012).

A 2006 study at the Georgia Institute of Technology found that over the course of one semester, students in a flipped classroom setting outperformed students in a traditional lecture (Day & Foley, 2006). The study involved 46 students who were in two different sections of the same computer science course. The students were divided into an experimental and control group, where the experimental group was “flipped” and the control was traditional (Day & Foley, 2006). The experimental section was taught using online web-based lectures, and in class time was devoted to learning activities which sought to increase higher order thinking. Sample tasks included role-plays, group presentations, breakout group discussions and many more active learning techniques (Day & Foley, 2006). The control group was taught through a regular in-class lectures. Attendance for both sections was required. The results of the study found that the experimental group outperformed the control group on every assignment and exam (Day & Foley, 2006). On both the midterm and final exam, students in the experimental group scored an average of 10% higher. The experimental section scored more than eight points higher on the final course grade ($p < 0.01$) (Day & Foley, 2006). Thus, the experimental group received a final grade on average 7% higher than students in the control group (Day & Foley, 2006). The research findings of this study support the conclusion that the flipped classroom is a more effective technique to teach students than the traditional lecture method.

**Pause Method**

The pause method has been shown to improve student classroom performance (Bacchel & Thaman, 2014). The way that the pause method works is simple: faculty simply give students a brief two to three minutes pause every fifteen to twenty minutes during the lecture to look over their notes, reflect on them, and discuss and explain the most important details with their peers (Bacchel & Thaman, 2014). Many students especially enjoy this method because it allows them to briefly rest during the lecture. In addition, many students feel that that the pause procedure helps them have better in-class interactions with their peers because they have more chances for interaction (Bacchel & Thaman, 2014). According to Bacchel, "[the advantage of the pause method is] less time in preparation, students get time to reflect, discuss in their group and delve deeper into the material" (2014, p.2). Due to the numerous benefits associated with the pause method, it should be implemented into all classrooms.

According to a 2014 study by Bachhel and Thaman conducted over the course of a semester with over 150 medical students, the pause procedure led to significantly better test scores. In the study, students were divided into an experimental and control group. The experimental group was given several pauses throughout the lecture to analyze their notes with classmates while the control group was not. Both groups were taught the same materials and there was no difference in course work. At the end of semester, student test scores were compared and quantified. The experimental group scored 7% higher on the test compared to the control group with $p < 0.05$ (Bacchel & Thaman, 2014). Another implication of this study was that the test was administered 15 days after the final lecture (Bacchel & Thaman, 2014). The fact that the students in the experimental group scored higher than the students in the control group provides evidence that the pause method and other active learning techniques may encourage greater long-term retention of information (Bacchel & Thaman, 2014).

Active learning techniques may also include fostering active listening. One such example is the clarification pause, which allows students time to develop questions and answers from the lesson. During the pause, instructors should walk between students to allow for personal questions. With this technique, more timid students can feel engaged in the class (Faust & Paulson, 1998).

Another study demonstrated that students remembered more after a class was over if they had pauses in the lecture to discuss their notes with other students (Ruhl et al., 1987). Seventy-two undergraduate students were divided into a control and experimental group; the experimental group was taught using the pause method (Ruhl, Hughes, & Schloss, 1987). After five lectures, students from each group were asked to recall facts (Ruhl et al., 1987). The experimental group was able to remember on average 109.50 facts while the no-pause group was only able to remember 82 facts (Ruhl et al., 1987). Students in the experimental group had significantly higher scores than the control (Ruhl et al., 1987). As this and the other mentioned studies show, the pause method is a useful active learning technique which instructors can utilize to promote student achievement.

**Debates**

For over 4,000 years ranging from the time of the ancient Greeks and Egyptians, academic debate has been used as one of the most effective methods for developing learning critical thinking skills (Doody and Condon, 2012; Kennedy, 2007). Debate could be defined as the process of considering multiple viewpoints and arriving at a judgment (Kennedy, 2007). Freeley and Steinberg (2005) offer a more complex definition state that debate involves considering multiple viewpoints before making a judgment and they state that debate ranges from an individual debating with oneself to decide to groups of individuals using debates in order to convince others of something (as cited in Doody and Condon, 2012).

Debates are useful in the development of critical thinking skills and as a means to challenge misconceptions, assumptions, and to arrive at new ways of thinking through peer collaboration (Doody & Condon, 2012). As a result, debates are an effective strategy in classrooms for several reasons including giving students greater student responsibility over their learning, increased student participation, and enhanced higher order thinking abilities. First, debates flip the classroom and place the learning responsibility on the students (Kennedy, 2007). This changes the learning process from a passive to an active one, and forces students to place a higher value upon their own abilities to interact with the materials (Doody & Condon, 2012). This in turn empowers students to take a greater role in the learning process. Next, debates promote student participation and participation. Berdine said that "Students place a higher value on participating than on learning by being lectured at and receiving information passively" (As cited in Kennedy, 2007, p.183). According to Combs and Bourne (1994), 78% of surveyed students in a senior marketing course thought that debates enabled them to learn more. According to Brown (2015), "87.5% of students would like to see the use of debates in future modules." Thus, debates prevent inertia from occurring in a class. In addition, debates also have the added benefit of encouraging critical thinking. The critical thinking skills in debates include interpretation, analysis, evaluation, inference, explanation, and self-regulation (Doody & Condon, 2012). Debates force both students and instructors to re-read and re-evaluate both their own and the opposition's position more intently than what a traditional lecture requires (Kennedy, 2007). In summary, debates are an effective means for teaching due to a multitude of reasons because they include students in the learning process while promoting participation, motivation, and higher order thinking skills.

The lessons learned from in-class debates can easily be transferred to real life. Debates can prevent misconceptions by encouraging deeper thought about the content. The critical thinking skills developed from in-class debates can be applied to real life situations, where information is constantly new and changing. Debates also develop oral communication skills between students (Kennedy, 2007). Williams, McGee and Worth discovered from a survey of 70 universities that student communication skills improved due to debates (as cited in Kennedy, 2007). According to Kennedy, this is because "debate involves not only determining what to say, but how to say it" (2007, p.184). A good example of this is in science when students learn highly specific technical vocabulary, debates can help students determine how to properly use new terms through communication and identify the context in which new terms should be used. Debates also encourage empathy between students and the teacher (Kennedy, 2007). When students can hear both sides of an issue, they are able to see the full picture as opposed to only one side. An added benefit of debates is that they allow students to see the issues theoretically and practically, in turn minimizing instructor bias (Kennedy, 2007). By learning about both sides of an issue, students can see beyond one person's perspective. In summary, there are a number of powerful reasons to use debate in the classroom.

**The Minute Paper**

The minute paper is an effective active learning technique, which allows faculty to evaluate what students learned from a specific lesson. The minute paper asks the students to recall and process the information they are given in a short amount of time (Angelo & Cross, 1993). Students are asked to answer questions such as: "What is the most important thing you learned today? or What is the muddiest point remaining at the conclusion of today's class?" (Chizmar & Ostrosky, 1998). By allowing students one or two minutes to respond to a lesson, the instructor can understand to what extent the message is understood. The paper can be written anonymously, however students are less engaged with the process when they can respond anonymously (Harwood, 1996). For students to feel most engaged, they should label their statements with their name, and the instructor should address common questions and statements in later lessons.

A study conducted during the fall of 1992 and 1993, and the spring of 1994 with university economics students demonstrated the effectiveness of the minute paper. In the study, four instructors each taught a control and an experimental section of the same course with no differences with one exception; in the experimental section, the instructors used the minute paper technique (Chizmar & Ostrosky, 1998). The enrollments for each instructor were: instructor 1 had 158 control and 238 experimental students; instructor 2 had 26 control and 25 experimental students; instructor 3 had 48 control and 24 experimental students; and instructor 4 had 24 control and 28 experimental students (Chizmar & Ostrosky, 1998). In total, 256 students were part of the control group and 315 students were part of the experimental group (Chizmar & Ostrosky, 1998). The study found that students who were in the experimental sections of the courses scored on average approximately 6.6% higher in their knowledge of economics concepts in comparison to students in the control section (Chizmar & Ostrosky, 1998). This evidence demonstrates that the positive effects of the minute paper are not directly reliant on instructor or student ability (Chizmar & Ostrosky, 1998). The study also shows that every student can benefit from the minute paper (Chizmar & Ostrosky, 1998). A final consideration is that both inexperienced and experienced faculty both had similar growth in student scores; thus, the minute paper may serve as a tool for helping all faculty, new and experienced, and their students be successful in the classroom (Chizmar & Ostrosky, 1998). In summary, the minute paper is a viable tool for instructors to reach their students.

