JOURNAL of WOMEN AND MINORITIES in TECHNOLOGY

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Affective Domain Learning and its Effect on Cybersecurity Ethics

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Abstract

Cybersecurity is recognized as an interdisciplinary field of study. Education and training is offered in computer science, business, engineering and various other departments in colleges and universities around the world. Training is also offered by many national organizations. The curricula of these various schools and organizations tend to focus on the technical components of cybersecurity training with minimal focus on the ethical component. This article discusses the ethical component of cybersecurity training in general and specifically addresses the lack of the affective domain.

Keywords: cybersecurity training, ethics, affective domain

The security of electronic data in today's society ranks high on the list of essentials for a business enterprise. Hackers are constantly seeking to breach the defenses of an organization to obtain data that can be utilized for a variety of nefarious purposes. Businesses often concentrate on hardware and software to defend their data, while providing some basic level of cybersecurity awareness training for the employees who come into contact with that data. Despite this training, employees are directly responsible for the vast majority of security breaches in an organization (Shred-it, 2018).

The failure of awareness training can be linked to how the training is conducted and the lack of Affective Domain (AD) learning in the training itself. Traditionally awareness training provides the knowledge and skills to help thwart hackers, but fails to instill the third, and perhaps most important element of AD learning, the attitude and willingness to comply with the lessons of the training and the ethics that accompany it. Employees are aware of the negatives of a cyber-breach, know they should not open potentially malicious emails or click on enticing links while using the organizations computers, or their personal computers, yet, they go right ahead and do so.

Shoemaker and Conklin (2010) identify the goal of security awareness training as to "ensure a reliable level of secure practice across the organization" (p. 2). Cybersecurity awareness training is often provided to all employees as a fundamental basis to ensure they are conscious of their security duties in the workplace and execute these as expected. However, like all awareness training, it is meant to

familiarize employees with the basic concepts with the hope that the employees will take away the knowledge and skills necessary to perform effectively back on the job.

The gap most often missing in awareness training situations is the human element of applying the skills. Learners provided with only knowledge do not integrate the content into their personal value system and implementation becomes unpredictable. Bloom (2015) identified three human learning domains: cognitive, psychomotor and affective which represent the knowledge, skills and values of human performance. The integrated framework of these domains, Bloom's Taxonomy, identifies the means to impact employee performance through appropriately developed training addressing the behavioral aspects that are most frequently passed over in traditional training courses—whether online or in the classroom. Investigations most often reveal that employees are knowledgeable of management's expectations but did not carry those expectations out successfully in the work place (Shred-it, 2018). If we are to achieve behavioral change within organizations, the need to adequately train to provide a cultural shift from complacent to engage must happen now. To achieve that, a fundamental change must take place in our training to drive the adoption of affective learning products and technology in the enterprise that alters the values of the learners so the content details the appropriate ethical behavior and becomes assimilated into their personal belief system. Breaches of policy which occur at the human decision making level are the key target for a new era of security training which can only be reached through incorporation of affect domain learning – training that not only changes the believe system of the individual, but reinforces ethical values to do the right thing.

According to Knowles (2016), ethics is the "moral principles that govern a person's behavior – is a critical part of any sound cybersecurity defense strategy" (p. 1). The titles 'cybersecurity awareness training' and 'cybersecurity ethics training' may seem like straightforward collections of ideas, tools, and techniques that can be easily understood by all. Unfortunately, that is not so. What is included in cybersecurity awareness varies greatly and while ethical considerations are often included under the guise of legal compliance or main-stream standards, the ideals are often presented as terms or concepts with little tie to an individuals' job role or personal beliefs.

Unfortunately, ethics is rarely the focus of a course, instead it is a subtopic within a course or cybersecurity subject area. This can be due to an inexperience with teaching more abstract topics – after all, computer hardware can be touched and manipulated, code can be typed and tested, pen testing tools can be used. It is often seen as a general education or gen-ed topic in a curriculum plan and therefore not given the attention and focus necessary. Additional factors such as the ethical considerations of teaching ethics like including simulations that may include a student behaving in an unethical way which is then witnessed by peers.

The challenge of whose or which set of ethical standards to teach is also potentially overwhelming. When schools have vastly homogenous populations it may seem like the ethical basis should be understood when that is often not the case. When diversity is the milestone of a school like it is at

Rutgers University, Purdue University, University of Houston, and Stanford University the differences in nationality, cultural influences, and societal norms can make the challenge overwhelming. Covering the legal compliance content including the ethical behavior expectation included in each is often all that is covered. To that end many schools identify the course where the content is introduced as a 'Legal Compliance and Ethics in Cybersecurity' course.

But what of the ethical considerations not governed by legal compliance? What about the challenge of not escalating privilege or alerting tech support if an issue is identified instead of ignoring it? When does one get involved as opposed to turning a blind eye? These questions are important because how a student is trained and if they can relate to the material from training will result in how they behave on the job. Elevating ethics from a nebulous topic relegated to whatever time is left and into a focus of a course or program which offers role-playing or concrete, relevant examples is a daunting task, but one we must address.

To aid in what to include in the course there are several frameworks available including the National Institute of Standards and Technology (NIST) National Initiative for Cybersecurity Education (NICE) cybersecurity workforce framework that can be found in NIST SP 800-181 (NIST, 2017). The National Security Agency (NSA) has included ethics into the curriculum requirements for the National Centers of Academic Excellence (CAE) program curriculum mapping guidelines (NSA, 2019). Even the American Bar Association (ABA) has identified and published articles on the subject including 'Cybersecurity: Ethical obligations outlined by legal tech experts' (2018). These programs and frameworks offer what should be included or taught but do not address the depth or offer requirements for how the subjects within cybersecurity ethics should be taught.

Cybersecurity is recognized as being multidisciplinary in nature (McGettrick et al, 2014). It touches a vast number of industries including government, financial services, healthcare, transportation, manufacturing and many others. Cybersecurity professionals are trained in college and university degree programs at the under graduate and graduate levels and through professional development and training programs offered by businesses and other organizations within various industries.

In 2015 the Association for Computing Machinery (ACM), IEEE Computer Society (IEEE- CS), Association for Information Systems Special Interest Group on Information Security and Privacy (AIS SIGSEC) and the International Federation for Information Processing Technical Committee on Information Security Education (IFIP WG 11.8) formed a joint task force. The purpose of the task force was to develop comprehensive curricular guidance for cybersecurity education for academic institutions and industry based programs. Acknowledging cybersecurity as an interdisciplinary course of study that is fundamentally computing based, but recognizing that it includes aspects of risk management, law, policy, human factors, and ethics, the task force gathered resources from a number of respected sources to create guidelines that build upon prior work in computer security, information assurance and cybersecurity education, training, and workforce development (Joint Task Force Committee, 2017).

The task force guidelines identify eight knowledge areas (KAs) that should be included in cybersecurity curricula. The KAs are data security, software security, component security, connection security, system security, human security, organizational security and societal security. These KAs are designed as a basic organizing structure for content and include topics that students should learn. They were also designed as guidelines for institutions restructuring existing cybersecurity programs and those developing new programs, (Joint Task Force Committee, 2017). There is evidence that these guidelines are being used by many institutions as they structure their cybersecurity education and training programs. Cabaj, Domingos, Kotulski, and Respício (2018) conducted a study which analyzed 21 cybersecurity master degree programs of top ranking universities. Their study found that these university programs aligned with the KAs specified in the Joint Task Force Report. Yang and Wen (2017) conducted a study of undergraduate cybersecurity programs in AACSB accredited business schools in the United States. They found that the KAs specified by the Center for Academic Excellence, which were among those incorporated by the Joint Task Force, were used as guidelines for the 27 programs they studied.

Most of the KAs are technically oriented. However, the human security KA includes topics on personal compliance with cybersecurity rules, policies and ethical norms. Ethics is defined as "moral principles that govern a person's behavior or the conducting of an activity", (Merriam-Webster, 2019). Ethics plays a very important role in cybersecurity. Cybersecurity is concerned with securing or safe guarding data, computer systems and networks. While these elements have some pure economic value in and of themselves, according to Shannon Vallor, 2019, "cybersecurity practices primarily protect the integrity, functionality, and reliability of human institutions/practices that rely upon such data, systems, and networks." Cybersecurity professionals work in hospitals, financial institutions, transportation organizations, and other organizations that store and utilize medical records, credit card information, and other important data and systems that affect the lives of human beings. Because of this, ethical issues are at the core of cybersecurity.

According to research, students need guidance and experience to aid them in building or developing the "philosophical sophistication necessary to assimilate the information into their view of themselves (Mintz, Jackson, Neville, Illfelder-Kaye, Winterowd, & Loewy, 2009, p. 644). The need to "reconcile personal and professional values" is essential to students and employees making the right decision when a situation presents itself requiring an ethical response (Ametrano, 2012, p. 154). Ametrano (2012) posits "although even the most experienced professionals find such situations difficult, the process of learning to make value-laden, ethical decisions is even more challenging for students" (p. 154). The process can be almost impossible when the specific elements necessary to determine ethical behavior in a given situation are not relayed to the student.

There are many dynamics for how much assimilation of new ethical ideals the student will accept (Ametrano, 2012). To immerse the student in situations where ethical decision making is required Ametrano (2012) suggests "having students apply information in case studies, role playing, discussion

and interaction with peers, and self-reflection" (p. 155). The "cognitive development in the moral domain" (Neukrug, 1996, p. 104), is essential for students to make the appropriate ethical decision when on the job.

Teaching students to assimilate the values into their personal ethical code is all the more daunting when there are few cybersecurity situations that have a 100% correct answer or which are made up of single, isolated decisions. Often, the ethical progression of a situation, attack, course of action is built over time and a variety of disparate actions that when viewed in totality allow the picture of what transpired, by who, and with what internal assistance (intentional or accidental) to emerge. Preparing the cybersecurity workforce to approach problems in an ethical manner and from the standpoint that every action has a consequence which may escalate a situation is a new approach that few have attempted.

Ethics courses within the human security KA is the area where the affective domain is best applied to cybersecurity training. The affective taxonomy identifies learning objectives that are associated with the learner's feelings, emotions and degree of acceptance or rejection (Krathwol et. al., 1964). The taxonomy consists of five stages that moves a learners affect for a concept or value from general awareness to consistently guiding or directing their behavior toward the acceptance (Seels & Glasgow, 1990, p. 28). The stages are receiving, where the learner accepts and tolerates the concept or value; responding, where the learner makes a small commitment and complies with the concept; valuing, where the learner wants others to recognize that they value the concept; organization where the learner starts to relate this new value to those he or she already holds; and finally characterization where the learner consistently practices or acts in accordance with the value (Krathwol et. al., 1964).

The typical cybersecurity course covers material on legal compliance, a code of ethical behavior such as the rules of a certification body like International Information System Security Certification Consortium (ISC)2 or a professional organization like Information System Security Association (ISSA). This aids in identifying higher arching principles one must adhere to but does not delve into what constitutes that behavior and how large collections of decisions, enacted with ethical choices, may still be undermined by one poor choice in the progression of activities one engages in. These complicated applications of ethical behavior are what schools should focus upon as once the student is employed in the field the assumption is that they will know how to respond.

The question is how to implement the affective objectives in cybersecurity education. One way to approach this is to develop objectives and content to support them within the content of the lesson. Then, incorporate exercises in the content that move the learner through the stages of the affective taxonomy.

For example, system administrators have access to highly confidential information that if exposed to the employees within the organization could result in detriment to the performance of the company. Ethical behavior is therefore a much-needed personality trait. A cybersecurity ethics course would incorporate affective objectives from Bloom's Taxonomy by first developing objectives and building

awareness of the issue of security, actively participating in discussions of the need and willingness to comply with the security policy, to commitment to ensuring a secure environment and doing so overtly (role play works well for this level or in an online course a simulation may work well). Finally, the instruction must move the learner to prioritize and internalize the security concept, so this becomes characteristic of the individual and their professional commitment to it may influence others to not only lead the way in behavior modeling but to influence their value of ethical security, not only in the workplace but beyond. Once the overall objectives are clear, exercises will be developed to guide the learner through the process.