**Podcasts**

A new and emerging technique, podcasting, refers to the distribution of audio or video files in digital format (McGarr, 2009). Typically, podcasts are downloadable, and the listeners subscribe to them, in turn receiving new podcasts whenever they come out. The use of podcasts in higher education has the potential to provide information to supplement traditional lectures. Podcasting is a useful resource in education for several reasons including convenience, flexibility, and accessibility of learning. First, podcasting is convenient for students. Students can listen to podcasts anywhere they want, especially if they have a mobile device. By having mobile access to course materials, students can study when they have free time, such as when they are commuting, on lunch break, or simply outside of the classroom (McGarr, 2009). This is especially helpful for professionals with busy schedules. Podcasts can also improve the quality of learning because students are able to focus more time onto listening to the lecture. They are able to listen to the podcast multiple times, slow down the speech, and take notes in a more comfortable and relaxing setting.

The effectiveness of the podcast in education is supported by many studies. A study at a South African university involving 148 first-year medical students found that podcasts can directly improve student exam performance (Beylefeld, Hugo, & Geyer, 2008). Students listened to podcasts of the lectures in preparation for an oral examination (Beylefeld, Hugo, & Geyer, 2008). Roughly 87% of the participants described the podcasts as "meaningful" (Beylefeld, Hugo, & Geyer, 2008). More than half of the class, 58%, obtained higher grades on the questions that tested material covered in the podcast than on the questions using traditional means of instruction (Beylefeld, Hugo, & Geyer, 2008). Moreover, students responded positively to receiving the course information through the podcast format. Another study at a New York state college examined the effect of podcast learning on 66 undergraduate general psychology students (McKinney, Dyck, & Luber, 2009). Students were divided into two groups, the podcast group and the in-class lecture group. The study found that students who received class materials from podcasts scored higher on their final exam than students in traditional lectures with $t(64) = 2.12$, $p < 0.05$ (McKinney, Dyck, & Luber, 2009). Most of the students in the podcast group reported taking notes while listening to the podcast as well as listening to the podcast multiple times to review for the exam (McKinney, Dyck, & Luber, 2009).

## Active Learning Challenges

There are a lot of challenges that can prevent faculty from using active learning in their classes such as 1) teaching time, 2) large class sizes, 3) departmental pressure, 4) lack of equipment, 5) planning time, 6) fears of losing control, 7) insecurities, and 8) fears of poor evaluations.

One of the challenges is that there is not enough time to do the active learning activities (Bonwell & Eison, 1991). Another challenge can be that the class can have many students, which makes it difficult to coordinate an active learning activity (Bonwell & Eison, 1991).  Equipment may be lacking for the teacher as well, which can be a problem that happens more in a developing country. This equipment can be books, or technology, or even the furniture in the room and how it is arranged (Bonwell & Eison, 1991).  As there are several active learning strategies that do require materials, this can limit the options for faculty without those materials.

Other challenges include faculty feeling that the active learning lessons may require too much effort to plan (Bonwell & Eison, 1991). They may have lectures set up already that they can easily re-use, so it is difficult to take the time to make a change without knowing if it is worthwhile. Even if they are willing to plan an active learning lesson, the professor might worry about losing control of the class (Bonwell & Eison, 1991). Faculty might feel more comfortable lecturing, rather than trying to organize and facilitate student activity and interaction. Also, they may be afraid of giving the impression that they do not know much about the material, and having a lecture allows them to show how much they know (Ndebele & Maphosa, 2013). Another challenge of active learning is that instructors may feel "sidelined" or less involved in the class. Rather than the professor spending time at "center stage," he or she must provide more class preparation so that the students can hold the spotlight (Ito & Kawazoe, 2015). Another challenge is that faculty are evaluated by their students at the end of class, and they might fear getting a worse evaluation if the students do not like a new teaching method that they are not used to (Ndebele & Maphosa, 2013).

The last challenge may be that students may learn the material at a slower rate with active learning techniques. More time may be used employing the active learning techniques than furthering the spread of information. Special modifications in course planning can help to speed up the learning process (Ito & Kawazoe, 2015).

**Active Learning in Science and Math**

Active learning can be used in science and math classes to lead to student improvement. See Figure 2 for example of how a traditional science classroom can look different from an active learning science classroom. As the photos demonstrate, the traditional classroom is rigid and does not allow much room for collaboration. The active learning science classroom, however, is set up to facilitate collaboration. Students can work in groups and easily move around the room. In addition, the technology in the active learning science classroom is much newer, including television monitors around the room and smartboards or whiteboards for each table.

*Figure 2*. A science classroom at Auburn University arranged for traditional lectures (inset) and redesigned for group problem-solving.

Freeman et al. (2014) carried out a meta-analysis of many studies on active learning in STEM courses, and they found that active learning led to higher student grades and lower rates of failure. In a study of 6000 students in introductory physics classes, the use of interactive engagement led to an overall improvement of student performance versus traditional lecture-based methods; in comparison to 14 traditional classes, 48 courses which used active learning methods achieved an average gain almost two standard deviations above the traditional courses (Hake, 1997). Another study found that an organic chemistry professor who used active learning techniques in a department where other faculty did not use much active learning, had a 20-30% higher pass rate over lecture only classes (Paulson, 1999). The specific activities that can help science students, at least for one study on physics classes, included interactive lecture demonstrations (such as demonstrating laws of force or motion), which have been shown to greatly increase student understanding of the related concepts (Sokoloff & Thornton, 1997).

A 2009 study found that restructuring a traditional biology course to incorporate active learning techniques had a significantly positive impact on student attitudes and performance (Armbruster, Johnson & Weiss, 2009).). The study focused on the effect of implementing an active-learning curriculum in an undergraduate biology course over the course of three semesters (Armbruster et al., 2009). In 2008, the faculty redesigned the introductory biology course curriculum to focus on active learning pedagogy and student-centered learning (Armbruster et al., 2009). The principal motivation for this was poor student motivation; the faculty were becoming increasingly concerned with low attendance rates, limited student participation, and sub-par student performance on exams (Armbruster et al., 2009). In the study, 2007 served as the baseline year for which the future results would be compared. During 2007, traditional lecture methods were utilized by the faculty. Beginning in 2008, and then again in 2009, an active learning approach was adopted. Students were put into groups of four on the first day and were asked to sit together for the entire semester (Armbruster et al., 2009). Throughout the semester, the groups engaged in problem-based learning where they investigated real-world problems (Armbruster et al., 2009). While students interacted in problem solving, the instructor monitored the groups and reviewed student understanding (Armbruster et al., 2009). In addition, students used personal clickers to engage in course presentations. This course restructuring yielded significant improvements in self-reported student engagement, satisfaction, and increased student performance (Armbruster et al., 2009). While student satisfaction was demonstrated to be significantly higher in 2007 and 2008 than in 2006 ($p = 0.05$) there was no difference between 2007 and 2008 ($p = 0.05$) (Armbruster et al., 2009).

Beyond just in-class performance, active learning can also lead to students become lifelong learners in science as well. Lord et al. (2012) measured student responses to the Motivated Strategies for Learning Questionnaire, which was developed by Pintrich and his colleagues (Pintrich, Smith, Gracia, & McKeachie, 1991, 1993). By combining those results with qualitative observations of student-faculty and student-student interactions, they found that students taking an active learning class improved on several criteria important for becoming lifelong learners. In another meta-analysis of 39 studies, the use of small-group learning in undergraduate science classes was effective also for improving student attitudes toward learning and their persistence in a STEM curriculum (Springer et al., 1999).

## Saudi Active Learning

In Saudi universities, teaching methods are relatively traditional and use PowerPoint lecture-based teaching as the standard means of instruction (Alwasal & Alhadlaq, 2012). For the most part, student-centered learning strategies have been overlooked and not implemented in the mainstream for several reasons. First, in the past several decades, there has been a large expansion in the number of universities in Saudi Arabia, causing a faculty shortage (Alwasal & Alhadlaq, 2012). There has also been a huge increase in the number of students attending universities (Albaikan & Troudi, 2010). The growth in the number of students along with many inexperienced faculty using traditional lecture methods has placed strain on the quality of education (Alwasal & Alhadlaq, 2012). In addition, many faculty members in Saudi universities are given many obligations outside of teaching their classes. Many university faculty are expected to produce top-quality research along with teaching their classes and advising their students (Alwasal & Alhadlaq, 2012). This has caused faculty to feel overworked due to their many responsibilities (Alwasal & Alhadlaq, 2012). Last, many faculty members who have taught for many years feel more comfortable using traditional teaching methods. Therefore, they may have difficulty adjusting to new teaching methods (Albaikan & Troudi, 2010). Generally, many faculty members do not wish to change the ways they teach their classes. Due to all these factors, Saudi higher education today is primarily based on traditional teaching methods.

Many challenges are associated with modifying the teaching curriculum. First, many instructors have never received any training or workshops on how to teach beyond a traditional lecture (Alwasal & Alhadlaq, 2012). In fact, most faculty members, especially in STEM subjects, have never been formally trained as teachers (Alwasal & Alhadlaq, 2012). For many faculty, their only experience in teaching is based upon their own learning experiences in traditional lectures. In addition, the Saudi STEM curriculum is loaded with topics and subjects; many faculty members are afraid to adopt non-traditional learning techniques because they fear losing valuable class time to what they perceive are ineffective activities (Alwasal & Alhadlaq, 2012). Instead, they believe that the traditional lecture is the most effective way to deliver content to students. A final factor is that some believe students prefer to learn through the traditional lecture. While this may be true in some cases, this could largely be attributed to the fact that students have never been exposed to any other teaching methods. Therefore, many students are unaware that there are other ways to learn materials aside from passively listening to a teacher. Thus, in summary, moving away from the traditional lecture in Saudi Arabia is not a simple task, but as research supports, it is necessary.

The benefits to moving beyond the traditional lecture are extensive. First, it is important considering that the requirements of the modern workplace are much different than they were in the past. Students today are required to be able to analyze information, creatively solve problems, and adapt their lives to the growing complexities of technology and globalization (Alwasal & Alhadlaq, 2012). To develop these skills, faculty should decrease lecture time and increase opportunities for student involvement (Alwasal & Alhadlaq, 2012). Also, by transitioning away from the traditional lecture, Saudi students can become more responsible for their own learning. As a result, the success or failure of a class does not depend only on the teacher because the students are also responsible. Every member of the classroom has the responsibility to add content and knowledge to facilitate learning. An additional benefit is that active learning allows faculty to cover more information in less time. As previously mentioned, many instructors find it difficult to cover all of the course material in the course of the semester due to time constraints (Alwasal & Alhadlaq, 2012). Reducing the amount of content covered in class and shifting this to out of class learning, or using other active learning techniques, can allow instructors more time to introduce new material. During class time, instructors can instead focus on assessing student understanding of concepts and helping students develop higher-order thinking skills. In summary, an array of benefits can be associated with moving beyond the traditional lecture toward active learning techniques.

While the subject of active learning in Saudi Arabia universities is still a relatively new concept, there have been a few studies in Saudi Arabia, which demonstrate the effectiveness of active learning within the culture, and student preference for it. One study conducted at the Alfaisal University College of Medicine examined 127 medical students (Sajid, et al., 2016). The study compared student final grades between the 2014 and 2015 spring semesters. Students were instructed using traditional methods during the 2014 semester. Students were taught using a flipped classroom methodology during the 2015 semester, including take-home PowerPoints with a voiced over lecture and online real-time discussion boards where students could communicate with their classmates and teachers during the online lectures (Sajid et al., 2016). Upon completion of the 2015 semester, an overwhelming 73.1% of students said that they preferred the non-traditional classroom lecture to the traditional (Sajid et al., 2016). In addition, 81% of students preferred the active learning techniques used in class by their teachers. Finally, there was an overall improvement in final grades. The 2015 semester had a slightly higher number of students passing with A’s and B’s compared to 2014 (Sajid et al., 2016). As this study demonstrates, the practice of active learning if used properly can be successful in the Saudi higher education learning context.

It is of growing interest in Saudi Arabia to establish higher learning institutions that provide a quality of education comparable to that of developed countries. To achieve this aim, in 2004 the Saudi government established the National Commission for Academic Assessment and Accreditation (NCAAA) with the purpose of raising higher education standards (Alwasal & Alhadlaq, 2012). As a requirement for receiving NCAAA accreditation, higher learning institutions must demonstrate a well-organized curriculum and a focused educational strategy that graduates competent students and prove a continued interest in the development of effective teaching practices (Alwasal & Alhadlaq, 2012). Thus, any university, which seeks NCAAA accreditation, must do more than use traditional teaching methods. To meet the growing demands of higher education, Saudi universities must adjust their teaching methods. At the present, there is a relative lack of data on the use of active learning methods in Saudi universities. Consequently, this dissertation seeks to provide evidence of Saudi university science faculty opinions on the use of active learning practices, and the challenges associated with using them. The potential use of this research could be the future introduction of an active learning curriculum in Saudi higher education.

CHAPTER III: RESEARCH METHODS

## Introduction

The purpose of this study is to investigate the relationship between Saudi professor attitudes toward active learning and the rate of usage of active learning techniques. To gather this information, two surveys were used to measure attitudes and use of active learning techniques. The results of this study could generate discussions about active learning and help further develop active learning techniques in the higher education system in Saudi Arabia. Another result of this could be an improved curriculum where students are more engaged and involved and perform at a higher level in terms of exam scores and application of course content into higher order thinking. This chapter will define the scope and limitations of the research design and the methods used to collect and analyze the research data. Thus, the goal of this paper is to investigate Saudi faculty attitudes towards active learning and to see how they practice it, and to see if there is a correlation between attitudes and actions and to predict if the attitudes affect what faculty do in their classrooms.

Active learning techniques can make classroom management very difficult. Some faculty fear that they will lose control over the classroom if they use active learning techniques. Another reason participation in active learning in Saudi Arabia might be low is that the curriculum in Saudi universities is so overloaded that some faculty might think that there is no time for it (Alwasal & Alhadlaq, 2012). Many faculty might believe that active learning wastes classroom time. Due to these factors, there is an overall reluctance amongst Saudi faculty to utilize active learning techniques in their teaching methodology. Ultimately, an active learning curriculum encourages students to learn materials in the most practical and efficient manner possible, all while maximizing their success in the classroom.

**Theoretical Framework**

Two key aspects of active learning are creative problem-solving through the use of higher order thinking and social interaction (Brame, 2016). Constructivist learning theory is the framework for active learning techniques. According to constructivist learning theory, students learn by building their own knowledge, and then make connections between innovative ideas and experiences and prior knowledge to form a deeper understanding (Bransford, Brown, & Cocking, 1999). This concept is in accordance to Vygotsky's theory on the Zone of Proximal Development (1978). According to this theory, appropriate instruction should be somewhere inbetween what learners can already do and what learners cannot do. As a result, instruction should aim to facilitate new knowledge that can incorporate prior knowledge. An added benefit to this approach is that students can clear any misconceptions they may have (Brame, 2016).

Both active learning and constructivist learning theory focus on the development of student abilities over rote memorization and traditional teaching methods (Brame, 2016). Consequently, learners can either add additional information to what is already understood or change one's thinking to integrate the additional information (Cambridge International, 2015). Another aspect of active learning is social interaction. For example, cooperative-learning groups are a constructivist-based activity that promotes student interaction and the exchange of ideas (Brame, 2016). According to Vygotsky's sociocultural theory of development, "learning takes place when students solve problems beyond their current developmental level with the support of their instructor or their peers" (1978). Thus, learning requires social interaction between peers (Cambridge International, 2015). Through social interaction and the promotion of higher order thinking skills, students can form a deeper understanding of course content.

## Participants

The research included 41 faculty members from two Saudi universities who ranged in rank from lecturers or instructors, assistant professors, associate professors to full professors. The two universities were urban and both have a small student population. Two surveys were given directly to Saudi faculty members or to their departments. Upon completion, the surveys were mailed back to the host research institution for this study. The participants were selected by researching and choosing science department members at the two universities. Forty one participants out of 250 who were contacted completed the surveys. The participants genders included 14 female, 26 male, and one unknown. Participants ranged in age greatly: 9 of the participants were age 30 or less, 12 were between ages 31 to 40, 11 were aged between 41 to 50, and 8 were aged 50 or older.

## Development of Instruments

Multiple experts were consulted during the development of the surveys. One expert is the director at a university center for teaching and learning, and another expert, is the coordinter of faculty learning spaces/classrooms in a building designed for active learning. They were both consulted for feedback on the development the survey instrumentation. A third expert was consulted who has a Ph.D in science eduction, who reviewed the surveys to check their correlation with science-specific teaching. Finally a fourth person, a science faculty member at a US institution, who is an expert in active learning and uses it in his classroom reviewed the surveys. Based on the initial feedback from the US faculty, some changes were made. One of these changes was to add a definition for active learning at the beginning of the survey because it was likely that many Saudi science faculty members are unaware of what active learning means. Second, an additional survey was added (Survey 2- Usage of Active Learning) to measure how often faculty use active learning techniques. Note that originally, this study planned to use only one survey to measure faculty attitudes and preferences towards active learning. Initially, Survey 1 had 29 questions. Three questions were similar, so they were collapsed into one question. Two other questions were similar, so they were collapsed into one question, and one question was removed because it was similar to a question in Survey 2. Last, an open ended question was added to the end of Survey 2 (Usage of Active Learning); "What is your teaching style?" This process provided evidence of face and content validity.