By focusing on the affective domain and how a student perceives the information as congruent with or opposing their ethical views will aid in creation of material that will provide students understanding beyond the terms and compliance often taught. Assessing their understanding and assimilation of the material through role playing and other activities offers educators the opportunity to provide feedback and guidance. Because the affective domain deals with a student's existing knowledge and attitudes assessing where that student is regarding ethical decisions may be beneficial for determining how to present the material. Offering content in a way that requires the student to make quick decisions or to apply a concept with little opportunity for research or study, more of a 'gut instinct', usually offers a better assessment of how the student truly feels about the situation as there is no time to prep or identify the socially acceptable answer (Krathwohl, Bloom & Masia, 1964). Having that baseline of behavior allows faculty to build from that point instead of rehashing the same content in a course that is taught often in the curriculum. It allows for more customization if foundational or introductory concepts are already known so more authentic learning experiences may be introduced.

Providing context for the concepts is one of the most essential elements in teaching for the affective lens. By showing situations that a student may encounter when in application of a cybersecurity job the material is more likely to resonate with that student thus making recall of that situation and the proper decision easier if the need should ever arise in real life. Obviously it is impossible to provide examples that are pertinent to every job students may take or to identify a specific example for each student, but every teacher can approach the subject with the intent to provide general context. Allowing for reflection of one's actions and the decision process is often a valuable learning experiment and may offer value in the student determining their initial choice was not the best for a given situation and retaining that information for future use and application.

Peer collaboration may offer insights that the student will recognize and accept, making it a smoother acquisition into their own behavior when modeled and discussed with peers. However it is approached, approaching cybersecurity ethics as an essential element in any cybersecurity program is only the first step. Building a quality curriculum and authentic learning experiences takes continued commitment and an investment of time and funds. The state of cybersecurity ethics depends on our success in this area, making this an area worthy of such an investment.

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Engineering Technology Students:

Senioritis Female and Minority Students Perspective

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Abstract

Senioritis is often associated with the academic setting, but it can also be associated with the end of a period with an employer, or a change in one's environment such as retirement. The result of this affliction also varies by the person or situation. A required course at a midwestern university that is most often taken by senior engineering technology students at the end of their studies were exhibiting behaviors that concerned the instructor and grader. The behaviors noted were as follows: students were absent from class, exhibiting characteristics often associated with lack of sleep or impairment due to the previous evening's activities, as well as general lethargy. Such disquieting behaviors were recognized by the instructor and grader as symptoms of senioritis, but the likes of which that had not been significant in previous semesters. The students were asked about this conundrum and their responses hinged on vagueness as if they did not want to really answer the question. As a result, the instructor asked if they would be willing to write up what they thought senioritis is, was and how it applied to them. Upon posing this question not only were the students positive in doing this, but they were also very interested in learning what their peers were experiencing as well. Many of these students indicated that they thought they were the only one with this problem, except for maybe their close friends. Additionally, most indicated that they felt like they were the only one having motivation issues as students in general refrain from discussing such issues. The researcher examined the resulting reflective essays and found a plethora of reasons for the behavior, yielding some expected and not so expected reasons. This paper shares those findings with the intent of providing an inside look at students and the issues they battle as they come to the end of their studies. Most notably the results of students who are female and of minority student populations.

Keywords: engineering, minority students, behaviors

Introduction

Nearly everyone that has attended school and completed a course of study has experienced senioritis. To take it a step further it is a phenomena that also happens at the end of time in a workplace or environment (A. Lucietto, 2018). The researcher for this study also works as a professor of practically only senior engineering technology students. In the Fall semester of 2018, it became obvious that students were struggling with a variety of symptoms all possibly related to this affliction of senioritis. Students were asked to share their thoughts regarding senioritis and how it was impacting their lives. Senioritis as it has been researched, and the concluding results of the student essays are shared to

support efforts to modify or adapt the learning environment of students nearing the end of their academic study. Such modifications will seek to encourage continued learning, and motivation to complete their studies. The authors have taken this a step further and have narrowed the focus of this paper to how female and minority students deal with senioritis based on a comparison of their essays to those provided by the general student population studied in this work.

This distinct population of female and minority students is a particularly interesting population in that this population may experience certain issues that many engineering technology students may not experience. Such issues may be but not limited to: feelings of loneliness, lack of camaraderie among their peers, cultural shock, and low self-esteem. Engineering Technology and related fields, are primarily male dominated with minority students as a gender whole being of a smaller amount compared to the majority (National Science Board, 2018). As such those students who are female and of a minority are of an even smaller grouping (Catalyst - Workplaces that Work for Women, 2019). Female and minority student numbers, although have been showing promise in growth in STEM fields over the years, is still lower than that of just the male population. As such the possible psychological effects of knowing one is different than many of one's classmates may attribute themselves to behaviors linked to that of senioritis. Therefore, by studying this population of female and minority students, will allow a look into how this specific population's experiences may have led to senioritis and if these experiences differ from that of the general student population.

Literature Review

To limit discussion to Seniors in the 4-year engineering technology setting, the following will be discussed: definition of senioritis, effects of senioritis, and the unique issues of female and minority student populations as they relate to senioritis.

Engineering Technology Student Population. Students in engineering technology are generally very hands on, and enjoy learning by doing, seeing, and participation. To put this into perspective via considering other technical areas, a hands-on continuum was developed by these authors in an earlier paper and is shown in Figure 1.