## Research Questions

The research questions for this study, and the sources of data are:

1. What are the attitudes of Saudi Arabian (SA) university science faculty towards active learning techniques? (Source: Survey 1- Attitudes Toward Active Learning)

2) Which active learning techniques do faculty use in SA? (Source: Survey 2- Usage of Active Learning)

3) What is the relationship between what faculty do in class and their attitudes?

The hypothesis for this study is that Saudi Arabian faculty will likely use active learning practices when they: have access to active learning techniques and strategies through university support; think active learning techniques are easy to use; and have adequate teaching skills to use active learning techniques. In addition, it is predicted that faculty who use active learning techniques will likely teach interactive classes where students are more involved in the learning process. Thus, this paper hypothesizes that professor beliefs and skills towards active learning techniques have a direct effect on what faculty do in the classroom.

## Surveys

There are two researcher-developed surveys. The first survey consists of 25 questions: Survey 1: Attitudes toward Active Learning (see Appendix A) and Survey 2: Usage of Active Learning (see Appendix B). The survey questions on Survey 1 are related to four constructs that may influence faculty usage of active learning. These four constructs are:

1. Perceived support from the university,
2. The attitudes about how useful active learning is,
3. The attitudes about how easy active learning is to implement, and
4. The perceived skill of the professor

All the questions in Survey 1 were answered on a four-point Likert-type scale. A four-point Likert scale, also known as a forced Likert scale, was chosen because it forces participants to choose an answer; thus, there is no neutral option. This is useful because it encourages specific responses. Specifically, the four-point Likert scale is useful when recording opinion on services and activities that have already been experienced (Garland, 1991). Thus, this well summarizes the intent of this study: to find participant opinions on the use of active learning techniques. Participants were asked to answer questions based on four options, from 1 (strongly disagree) to 4 (strongly agree).

Questions were developed from the common obstacles to active learning as defined by Bonwell and Eison in their 1991 paper, “Active Learning: Creating Excitement in the Classroom.” A variety of questions were used to measure each of the four constructs. Questions were aimed at assessing the preexisting beliefs and attitudes the participants had towards active learning, in addition to the availability of support, usefulness, ease, and skills. The responses in Survey 1 were separated into constructs, and then averaged into one score for each construct.

The questions in Survey 2 were based on a five-point Likert-type scale. The participants were asked about the frequency that they use active learning techniques in the classroom based on five options, “Never,” “Once Per Semester,” “Once Per Month,” “Once Per Week,” or “Once Per Class.” In addition, there was an open-ended question which asked participants to describe themselves as teachers and their teaching skills, styles, and techniques. This question was intended to see how the faculty view their own bias towards or against active learning. The surveys will be described in more detail below.

**Survey 1: What faculty think with four constructs.**

Survey 1 examines four separate constructs: perceived support, perceived usefulness, perceived ease of use, and professor teaching skills.

***Support***. The first construct, support, refers to the availability of support that the faculty members think they receive from their university. Support could come in a few different forms. These include professional development through workshops and seminars, the presence of support staff such as colleagues, administration and office staff, and finally the willingness of the university to provide funds for items such as active learning technology, materials, and other resources (Bonwell & Eison, 1991). Another form of support is university willingness to accept the use of active learning techniques, and to promote it with the faculty. Many faculty feel that they need either more classroom time or less content in the semester to promote deep understanding of principles; thus, universities should work with their faculty to support the use of active learning in the curriculum (Alwasal & Alhadlaq, 2012; Bonwell & Eison, 1991). Another aspect here is that the participants in this survey are science faculty. Science faculty in Saudi Arabia typically do not have training in educational theories or methods (Alwasal & Alhadlaq, 2012). As a result, many science faculty members may be unfamiliar with active learning techniques, and may need additional training to implement these practices in the classroom (Alwasal & Alhadlaq, 2012). Examples of questions in this construct are: My university provides training and workshops on how to use active learning, and My university will help me purchase active learning materials. In summary, support is key to the successful utilization of active learning techniques.

***Usefulness***. The second construct examines faculty attitudes on the perceived usefulness of active learning techniques, and whether they believe active learning will help their students reach their academic objectives. Specifically, one question asks whether faculty believe that active learning is a good fit for science education (Handelsman et al., 2004). This construct examines whether or not faculty believe that their students will learn and enjoy class if active learning techniques are used (Bonwell & Eison, 1991; Moore, Fowler, & Watson, 2007; McCarthy and Anderson, 2000). Another question asked faculty if they believe that students interact with the materials more efficiently through the use of active learning techniques (Handelsman et al., 2004). Another question asked whether student interaction with materials and other students is important to the learning process (Bonwell & Eison, 1991). Examples of questions are: Active learning is a good fit for science education and Students who enjoy class will learn better. All of these questions provide evidence of whether faculty see active learning as a useful tool.

***Ease of use.*** The third construct, perceived ease of use, investigates faculty opinions about how easily they could use active learning techniques in the classroom. Examining this construct sheds light on the potential usage of active learning. It is likely that if a faculty member believes that active learning practices are easy to use, they will be more likely use it in the classroom (Alwasal & Alhadlaq, 2012). On the other hand, faculty will likely be reluctant to incorporate active learning techniques if they find them difficult to implement. To assess this, the survey asks faculty members if there is enough time to use active learning technique (Bonwell & Eison, 1991). Another question asks if active learning can be used with large classes easily (Bonwell & Eison, 1991). An additional question asks whether there is enough time in a class session to use active learning (Alwasal & Alhadlaq, 2012; Bonwell & Eison, 1991). Examples of questions are: Active learning is difficult to incorporate into the time available to teacher course contents and I find that using active learning strategies are easy for me. All of these questions demonstrate professor attitudes towards the perceived ease of use of active learning.

***Skills.*** Last, the fourth construct investigates teaching skills. This construct was chosen to provide greater insight on the ability that faculty members think they have to use active learning techniques. This construct primarily focuses on professor resourcefulness with technology (Moore et al., 2007). Science faculty should be regularly trained in computer skills to keep up with the changes in technology and to keep skills current (Moore et al., 2007). This will in turn allow for faculty to incorporate new technology-driven active learning techniques (Moore et al., 2007). According to Moore's 2007 paper, "Pedagogical practices should also drive faculty decisions about the technology tools best suited for specific learning objectives in a specific learning environment… helping students make the transition from passive to active learners means engaging them in the conversation." For example, faculty can use a series of mini lectures with interactive components which are about 15-20 minutes during a 50-70-minute class time; including audience response devices is yet another strategy (Moore et al., 2007) Thus, both pedagogy and technology skills are important to an active learning curriculum. Therefore, some questions examine faculty ability to use technology in the classroom. Questions regarding the use of technology were selected because many of the new and emerging active learning techniques require the use of technology such as Audience Response Systems, Podcasts, PowerPoint and projectors, and online class webpages just to name a few (Cain et al., 2009; Graham et al., 2007; Moore et al., 2007). Example questions are: I have technology experience that I could use for active learning and I do not need help from others to apply active learning strategies Thus, in summary the fourth construct is intended to provide more information on professor teaching skills, especially in terms of technology.

These constructs were chosen based upon the literature review. The expectation is that through analysis, participant responses along the lines of these four constructs will provide information on the pre-existing attitudes faculty have toward active learning. The attitudes determined from this study will be examined in comparison to the use of active learning techniques.

**Survey 2: What faculty do.**

Items in Survey 2 were derived from “A Tool for Measuring Active Learning in the Classroom” (van Amburgh, Devlin, Kirwin, & Qualters, 2007). The survey focuses on a faculty member’s favorite classes to teach. The favorite class was selected because for one, it is here that faculty will most likely have the greatest ability to be creative and nonconventional. In addition, it is likely that faculty members will put forth extra effort in the classes they enjoy. Another factor is that by selecting one class, survey participants can focus more specifically on past lessons. Finally, it could be assumed that a faculty member’s favorite class is likely to be memorable. Thus, in summary this survey selected the favorite class because participants would have greater ease recalling the events and their teaching practices.

All of the questions were related to the practice and usage of active learning in classes. The activities were described without providing the exact name, so as to ensure that there was no confusion. For example, one question asked if short writing assignments are assigned at the end of class. While many faculty may actually do this already, they may not realize that this activity is called the “One-Minute Paper.” Thus, the intention here is to remove any ignorance bias from the participants’ responses. Other questions focused on student collaboration. Several questions asked about small group presentations, student in-class talk time, and how often students work together. As collaborative learning is an essential part of an active learning curriculum, it is important to know how often students work together. Example questions are: Do you ask students questions in your class and expect them to answer?  And Do students participate in your class by answering your questions?

Participants answered with this Likert scale: 1=never, 2=once a semester, 3=once a month, 4=once per week, and 5=once per class. The overall purpose of the questions was to assess whether faculty use active learning techniques in their classes, and how often they use them.