Hands-on ➝ *Theory*

Technology Engineering Technology Engineering Science Math

Figure 1. Hands On-Continuum

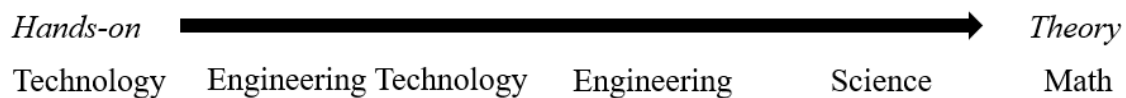Students in these programs often begin studies in other parts of the university, or in a community college (A. M. Lucietto, 2016, 2017). These students are interested in seeing how things work, taking things apart, making them better, then reassembling and checking out the new functions. While they may differ than many other students in their mode of learning and functioning, they are subject to many of

the same issues. In the case of senioritis, anecdotally it has been noted most frequently that these students are ready to leave the academic environment as soon as they get a job offer.

Definition of Senioritis. With its many facets and no discernible bounds, senioritis is a rather interesting term to define. Most will define senioritis as something experienced by students as they approach the end of their academic time prior to graduating (Hoover, 2003; Icel, 2018; Manning, 2011a; Puente, 2012). Most work in this area has focused on the high school years or transition into college (Anonymous, 2003). While others would define it as something that happens at the end of a time with an employer (A. Lucietto, 2018) or in the years prior to death (Cahill, 2015; Maxfield, 2015).

Generally, senioritis is a term used in the United States and Canada that is evidenced by decreased motivation exhibited by students after they accept a job offer or move closer to the end of their academic studies in a program of study. The effects of this ailment are significant, sometimes the result is catastrophic.

Effects of Senioritis. Students exhibit the effects of senioritis in different ways. Some resort to behaviors familiar to them, while others become depressed (Weinstock, 2018), and some react to their environment in ways that are uncharacteristic. Overall the effects are detrimental to grade point averages, student health, and their ability to function. In the classroom these effects manifest themselves in the form of the students often becoming unruly and difficult to manage.

Although the behaviors of senioritis may be similar across the board it is important to note, that the severity of the effects of senioritis typically increase with time. For example, both high school and university students, for the most part experience similar behaviors related to senioritis. However, university students will experience the effects of senioritis more poignantly than that of the high school counterpart (Fowler, 2014).

This disparity between high school and university students can be explained due to the issues that fourth- and fifth-year university students may experience differing quite a bit from that of students transitioning from high school to college. The issues that fourth- and fifth-year university students may face are but not limited to: applying to graduate or professional school, stress of entering the real world upon graduation, student debt, obtaining a job, starting a new job, regretting choice of college degree, and/or facing the long journey that is adulthood. These types of issues are generally accompanied by high degrees of stress and anxiety that may last quite a while until some sort of plateau is found for the individual.

Contrary, the issues facing high school students transitioning into college may be buffered by the excitement of beginning a new chapter in entering college and the bliss of youthful ignorance. Although many students face student loans throughout their college career, the pall of having to pay off their student loans does not generally descend until the end of one's college career, and reality sets in.

How to Deal with Senioritis. Senioritis may be dealt with in any number of ways. Some of the more conventional methods used are but are not limited to: take care of yourself, stay organized, get

motivated, have realistic expectations for yourself and your future, and visit the career center about post-graduation plans (McMullen, 2011).

Although the symptoms of senioritis may be same among the vast majority, the way in which these symptoms effect each student's mindset is unique to the actual person. As such methods that are used to manage senioritis for students, notably those who have not yet reached their majority, may not work. Additionally, these methods also do not generally work for students that are adult, and sometimes have children and families of their own. Much of the available research focuses on the transition from high school to college and found that STEM topics were interesting to otherwise unmotivated and depressed students (Icel, 2018).

That however does not address the issues that this author witnessed with fourth- and fifth-year university students. Therefore, methods of reducing/eliminating the effects of senioritis for that of university students would need to be modified to cater towards the problems plaguing fourth- and fifth-year university students.

In a literature search completed for this paper, it is evident that the work in this area is lacking.

As an experienced faculty member, the author has introduced novel learning techniques into the classroom. Using the feedback from the senioritis assignment, it can be shown that the author has managed to motivate and engage the students. One student commented:

"… [she] has caught my attention specifically. She doesn't straight lecture us very often at all. Bringing in guest speakers, making bi-weekly or weekly group presentations where we can discuss items rather than just write or test about them, and planning small trips around the area gives us all a different look on the topics we are learning. It is really appreciated to have this different spin on a class and I hope she changes many other professors' approaches in the future." (AK, 2018)

Female and Minority Students. Focusing mainly on the population of female and minority students offers a novel look into how senioritis may affect individuals of certain backgrounds that differ from that of the majority. Particularly in this case, how students who are female and of a minority compare to that of those who constitute the majority.

Female and minority students' offer a novel look because they may experience certain issues that the majority most likely would not encounter. Science, Technology, Engineering, and Mathematics (STEM) majors are typically male dominated fields (Catalyst - Workplaces that Work for Women 2019) of which likens female and minority students to a small subgroup of the overall population.

When a person belongs to a minority group, often moving into an area where others are unlike you and are of a particularly overwhelming majority becomes a most daunting experience. This alone can lead to issues for female and minority students involving loneliness, feelings of being lost, low self-esteem, lack of colleagues like them, and a higher level of anxiety. In the United States, STEM is considered a typically male dominated field regardless of ethnicity. Considering available data, the

number of women in STEM disciplines in the United States are far fewer than men, with similar findings in data from other countries (Catalyst - Workplaces that Work for Women 2019).

Imposter Syndrome. Another issue that female and minority students frequently experience is the need to prove themselves. This is usually found with changes in employer, position, and department as one moves through an academic or professional career. Note should be made regarding females, both students and professionals, as a result of past misconceptions that women were not capable enough to enter a STEM field.

The feeling to prove one's worth can manifest itself in multiple ways. In a college setting, this typically is in the form of making sure one receives top grades and/or joining extracurricular activities notably those relating to STEM fields. Working/studying to earn top grades is already an exhausting journey for just one semester. Though if done from one's freshman year and carried out to one's fourth or fifth year it can easily lead to a an overworked individual. Additionally, if earning top grades was combined with a STEM extracurricular activity this would most likely result in a burnout by their fourth or fifth year (Manning, 2011b). This burnout feeling is another behavior that may lead to senioritis.

If a student works hard but does not receive top grades, especially early in their college years this usually leads to low self-esteem. Lack of confidence after a bad semester or year or more can also possibly lead to that of which is known as the imposter syndrome. The imposter syndrome is the feeling of not being good enough and/or deserving to be where you are. This syndrome impacts many worldwide, but also especially that of females (Simmons, 2016; Simpkin, 2017). The constant feeling of not being good enough coupled with remnants of the age old stigma that women are not capable enough for STEM, the likehood of a female or even minorities developing the imposter syndrome is more or less a given at some point. Especially, for those in the college setting the imposter syndrome can have detrimental effects for young minds making their way in unfamiliar territory. The effects potentially result in the development of low self-esteem resulting in a transfer from STEM major to a non-STEM major or complete dropout from college.

Overall, the issues that female and minority students must deal with are more personal physiological lack of confidence issues that can have deleterious and detrimental effects on one's mental faculties. In sports, evidence shows that cognitive fatigue effects physical performance (Russell, Jenkins, Smith, Halson, & Kelly, 2018). Although most commonly applied to sports, this concept is transferable to academic work. When a person begins to believe that success is not within their grasp, or the material they are studying is out of reach, regardless of how perfect their attendance in class, it is likely without remediation they have already failed. However, the development of targeted pedagogy is likely to help female and minority students overcome some of the more common issues they face, reduction of their developing fully debilitating symptoms of senioritis that may occur and aide in the transition to their post academic path.

Research Questions

The data was collected in a classroom setting, with a cross section of students in the program. With a focus on female and minority student performance and their unique issues, the instructor pulled the essays provided by these students out for further study. The questions supporting this interest and contrasting the population follow:

- *Do female and minority students manage senioritis in the same way as the general student population?*
- *How do female and minority students cope with senioritis?*

Methods

Students were asked to provide a one-page assignment defining senioritis, and then to share how it affected them. Essays from female and minority students were copied and after all names were redacted from all files to allow anonymous analysis of the essays. Two files exist, without any identifying information. One is the class at large and the other has only essays provided by female and minority students.

NVivo was used to generate word counts and begin sorting for concepts and themes that are relevant to the question asked. To constructively analyze the content of the material submitted, three methodologies for data processing will be used. The first will be Top 10 Used Words, where the documents are surveyed for most commonly used words, in this case the top 10 words. Then the documents are read by multiple researchers who examine the context in which the top 10 words are used as well as searching for emergent themes, and finally an examination of the submissions by use of word clouds. These three methods are then triangulated and compared for themes, and contextual commonality.

Findings

Examination of the transcripts using NVivo provided an insight into some of the issue's students were experiencing as related to senioritis.

Word Hierarchy. The first review was to identify the top 10 most used words in the documents. Using the word tree utility, the researchers developed a pyramid to display those words and their relationship to one another, this is shown in Figure 2 and 3.
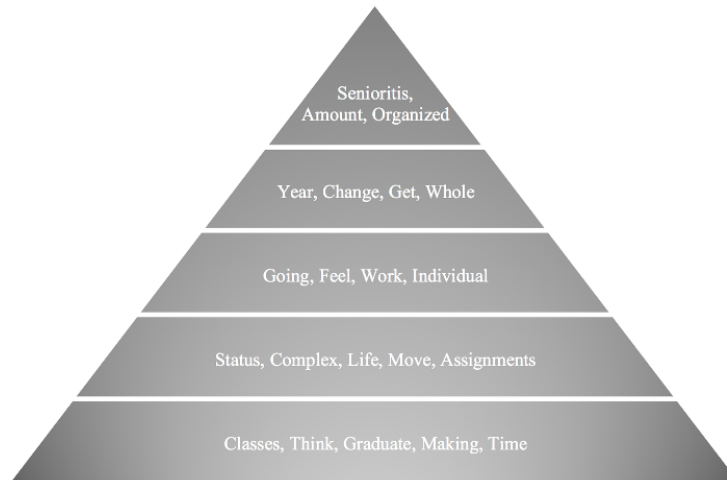
Figure 2. Hierarchy of Words Used by Female and Minority Students Describing Senioritis

Figure 3. Hierarchy of Words Used by Senior Students Describing Senioritis

Emergent Themes. With further examination of the data, the authors read the transcripts provided by female and minority students. The following was noted by the authors as trends and issues identified in these documents.

Students were asked to define senioritis in their own terms and then share how it has affected them. The authors found the description shown below the most representative of this group of female and minority students:

> *"A significant decrease in motivation to study, go to class, or work on any school work as a result of being very close to graduation."*

They also found this statement representative of much of what was shared in these essays:

> *"… you feel burnt out of the four+ years of college you have endured. […] … now you really don't want to do any more work for school since you will have a job."*

Some of the students shared that they felt senioritis was a form of mental illness, one likened it to depression, another shared the inability to get out of bed, and most described it as a general lethargy. Words and phrases most frequently used included motivation, procrastinate, not caring, individual, friends, no longer organized, graduate, work in both school and in the context of a future job.

Coop and Internship Experience. Students with experience in coop or internship experiences shared that they already have a job lined up and the rest did not matter. They shared that they had already made real money and going back to the classroom was not what they wanted to do. Those with coop experience said their friends were on the four-year plan and have already graduated, making them feel "old" and forlorn to not be graduating in four years.

Lack Motivation. Some students specifically said they had little to no motivation to do anything related to academics. Others shared that they already had a job lined up, so why do anything? While others stated that they were looking for a job, and were not sure whether to pursue a job or graduate school. A decision-making process that took up their time so their level of motivation was depleted.

DISENGAGED. THESE STUDENTS REPORTED DISENGAGEMENT IN A COUPLE OF DIFFERENT WAYS. A FEW OF THESE STUDENTS INDICATED THAT THEY FELT THEY WERE DONE AND "HAD MADE IT." THE RESULT WAS DISENGAGEMENT, A REACTION TO BELIEVING THAT IT WAS NOT NECESSARY SO WHY DO IT? MOST NOTED A DECREASE IN LETTER GRADES AND A LAISSEZ-FAIRE ATTITUDE, RESULTING IN LESS EFFORT BEING APPLIED TO CLASSES, PROJECTS, AND ANY SCHOOL RELATED WORK. ONE STUDENT DESCRIBED SCHOOL AS A "CRIPPLING ENVIRONMENT," AND SHARED THAT THEY JUST COULD NOT ENGAGE.