The second part of the survey is one open-ended question. The question asks the participants to describe themselves as a teacher and their teaching skills, style, and techniques. Based on their answers, it can be interpreted whether they teach actively or passively. The question provides greater insight on the professor's teaching style, and demonstrates if they teach actively or passively.

The responses to the questions for each construct were added together and averaged by the number of total questions. There were five questions under the first construct, support. There were ten questions for the second construct attitude and usefulness. There were seven questions for the third construct attitude and ease of use. Finally, there were three questions for the fourth construct, skill of instructor. Since each construct had a scale from 1 to 4, and there were 4 constructs, the sum of constructs could be as low as 4 and as high as 16.

In Table 1, the questions are sorted into constructs.

Table 1
*Questions from Survey 1 of Attitudes Organized by Construct*

| Construct | Questions from Survey |
|---|---|
| Support (5 total questions) | 6. My university provides training and workshops on how to use active learning.<br>10. My university will help me purchase active learning materials.<br>17. The University provides many resources that support applying of active learning.<br>22. My university has resources on campus where I can ask for help with active learning.<br>24. My university has the right facilities and rooms for active learning. |
| Attitudes- Usefulness (10 total questions) | 1. Active learning is a good fit for science education.<br>5. Students who enjoy class will learn better.<br>7. Active learning can help students and professors reach academic objectives.<br>8. Active learning helps me achieve my teaching goals more quickly.<br>11. Active learning encourages students to discuss more in class.<br>14. Active learning strategies help me to accomplish educational goals more quickly.<br>15. I find that students use course materials more with active learning strategies.<br>16. I find that applying active learning strategies is enjoyable.<br>23. Interaction with other students or materials is more important than lecture for student learning.<br>25. I find that students interact with course materials (e.g. demonstrations, microscopes, reading materials) better with active learning strategies. |
| Attitudes- Ease of use (7 total questions) | 2. Active learning is difficult to incorporate into the time available to teacher course contents.<br>3. I find that using active learning strategies are easy for me.<br>9. My course already has activities, so it is easy to use active learning strategies.<br>12. Active learning is good for small groups only.<br>18. I can use active learning in a large class easily.<br>19. There is enough time in a class session to use active learning.<br>20. There are many different options for active learning actives that I could choose from. |
| Skill of lecturer/professor (3 total questions) | 4. I have technology experience that I could use for active learning.<br>13. I do not need help from others to apply active learning strategies.<br>21. I have sufficient computer skills for applying learning strategies that rely on technology. |

For Survey 2, the survey of usage, there were 16 questions based on a five-point Likert scale.  Each number represented a frequency. These questions asked participants about how often they use active learning techniques. For example, when asked how often the teacher used an active learning technique, the teacher could choose 1 for never, 2 for once per semester, 3 for once a month, 4 for once per week, or 5 for once per class. The average of the 16 questions was computed to create a score for Survey 2.

## Procedure

The survey participants were from two universities in Saudi Arabia. The Institutional Review Board (IRB) at the host research institution and the respective Saudi Arabian universities approved both surveys before the research was conducted. The surveys were given directly to Saudi faculty members or to their departments. Upon completion, the surveys were mailed back. The participants were found by researching the science department faculty at the two selected universities.

This study was conducted using two pen and paper surveys to determine the pre-existing beliefs of Saudi faculty about active learning practices and their usage of these practices. The first survey focuses on examining the constructs of 1) institutional support; 2) attitudes about the usefulness of AL; 3) perceived ease of use of active learning techniques; and 4) the skill of the instructor. The second survey focuses on the teaching practices commonly used by the professor in the classroom. The questions in the surveys focus on specific active learning techniques and their frequency of use.

## Analysis

The data collected from the two instruments were analyzed for descriptive information: standard deviation, mean, frequency, and range. Question 2 from Survey 1 was reverse coded because it is a negative statement about active learning. Using a linear regression model, the data from Survey 1 were compared to that of Survey 2 to see if there were any correlations between attitudes and usage of active learning techniques, and to see if any attitudes predicted usage. SPSS version 24 was used to compile the research data and run the regression and compute the statistical information.

## Limitations

One limitation of this study is that the sample size is possibly not reflective of all faculty in Saudi Universities. Furthermore, not all faculty members participated in the study. For example, only 41 participants out of 250 contacted completed surveys. Another potential limitation is that some of the responses may be biased towards or against active learning, and some may exaggerate the usage of it. In addition, faculty members may feel obligated to take the survey; if this is the case, it is possible they may not answer the questions with complete thoroughness. Also, some faculty may be unfamiliar with the topic of active learning, especially because they are science faculty and the term active learning is more related to the field of education. This research will be specific to Saudi Universities, and the findings may not share much in common with other cultures or countries. Potentially, the findings of this research are transferrable to other Arab universities. However, due to the numerous differences between Arab and non-Arab universities, the data from research would have a lower cross-cultural validation. Future research will be necessary to measure instructor attitudes and usage of active learning across a large sample size in Saudi Arabia. Also, future research could measure which active learning techniques fit best into each of the different STEM subjects.

## Summary

The research goal of this paper is to investigate Saudi faculty attitudes towards active learning and to see how they practice it, and to see if there is a correlation between the two, and if attitudes predict actions. The hypothesis for this study is that Saudi Arabian faculty will be likely to use active learning practices when they: have access to active learning techniques and strategies through university support; think active learning techniques are easy to use; and have adequate teaching skills to use active learning techniques. This paper predicts that faculty who use active learning techniques will likely teach interactive classes where students are more involved in the learning process. Thus, this paper hypothesizes that professor beliefs and skills towards active learning techniques has a direct effect on what faculty do in the classroom.

# CHAPTER 4: ANALYSIS AND RESULTS

## Introduction

This study was conducted to investigate Saudi faculty attitudes towards active learning and to see how they practice it, and to see if there is a correlation and predictive model between the attitudes they have towards active learning and their usage of active learning strategies. The survey participants were limited to science faculty at Saudi Universities. For Survey 1, the survey of attitudes toward active learning, analysis methods included: descriptive methods, Cronbach's test of reliability (Cronbach, 1951), and linear regression. For Survey 2, the survey of usage of active learning strategies, analysis methods included: linear regression and qualitative analysis of the open-ended prompt. After describing the demographic features of the participants, the responses from each question in Survey 1 were examined to describe participant attitudes towards active learning. Then, the responses from Survey 2, the survey of usage, were examined; the first 16 Likert-scale questions were compared to Survey 1 using a linear regression model. The final open-ended responses in Survey 2 were used to look for confirmation of Likert-scale data. Finally, at the conclusion of this chapter each of the research questions are answered.

### Reliability

To evaluate the reliability of questions on the survey about teacher's beliefs and the survey about teacher actions, Cronbach's alpha was computed for questions in each construct. There was evidence for excellent reliability in all of the constructs. This is shown in Table 2.

Table 2

*Reliability for the Constructs in the Surveys*

| | Cronbach's Alpha | Number of Items |
|---|---|---|
| Support | 0.752 | 5 |
| Usefulness | 0.922 | 10 |
| Ease of Use | 0.789 | 7 |
| Skill | 0.861 | 3 |
| Usage | 0.967 | 16 |

There was evidence of high reliability (over .70) for all constructs. The construct, "Usage" was derived from all the results from Survey 2: Usage of Active Learning.

## Descriptive Statistics

This chapter analyzes data related to the following research questions:

1) What are the attitudes of Saudi Arabian (SA) university science faculty towards active learning techniques?

2) Which active learning techniques do faculty use in SA?

3) What is the relationship between what faculty do in class and their beliefs?

The responses to Survey 1 were based on a four-point Likert scale, which examined the four-constructs of support, attitude of usefulness, attitude of ease, and skill. Each question in Survey 1 was related to a specific construct and a mean score was completed for each construct. There were five questions under the first construct, support. There were ten questions for the second construct, attitude of usefulness. There were seven questions for the third construct, attitude of ease of use. Finally, there were three questions for the fourth construct, skill of instructor.

Survey 2 included an open-ended question, which asked participants to describe themselves as teachers, and their teaching skills, styles, and techniques. Participant 7, a female aged between 41-50, said that she often teaches by "asking questions in the classroom." Participant 8, a male aged between 41-50, said that he often teaches by "discussion." Moreover, participant 1, a male aged between 31-40, often teachers by "PowerPoints," and he divides "students into groups." Participant 13, a male over the age of 50, described his teaching method as "learning from past experience;" this was interpreted as the use of prior knowledge. Participant 18, a male aged between 31-40, "assigns a project every week."