Procrastination. Most of these students noted a significant increase in procrastination. Some just did not want to do the work, while others waited until the last minute resulting in quality of work suffering. All noted that their level of concern or care was very different than the rest of their academic career.

The authors agreed that this group of students of female and minority students, were much more empathetic than the general group of students about their situation and how it relates to senioritis. The following are excerpts from the material provided, essentially sharing a lens into what the students are experiencing at this time in their lives.

"I can't wait to get out of college!"
"Seeing the light at the end of the tunnel."
"Senioritis is slowly crushing me."
"Senioritis is the worst thing with no cure."
"We just want to have fun."
"I find myself not wanting to be here anymore."
"I'm just ready to graduate and be done."
"I want to get a job where I can start making money."
"...physically I may be attending, but mentally I am not present."
"School felt tiresome. The routine from the previous year's felt pointless."

Finally, this group of students shared a multitude of thoughts regarding senioritis and how it has impacted them. They later shared with the professor that they found the assignment helpful in sorting out the way they felt and were reacting to when the academic end is in sight. Two observations shown below, with one directly from one student and the other a combination of multiple students follow:

> *One student shared their schedule from the time their alarm goes off in the morning. They kept hitting the snooze button, not wanting to go to class, not caring they will be late (like the are every day), sitting as far away from the professor as possible, and noting that half of their classmates in the first class are missing.*

> *Senioritis is emotionally trying for students. They've been in school for at least sixteen years and have been "training" for the end, when it's there they say "I don't want to be here… still, I am not ready to leave."*

Word Cloud Comparison. A comparison of words used by female and minority students in the assignments reviewed vs. the word used by the generalized senior student population follow in Figure 4 and 5.
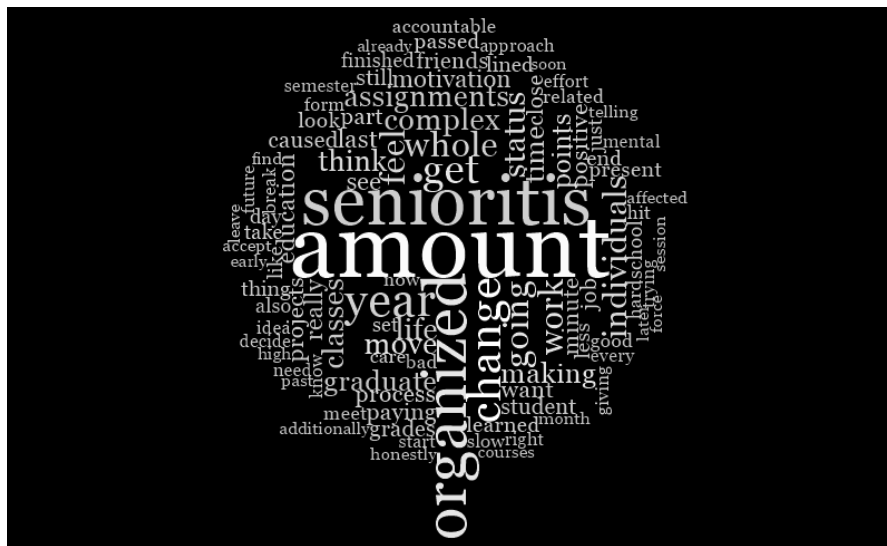

Figure 4. Word Cloud Focused on Frequently Used Words by Female and Minority Students
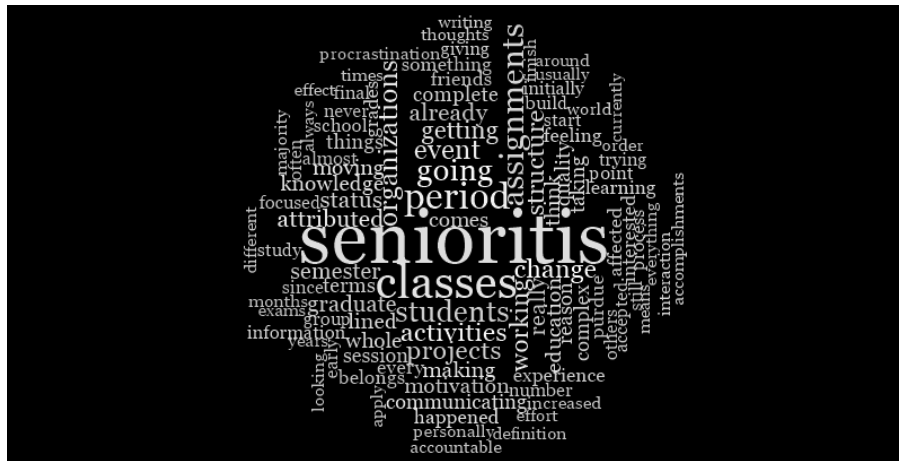
Figure 5. Word Cloud Focused on Frequently Used Words by Senior Students

Discussion

Overall, the differences in feelings resulted by senioritis between female and minority students compared to that of the general student population are not so very different. There are of course minute differences that indicate senioritis affects female and minority students a bit more emotionally and physiologically than that of the general student population. Figure 2 provides evidence that the female and minority population deal with senioritis differently than that of the general student population. The top tiers of the pyramid contain the words amount, organized, year, change, get, and whole. Indicating there may be some undertones that of being a bit different from that of the majority may relate to adjustments to a different environment and to those unlike themselves. Further synthesis of the data suggests that the amount of work may be too much, organization lacking, and the development of anxiety regarding changes experienced post-graduation. Complex was another word unique to this population, though not among the more frequently used, does show some insight that this population may be experiencing feelings of being overwhelmed, confusion, and/or uncertainty. Additionally, lack of motivation to get anything done combined with that of lack of wholeness in oneself may also be interpreted from the hierarchy of most words used by this population to describe senioritis. Overall, these words are indicative of individuals that may have at once been organized and full of life who are later weighed down by the thought of a burdensome and uncertain future.

While examining Figure 3, the hierarchy of most frequently used words in the general student population researchers noted that the top two tiers of the pyramid provided the words classes, period, assignments, going, and students. Thus, indicating general feelings of being exhausted and overworked. Gathering what little motivation they must go and attend classes and to try and pay attention. More likely daunting is the prospect of a class that forces interaction with the professor and/or other students, can be an extremely woeful prospect to the unmotivated. Structure was another word that was unique to this population. This may imply that there may be lack of structure in their personal and/or professional lives. Overall, these words indicate individuals who are tired, run down and listless.

In a comparison of the word pyramids words like both populations included organization, change, get, work, status, assignments, classes, and graduate. These words however used by both were ranked differently by the two different populations on the hierarchy of words. Regardless, this supports an assertion that the two populations are somewhat similar. However, the differences between these populations are still significant and should be considered. The researchers found the data to indicate that there was a general lack of camaraderie among the female and minority students as well as an overall lack of confidence.

Unique Issues of Female and Minority Student Populations. Unique to the female and minority students through the review of the provided essays is the issue of study skills. They indicated that they did not know how to study, and had issues earning top grades their first year. Like other students, they too have also taken more than four years to graduate and have found that to be an issue. Additionally, other students that they started school with were already graduated and working in a job. They refer to themselves as "old." Some that have had coops earning significant pay, of which that too has caused them angst in the form of senioritis.

A few of these students describe senioritis as a "lack of motivation." Others said…

"Senioritis is the worst thing with no cure."

"Senioritis is having the end be so close yet, so far."

"I can barely get out of bed."

The difference these students exhibited from those in the class at large is the fact that they have a job lined up. Some have been in the program for longer than four years, also causing difficulty for them as they watch their classmates move on with their lives.

Subsequently, these issues are ones that may have developed over time during academic study. As such, further study into overall course structure of the engineering technology program may need to be evaluated to account for these issues and the appropriate modifications carried out.

Further Study and Conclusion

Based on the results of this study, it is evident that further study of senioritis is warranted. Senioritis is not a condition reserved for just the academic setting. The effects of a student experiencing senioritis in their last semester before graduation is sometimes seen in the workplace.

Further study into the techniques used to encourage student engagement, motivation, and learning should be further investigated. Courses typically undertaken in the final year of academic study may need to be evaluated and modified accordingly to ease the effects of senioritis while maintaining quality. Some of the techniques utilized by the instructor in this study clearly had a positive effect on students and should be further developed and utilized by all faculty to create an environment that is pleasant and positive as students transition into their professional lives.

Additionally, to say that the causes of senioritis are reserved to that of just the final year of academic study would be parochial. The possibility that various experiences preceding that of the final year of academic study should also be investigated. Adjustments in course curriculum, course structure and the amount of student work load, for example may be areas that may lessen the cause and effects of senioritis and similar afflictions in earlier years of study.

In conclusion, the amount of work and overall lack of motivation were universal among both the general student population and of the female and minority student population. Although an all-encompassing solution would not be prudent as slight adjustments would need to be made to help female and minority students with their own unique issues.

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Anne Lucietto has nearly three decades of progressively responsible experience in industry, paired with adjunct teaching experience, and now as a full-time engineering technology faculty member. She has worked in a variety of industries such as power generation, fasteners, and heavy machinery; she has managed construction projects in national laboratories and for start-up projects. She researches her primarily senior students and is finding that the transition out of the classroom and into the career is something to learn more about. Dr. Lucietto has focused on researching students that are women and minorities, considering problems specifically encountered by this research population.

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Autonomous Drive Vehicle RADAR: Cybersecurity Defenses for the User and Vehicle

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Abstract

Autonomous Drive vehicles and the technology behind them is becoming is gaining more attention in today's technology environment. The gain in popularity is raising the awareness of cybersecurity threats to these vehicles. One of the primary areas for attack are the radar sensors. This article discusses the functions of RADAR, the attack threats associated with it and the defenses that are required to guard against these attacks.

Keywords: AD vehicle sensors, RADAR, cybersecurity attacks

Within the last decade, vehicle functionality depth has increased exponentially. The vehicle has advanced from the hulking mass of metal to the electronic machine powering consumers and commercial ventures. The functionality has been driven by the technology advances within the modules and equipment. The AD vehicles use the various technologies previously used on a much larger scale in other industries. The same technology trajectory is concurrent with autonomous drive (AD) vehicles. The AD vehicles are engineered to operate autonomously (Raiyn, 2018). For these AD vehicles the engineering advanced from theory and engineer's notebooks, from the rudimentary thought of a vehicle not requiring a human for operations. This was noted in cartoons from the 1950's. The hypothesis of the operational AD vehicle was refined with additional efforts, ranging from hypothesis application, financial resources, and direct labor. The AD vehicle is the proof of concept testing junction. The AD vehicles are at the stage with their sensors being active on the roads and expressways collecting data.

With the AD vehicle gaining a greater foothold in the vehicle industry, and consumer usage functions being brought online at an increased rate, the attackers have taken notice and are targeting the vehicles along with the modules contained therein (Loukas, Karapistoli, Panaousis, Sariginnidis, Bezemskij, & Vuong, 2019). As the AD vehicles have a greater number on the roadways, the attackers will continue their attempts to exploit any vulnerabilities. The AD vehicles have a number of sensors included as the standard package. The sensors vary greatly based on their functions. One of these sensors within the vehicle is the radar. The radar sensors located within these vehicles have been targeted for these cybersecurity attacks. While this is relatively new in comparison to the industry, the radar sensors and functions continue to be researched and tested. These attacks have the potential to be a significant detriment to the vehicle and humans. While significant, these attacks do have defenses available.