The mean and mode for each question is displayed in Table 3 with the following scale:

1=strongly disagree
2=disagree
3=agree
4=strongly agree

Table 3

*Frequency of Responses on Survey 1: Attitudes toward Active Learning*

| Construct | Str. Disagree N(%) | Disagree N(%) | Agree N(%) | Str. Agree N(%) | Mode | Mean (SD) |
|---|---|---|---|---|---|---|
| **Support** | | | | | | |
| Q6 training | 35 (85.37%) | 6 (14.63%) | 0 | 0 | 1 | 1.15 (.358) |
| Q10 purchases | 33 (80.49%) | 7 (17.07%) | 1 (2.44%) | 0 | 1 | 1.22 (.475) |
| Q17 resources | 32 (78.05%) | 8 (19.51%) | 1 (2.44%) | 0 | 1 | 1.24 (.489) |
| Q22 help | 26 (63.41%) | 10 (24.39%) | 5 (12.2%) | 0 | 1 | 1.49 (.711) |
| Q24 facilities | 28 (68.29%) | 7 (17.07%) | 6 (14.63%) | 0 | 1 | 1.46 (.745) |
| **Usefulness** | | | | | | |
| Q1 good fit | 1 (2.44%) | 3 (7.32%) | 19 (46.34%) | 18 (43.90%) | 3 | 3.32 (.722) |
| Q5 enjoyment | 0 | 3 (7.32%) | 27 (65.85%) | 11 (26.83%) | 3 | 3.20 (.558) |
| Q7 objectives | 0 | 3 (7.32%) | 29 (70.73%) | 9 (21.955%) | 3 | 3.15 (.527) |
| Q8 teaching goals | 1 (2.44%) | 8 (19.51%) | 27 (65.85%) | 5 (12.2%) | 3 | 2.88 (.640) |
| Q11 discussion | 0 | 9 (21.95%) | 28 (68.29%) | 4 (9.76%) | 3 | 3.08 (.521) |
| Q14 learning goals | 1 (2.44%) | 11 (26.83%) | 20 (48.78%) | 9 (21.95%) | 3 | 2.90 (.768) |

*continued on next page*

| Construct | Str. Disagree N(%) | Disagree N(%) | Agree N(%) | Str. Agree N(%) | Mode | Mean (SD) |
|---|---|---|---|---|---|---|
| Q15 course materials | 0 | 11 (26.83%) | 25 (60.98%) | 5 (12.2%) | 3 | 2.85 (.615) |
| Q16 enjoyable | 7 (17.07%) | 7 (17.07%) | 22 (55.66%) | 5 (12.2%) | 3 | 2.61 (.919) |
| Q25 course materials | 1 (2.44%) | 2 (4.88%) | 27 (65.85%) | 8 (19.51%) | 3 | 3.012 (.656) |
| **Ease of use** | | | | | | |
| Q2 difficult | 2 (4.88%) | 6 (14.63%) | 15 (36.59%) | 18 (43.90%) | 4 | 3.20 (.872) |
| Q3 easy | 9 (21.95%) | 11 (26.83&) | 20 (48.78%) | 1 (2.44%) | 3 | 2.55 (.744) |
| Q9 activities | 2 (4.88%) | 10 (24.39%) | 22 (55.66%) | 7 (17.07%) | 3 | 2.83 (.771) |
| Q12 small groups | 2 (4.88%) | 5 (12.2%) | 11 (26.83%) | 23 (56.10%) | 4 | 3.34 (.883) |
| Q18 large classes | 15 (36.59%) | 16 (39.02%) | 10 (24.39%) | 0 | 2 | 1.88 (.781) |
| Q19 enough time | 0 | 13 (31.71%) | 21 (51.22%) | 7 (17.07%) | 3 | 2.85 (.691) |
| Q20 many options | 1 (2.44%) | 9 (21.95%) | 24 (85.54%) | 7 (17.07%) | 3 | 2.90 (.700) |
| **Skill** | | | | | | |
| Q4 technology | 2 (4.88%) | 16 (39.02%) | 21 (51.22%) | 2 (4.88%) | 3 | 2.56 (.673) |
| Q13 help not needed | 11 (26.83%) | 10 (24.39%) | 18 (43.90%) | 2 (4.88%) | 3 | 2.27 (.923) |
| Q21 computer skills | 12 (29.27%) | 4 (9.76%) | 23 (56.10%) | 2 (4.88%) | 3 | 2.37 (.968) |

All the questions in the construct, Support, had a mode of 1, which means that the participants do not feel that they have support. On question 17 for example, there was only 1 positive response out of 41 total participants. The next construct, Usefulness, showed a different trend. Participants in general responded positively. The mode for each question was 3. Moreover, very few participants strongly disagreed that active learning techniques are not useful. In question 1 for example, 37 out of 41 participants marked a positive response. Ease of use is the only construct where questions had a mode of 4 (both questions 2 and 12). Finally, the construct, Skill, had a relatively average response. Participant responses were relatively even between agree and disagree. This was reflected in the means, which stayed between 2 and 3. The following table (Table 4) reveals the means and standard deviations for each construct as a whole.

Table 4

*Mean Scores and Standard Deviations for all Constructs*

| Construct | Mean | St. Dev. |
|---|---|---|
| Support | 1.312 | 0.584 |
| Usefulness | 2.933 | 0.796 |
| Ease of Use | 2.765 | 0.949 |
| Skill | 2.398 | 0.862 |

Usefulness had the highest mean and support had the lowest mean, while the greatest standard deviation was for skill, indicating that skills vary widely.

Survey 2 questions are listed in Table 5 while descriptive statistics are listed in Table 6.

Table 5

*Questions from Survey 2: Usage of Active Learning*

| *Number* | *Question* |
|---|---|
| 1 | Do you ask students questions in your class and expect them to answer? |
| 2 | Do students participate in your class by answering your questions? |
| 3 | Do you ever assign a short writing assignment at the end of your class to see what students learned? |
| 4 | Do you ask students to talk to each other after you ask a question? |
| 5 | Do you ask students to write down everything they know about the topic you are going to teach them BEFORE you teach them? |
| 6 | Do you ask students to write down what they find confusing during your class? |
| 7 | Do you ask students to suggest some exam question? |
| 8 | Do you give ungraded quizzes so you know what to re-teach? (clickers, paper quizzes, computer quizzes)? |
| 9 | Do your students give small-group presentations? |
| 10 | Do your students ever turn and teach each other? |
| 11 | Do you ask your students to create concept maps or diagrams to show their understanding? |
| 12 | Do you give students problems to solve in class? |
| 13 | Do use the Jigsaw technique? (each group becomes an expert on one topic, and then groups divide up and teach each other?)___ |
| 14 | Do students work together in groups in your class? |
| 15 | Do your students use models (with their hands) to help them understand concepts? |
| 16 | Do your students use computer simulations to help them learn concepts? |

Table 6

*Frequency of Responses on Survey 2: Usage of Active Learning*

| Question | Never N(%) | Once per Semester N(%) | Once per Month N(%) | Once per Week N(%) | Once per Class N(%) | Mode | Mean (SD) |
|---|---|---|---|---|---|---|---|
| Q1 | 1 (2.4%) | 10 (24.4%) | 16 (39.00%) | 14 (34.10%) | 0 | 3 | 3.05 (.835) |
| Q2 | 0 | 12 (29.3%) | 17 (41.5%) | 12 (29.3%) | 0 | 3 | 3.00 (.775) |
| Q3 | 0 | 12 (29.3%) | 10 (24.4%) | 13 (31.7%) | 1 (2.4%) | 4 | 2.83 (1.093) |
| Q4 | 13 (31.7%) | 6 (14.6%) | 12 (29.3%) | 10 (24.4%) | 0 | 1 | 2.46 (1.185) |
| Q5 | 20 (48.8%) | 17 (41.5%) | 4 (9.80%) | 0 | 0 | 1 | 1.61 (.666) |
| Q6 | 18 (43.9%) | 10 (24.4%) | 11 (26.8%) | 2 (4.90%) | 0 | 1 | 1.93 (.959) |
| Q7 | 22 (53.7%) | 10 (24.4%) | 6 (14.6%) | 3 (7.3%) | 0 | 1 | 1.76 (.969) |
| Q8 | 14 (34.1%) | 10 (24.4%) | 15 (36.6%) | 2 (4.90%) | 0 | 3 | 2.12 (.954) |
| Q9 | 4 (9.80%) | 23 (56.10%) | 12 (29.3%) | 2 (4.90%) | 0 | 2 | 2.29 (.716) |
| Q10 | 11 (26.8%) | 15 (36.6%) | 11 (26.8%) | 4 (9.80%) | 0 | 2 | 2.20 (.954) |
| Q11 | 21 (51.2%) | 11 (26.8%) | 8 (19.5%) | 0 | 0 | 1 | 1.68 (.797) |
| Q12 | 0 | 19 (46.3%) | 19 (46.3%) | 3 (7.3%) | 0 | 2 | 2.61 (.968) |
| Q13 | 16 (39.00%) | 14 (34.10%) | 11 (26.8%) | 0 | 0 | 1 | 1.88 (.812) |
| Q14 | 4 (9.80%) | 16 (39.00%) | 19 (46.3%) | 2 (4.90%) | 0 | 3 | 2.46 (.745) |
| Q15 | 22 (53.7%) | 9 (22.00%) | 10 (24.4%) | 0 | 0 | 1 | 1.71 (.844) |
| Q16 | 18 (43.9%) | 15 (36.6%) | 8 (19.5%) | 0 | 0 | 1 | 1.76 (.767) |

Note that the mode for Q12 is bimodal with 2 and 3 being the mode. The lowest mode was reported.

The mean score for the entire survey for all participants was 2.207 with a standard deviation of 0.978 points. Two points on the scale is equal to a frequency of once per semester. The frequency table from Survey 2 showed some interesting findings. First, in the third question, 13 respondents said that they assign short writing assignments at the end of class (e.g. The One Minute Paper). This question overall had the highest mode on the rate of usage, a 4, which is equal to once a week. In addition, questions, 1, 2, and 3 all had high means at around 3 points, which indicates a frequency of once per month. These questions all related to in-class participation and collaboration. For the most part, it seems that many active learning techniques are not used. For example, students rarely brainstorm before starting on a new topic (Question 5) or create concept maps to show their understanding (Question 11). Students also rarely use computer simulations to help them learn (Question 16).

A multiple liner regression was performed to predict what faculty do in their classrooms based on their skill, their support from their institutions, how easy they think it is to use active learning, and how useful they think it is. A significant regression equation was found ($F(4,36)= 85.81$ $p < .001$) with an $R^2$ of .905. The faculty's predicted actions in the classroom (Y) is equal to:

Y = -.438 + .347 (Support) + .358 (Usefulness) + .324 (Ease) + .148 (Skill) where Support is coded in points, Usefulness is coded in points, Ease is coded in points, and Skill is coded in points. The faculty's predicted actions increased .347 points for each support point, .358 points for each usefulness point, and .324 points for each Ease point, and .148 point for each Skill point.

All independent variables (Support, Usefulness, Ease, and Skill) were significant predictors ($p$ <.05) of what faculty do in the classroom. Additionally, with low VIF values, there was little evince of multicollinearity in the model, an assumption which has to be met. See Table 7.

Table 7

*Linear Regression*

| Constructs | Beta | t | Significance | |
|---|---|---|---|---|
| (Constant) | -0.438 | -2.165 | 0.037 | VIF |
| Support | 0.347 | 4.487 | 0 | 1.284 |
| Usefulness | 0.358 | 2.888 | 0.007 | 5.29 |
| Ease | 0.324 | 2.699 | 0.011 | 5.017 |
| Skill | 0.148 | 2.054 | 0.047 | 3.934 |

*Note*: a. Dependent Variable: Survey 2

**Correlation.**

Table 8 demonstrates how what faculty say and what they do is correlated for all four constructs: support, usefulness, ease of use, and skill.

Table 8

*Correlation Coefficients for Faculty Attitudes and Usage*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Usage | -- | | | | |
| 2. Support | .586*** | -- | | | |
| 3. Usefulness | .869*** | .316* | -- | | |
| 4. Ease | .890*** | .425** | .871*** | -- | |
| 5. Skill | .857*** | .409** | .837*** | .822*** | -- |

Note: *p < .05, **p < .01, ***p < .001, two tailed. N=41.

From the correlation table, it is obvious that the construct, Support and what faculty do (Survey 2) were significantly correlated, $r = .586$, $p <.001$ Usefulness and what faculty do (Survey 2) werealso significantly correlated, $r = .869$, $p<.001$. Ease and what faculty do (Survey 2) were significantly correlated, $r = .890$, p <.001.

Skill and what faculty do (Survey 2) were significantly correlated, $r = .857$, $p <.001$. Support and usefulness were significantly correlated, $r = .316$, $p < .05$. Support and ease of use were significantly correlated, $r = .425$, $p < .01$. Support and skill were significantly correlated, $r = .409$, $p < .01$. Ease of use and usefulness were significantly correlated, $r = .871$, $p < .001$. Skill and ease of use were significantly correlated, $r = .822$, $p < .001$.

## Conclusion

This chapter intended to answer the three research questions for this study. The first question was “What are the attitudes of university STEM Saudi Arabian (SA) faculty towards active learning techniques?” This question can be answered by using the frequency table, which shows that participants find active learning techniques relatively useful and easy to use, however they do not feel supported and have insufficient skills. The lowest response overall was to the question about training. Faculty strongly disagree that they have sufficient training. The finding was that overall many of the surveyed Saudi science faculty members feel there is a major lack of support at their host institutions. Many feel that there is not adequate training or workshops to gain additional skills in active learning techniques. In addition, some feel that there are insufficient classroom resources to support active learning usage, such as tables and the room layout. Many Saudi faculty members stated that it is easy to use active learning techniques, however it depends greatly on if there is enough available time in the curriculum, and available resources in the classroom. Also, it depends on the size of the class. In general, most of the participants scored right at the median for attitude on ease of use in Survey 1.

The second question was “Which active learning techniques do faculty use in SA? This question can also be answered using the frequency table from Survey 2. This table shows that many faculty members encourage participation, collaboration, and writing assignments on a weekly basis, however they do not use techniques such as the jigsaw, concept maps, pre-learning exercises and computer simulations. For the many faculty members, it is common to use blended learning such as online discussions and learning management systems, such as blackboard and canvas. In addition, many instructors use Socratic questioning methods; in-class discussions are commonplace.

The final question was “What is the relationship between what faculty do in class and their beliefs? In terms of the relationships, all four independent variables, support, attitude of usefulness, ease of use, and skill were significantly correlated with what faculty do ($p < 0.05$). Each construct predicted the use of active learning techniques. Based on the correlation coefficients, all four of these variables have a positive affect on faculty usage of active learning techniques. This means that we can predict whenever any of these four variables is increased, the usage of active learning will also increase.

CHAPTER V

## Overview

The purpose of this chapter is to discuss and review the findings of this study. In addition, it will examine the limitations to the research and provide recommendations for future studies. Overall, this study found that science faculty members at Saudi universities feel that they have a general lack of support from their institutions to use active learning techniques. In addition, this study found that there was a correlation between all the constructs and usage. For example, if faculty members found active learning practices easy or useful in the classroom, they are more likely to do it. Faculty who scored higher on the construct, “skills”, were more likely to use active learning in their classroom. As a result, this study found that all four of the constructs influence the usage of active learning. Thus, if universities seek to promote active learning practices, they should also make it a point to incorporate the four constructs into their practices. To be specific, if a university provides its faculty with professional development opportunities and has instructional resources available for active learning, the usage of it will also increase. Likewise, using seminars and workshops, faculty members can improve their attitudes towards the usefulness and ease of use of active learning in the classroom. This will increase the usage of active learning. Finally, this study found that a major component in the usage of active learning techniques is instructor skill. This includes both the knowledge of how to use the practices and the ability to use modern technology. Thus, universities should make it a priority that all faculty members are sufficiently trained in technology.

## Why This Study Is Important

According to the National Center for Education Statistics, the United States has one of the top science education systems in the world (2015). In addition, the United States regularly scores as one of the highest countries on the Trends in International Mathematics and Science Study (TIMSS) test (National Center for Education Statistics, 2015). In the United States, science education is a priority for all students. Science learning is essential for the progress of a country because almost all jobs and skills require a basic understanding of science principles. For example, an understanding of science is essential for someone who wants to become an engineer, invent a product, or start a company that brings in money and jobs. Science education is also important because it is the first step in a cycle. First, science education yields science understanding. Through having a greater understanding of science, students can then go on to be doctors, who improve public health, engineers, who improve industrial output, and faculty, who then go on to improve science education for youth. Thus, by improving the quality of science education at the university level, all aspects of society are also improved, and one way to improve the quality of science education is through the incorporation of active learning techniques into science curriculums. In the TIMMS test, Saudi Arabia scores at the bottom of science understanding. To improve this, Saudi Arabia needs to improve science teaching. This paper recommends that active learning techniques are a way to improve the quality of science education.

One of the major findings of this research was that most of the surveyed faculty members in Saudi universities feel that they do not have adequate support to use active learning techniques. However, support has many aspects. For the purposes of this survey, faculty members were only asked if they receive adequate training, support for purchases, and available facilities and resources on campus. For example, but not limited to, Saudi universities could add is a faculty learning center and a seminar series. This has proven quite effective. For example, at Auburn University, the Biggio Center provides faculty with professional development opportunities related to active learning and leadership development for institutional heads (Biggio Center, 2018). The Biggio Center provides opportunities for faculty to consult, attend workshops, and to collaborate with others as part of a greater community. Faculty are also introduced to the most current learning technology. Another resource the Biggio Center provides is weekly newsletters, which include recent research papers and information on active learning strategies. Through the Biggio Center providing all this content, faculty members feel supported and are able to teach using active learning.

Support can easily be misread due to it being such a wide subject. This is an interesting topic to consider and perhaps this study has surfaced a new research question for future studies: “Which factors of support influence the usage of active learning techniques?” As there are various aspects of support, and this study only asked about the most accessible forms (resources, facilities, training and workshops), it is possible there are alternate aspects, which require future research. For the purposes of this study, the positive impacts of professional development centers are immense and cannot be ignored.

## Connection to Saudi Education

Currently the higher education system in Saudi Arabia is undergoing major reforms as a part of the Vision 2030 project. One of the most important aspects of Vision 2030 is to change the education system to meet the needs of the market and create economic opportunities for young graduates (Vision 2030). As demonstrated through the literature review, traditional teaching methodologies do little to prepare students for the future. Instead, active learning is the best way to teach higher-order thinking skills such as problem solving and critical analysis. In the professional world, students will need to do more than just remember and recall information; they will have to apply the information they have learned into real world scenarios. This fact aligns with the Vision 2030 goal to alter the current higher education curriculum and to train faculty in the most current methodology available. Active learning techniques and activities would be the ideal tool for this. As already mentioned, active learning techniques can take many different shapes and forms. They can be used in situations with limited technology and they are versatile with the content. Last, a major part of the Vision 2030 initiative is to have at least five Saudi universities rank within the top 200 in the world. Active learning techniques yield higher test scores and more prepared graduates than traditional teaching techniques. With this knowledge at hand, how can instructors continue to not utilize active learning techniques? Active learning prepares students for the future by motivating them, having them collaborate, and by including them in the learning process. Through this renewed sense of ownership over learning, students can achieve great things. As Vision 2030 clearly points out, education is the pathway to the future. As a result, it is imperative that when reforming the Saudi higher education curriculum that the existing data, studies, and research are not overlooked. Active learning could lead Saudi Arabian universities to a hopeful future and its graduates to a promising tomorrow.

## Limitations

One potential limitation to this study is that the sample size may not be entirely representative of all the university faculty in Saudi Arabia. Another potential limitation is that many of the faculty members are trained in science only; it is common for science faculty to not have a background in teaching methodology. Many of the questions in the survey referred to teaching practices and methodologies, so this may prove unfamiliar. Some even asked what active learning is, even though it was defined at the top of the first page of Survey 1. In addition, the sample size was possibly not reflective of all the faculty at the two Saudi universities where the study took place. Thus, it may not represent of the entire faculty. Not all faculty members participated in the study. For example, only 41 participants completed surveys. Furthermore, there may be some biases towards or against active learning. As a result, some may exaggerate their usage of active learning practices. Additionally, there are limitations with self-report. It is possible that many faculty members may have felt obligated to take the surveys. If this is the case, the responses may not be completed with complete thought and care. Likewise, some faculty members may not be familiar with active learning. As already mentioned, active learning is a teaching methodology and thus may be unfamiliar to many science faculty members.

## Recommendations for Future Study

This study opens many doors for future research and studies. For example, there is still limited research on active learning in the Saudi Higher Education System. In addition, there is little information on the actual active learning practices that Saudi instructors use. It would be helpful to observe them in class and to see which practices they implement. It would also be interesting to add different constructs to a similar study.

It would also be interesting to analyze the efficiency of specific active learning techniques in the Saudi Higher Education System. Specifically, are certain techniques more effective to use than others at helping students learn. Specifically, does the culture of learning in Saudi Arabia have any affect over which techniques work the best?

Another interesting thought would be if this study were conducted in a neighboring nation with a similar culture of learning. For example, it may be interesting to analyze the usage of active learning techniques in other gulf Arab countries, for example United Arab Emirates. The universities there are comparatively like those in Saudi Arabia. Thus, it would be interesting to see if the findings from this study could be reproduced in the Arab Higher Education System.

Finally, it would be interesting to expand this study to a larger population. As was already mentioned in the limitations, the actual sample population was only 41. It would be interesting to expand this study to a larger pool of faculty.

## Concluding Thoughts

In summary, this study has found out many interesting things regarding active learning in Saudi Universities. It seems that many faculty members are not receiving the necessary training and support from their institutions. Thus, it is advised that more active learning workshops be held to develop faculty awareness and skills in active learning. As the research in the literature review has shown, active learning when used properly can improve student learning and their enjoyment of the class. In addition, this study highlights the need for future studies to continue the development of this topic. Active learning in Saudi Arabian universities is still a relatively new concept and requires more research and development. However, it has been shown as an effective tool to enhance student learning. Ultimately, this author views it as a vital tool and possibility for the future of education in Saudi Arabia.

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Appendix A

Survey 1

**Personal Information**

What is your name? ______________________(optional)

What is your academic rank?

Professor
Associate Professor
Assistant Professor
Lecturer

What is your gender?
Male
Female

What subjects or classes do you teach?

**Please indicate your level of agreement or disagreement on the following questions. Please circle your response**

1. Active learning is a good fit for science education.
   Strongly disagree disagree agree Strongly agree

2. Active learning is difficult to incorporate into the time available to teacher course contents.
   Strongly disagree disagree agree Strongly agree

3. I find that using active learning strategies are easy for me.
   Strongly disagree disagree agree Strongly agree

4. I have technology experience that I could use for active learning.
   Strongly disagree disagree agree Strongly agree

5. Students who enjoy class will learn better.
   Strongly disagree disagree agree Strongly agree

6. My university provides training and workshops on how to use active learning.
Strongly disagree disagree agree Strongly agree

7. Active learning can help students and professors reach academic objectives.
Strongly disagree disagree agree Strongly agree

8. Active learning helps me achieve my teaching goals more quickly.
Strongly disagree disagree agree Strongly agree

9. Activities in the course help me to diversify the active learning strategies.
Strongly disagree disagree agree Strongly agree

10. My university will help me purchase active learning materials.
Strongly disagree disagree agree Strongly agree

11. Active learning encourages students to discuss more in class.
Strongly disagree disagree agree Strongly agree

12. Active learning is good for small groups only.
Strongly disagree disagree agree Strongly agree

13. I do not need help from others to apply active learning strategies.
Strongly disagree disagree agree Strongly agree

14. Active learning strategies help me to accomplish educational activities more quickly.
Strongly disagree disagree agree Strongly agree

15. I find that students use course materials more with active learning strategies.
Strongly disagree disagree agree Strongly agree

16. I find that applying active learning strategies is enjoyable.
Strongly disagree disagree agree Strongly agree

17. The University provides many resources that support applying of active learning.
Strongly disagree disagree agree Strongly agree

18. I can use active learning in a large class easily.
Strongly disagree disagree agree Strongly agree

19. There is enough time in a class session to use active learning. Strongly disagree
Strongly disagree disagree agree Strongly agree

20. There are many different options for active learning activities that I could choose from.
Strongly disagree disagree agree Strongly agree

21. I have sufficient computer skills for applying learning strategies that rely on technology.
Strongly disagree disagree agree Strongly agree

22. My university has resources on campus where I can ask for help with active learning.
Strongly disagree disagree agree Strongly agree

23. Interaction with other students or materials is more important than lecture for student learning.
Strongly disagree disagree agree Strongly agree

24. My university has the right facilities and rooms for active learning.
Strongly disagree disagree agree Strongly agree

25. I find that students interact with course materials (e.g. demonstrations, microscopes, reading materials) better with active learning strategies.
Strongly disagree disagree agree Strongly agree

Appendix B

Survey 2

**Think about your favorite class to teach. Use the following numbers to describe how you teach that particular class.**

1= Never
2= once per semester
3= once per month
4= once per week
5= once per class

1. Do you ask students questions in your class and expect them to answer? ____
2. Do students participate in your class by answering your questions? _____
3. Do you ever assign a short writing assignment at the end of your class to see what students learned? ____
4. Do you ask students to talk to each other after you ask a question? _____
5. Do you ask students to write down everything they know about the topic you are going to teach them BEFORE you teach them. _____
6. Do you ask students to write down what they find confusing during your class?
7. Do you ask students to suggest some exam question? _____
8. Do you give ungraded quizzes so you know what to re-teach? (clickers, paper quizzes, computer quizzes) _____
9. Do your students give small-group presentations? _____
10. Do your students ever turn and teach each other? ______
11. Do you ask your students to create concept maps or diagrams to show their understanding? _____
12. Do you give students problems to solve in class? _____
13. Do use the Jigsaw technique? (each group becomes an expert on one topic, and then groups divide up and teach each other?) ______
14. Do students work together in groups in your class? ______
15. Do your students use models (with their hands) to help them understand concepts? ____
16. Do your students use computer simulations to help them learn concepts? ______

**Open Ended Question**

17. How would you describe yourself as a teacher, your teaching skills, your teaching style, and your teaching techniques?