RADAR

Within each AD vehicle, there are sensors engineered to monitor the environment and translate the data points into a 3D map of the AD vehicle's surrounding area. This is required as the vehicle needs to know exactly what other equipment is proximate to the vehicle. This would include street signs, other vehicles, bicycles, motorcycles, pedestrians, and other tangible items which would damage the vehicle or hurt other persons. To accomplish this, the sensors are strategically placed around the vehicle. These include the camera, radar, LiDAR, and other technologies.

The subject module collecting pertinent data is RADAR (**RA**dio **D**etection **A**nd **R**anging (Croci, 2002)). This began to be researched in earnest for vehicle applications in 1999 (Autonomoustuff, 2018a). The vehicle's radar actively probes the proximate environment by sending and receiving electromagnetic waves (Yan, Xu, & Liu, 2016). This operates within its environment as the radar maps the objects proximate to the sensor (Raiyn, 2018). This creates, as one of the sensors located on the vehicle, the 3D map used by the vehicle to properly navigate the roadways. Radar, in the AD vehicle format, has taken the form of short-range radar (SRR) and longer range radar (Sakkila, Tatkeu, Rivenq, El Hillali, & Rouvaen, 2012). The SRR was primarily developed by European vehicle manufacturers. The range for each option varies per manufacturer and hardware developer. In general, the short range is to 100 meters (Continental, n.d.). The medium range is 80 to 160 meters, and long range up to 250 meters (Yan, Xu, & Liu, 2016).

Radar has been attracting increasing attention, due to the improving technology and the increase in the number of vehicles incorporating this into their systems (Coelingh, 2010). Radar is imperative to the present and vehicle's operations. Radar, in summary, is able to detect objects of varying size and material in the different environments the vehicles operate in (Gavrila, Kunert, & Lages, 2001). The radar is useful as this is able to function appropriately in rain, snow, or any of the other varying conditions experienced throughout the world. While this creates the useful functions which make this beneficial for AD vehicle usage, this also creates an attack surface to target. This is due to the simple operation which radar uses (Raiyn, 2018).

One aspect which makes radar more of a useful tool for monitoring is based on aesthetic design. The radar sensors in use presently are not the previous generations which sat on top of vehicles, large and obtuse. The present radar sensors are not exceptionally large. These also function well with the vehicle design, as the sensors may be hidden behind certain materials or panels within the vehicle, out of the user's sight (Gavrila, Kunert, & Lages, 2001). This creates a function, without the detriment of the large piece of equipment on the exterior of the AD vehicle.

Presently, RADAR assists with the driving and user experience (UX) for adaptive cruise control, forward collision warning system, brake support, and other functions and alerts. This has also been noted to assist the user and vehicle systems with detecting objects in the driver's blind spot, changing lanes, and warning of potential vehicle crashes (Elisabeth, & Malaquin, 2018). Operationally, radar may be used for surveillance, tracking, threat evaluation, and other uses (Manama, 2014). There is also a

benefit to society with the AD vehicle technology being incorporated into the systems. The traffic fatalities are estimated to number over 1 million persons across the global roadways (Elisabeth, Malaquin, 2018). An additional objective of the AD vehicles is to reduce these numbers (Cornick, Koechling, Stanley, & Zhang, 2016). The advanced driver assistance systems (ADAS), which radar is a facet of, assists with this objective.

The research and use of radar in vehicles has not been static. This has expanded from the simple applications to the usage presently in the AD vehicles in operation and being tested. Yamaryo, Takatori, and Kidera (2017) have and continue to research new methods to improve radar functionality. The researchers analyzed new methods to expand the radar-created image. Their research indicated this may be improved with infusing the range-point migration (RPM) function.

Prior Attack Methodology

The general methodology for attacks have been oriented as an enterprise form of attack. This would have been in the form of malware, viruses, Trojan, DDoS, and DoS. These and other attacks were used to attack PCs, laptops, servers, routers, and other equipment (Raiyn, 2018). As the use of radar in AD vehicles is relatively new in comparison to enterprise systems, the enterprise attack plans were modified, when possible, to be applied to radar. As time passed and the focus on the AD vehicles began to increase, so did the attacker's propensity to target these (Raiyn, 2018). This surge of attention and expertise has engineered new attacks distinctly planned for the radar and other sensors.

Sensors

With AD vehicles, there are many sensors located throughout the vehicle. These may be GPS, LiDAR, cameras, RADAR, and others may be implemented as technology improves. These are involved in actively and passively detecting the vehicle's environment to provide information for the AD vehicle's operations. The sensors convert the acquired data into a usable digital format for the vehicle's system to analyze (Raiyn, 2018).

These sensors are vital to the AD vehicle's operations and the user's safety. The natural target for the attackers are the sensors. Any false or tampered with data is perceived by the vehicle network as being authentic and legitimate, and relied on as the vehicle operates along the roadways. The data comprises the data pool which, when analyzed, allows the AD vehicle to transport the human to the destination safely. The AD vehicle acts on the data and information, possibly to the detriment to the AD vehicle's system, physical vehicle, and the users.

Commonly Used Radar Sensors

There are many manufacturers for the radar sensors. These include, however are not limited to Autoliv, Accipiter Radar Technologies, Delphi, Easat, ISEE, DeTect, DRS, and others. The international standard for radar operating is 76 to 80 GHz. The radar commonly operates though at either 77 GHz or 79 GHz (Elisabeth, & Malaquin, 2018).

The Delphi models were chosen as samples due to the amount of publicly available data present online. The first is the Delphi ESR 2.5 (Electronically Scanning Radar) (Autonomoustuff, 2018a). The sensor was engineered for mid- and long- range coverage. For this sensor, the primary use is with collision avoidance (Stanislas, & Peynot, 2015). This provides these two data points, mid- and long- range, concurrently. This is notable as prior systems used multiple beams for this function, while the noted sensor uses one to provide the same set of two data points. For the mid-range, the sensor detects vehicles next to the subject vehicle changing lanes, and detects other vehicles and pedestrians. For the long-range, exact data points for other vehicles, for their range and speed is detected. This module is able to detect up to 64 unique targets. For the mid-range, the coverage area is 60m, and the long-range up to 174 m. Both ranges are updated every 50 msec.

The other sensor model is the Delphi SRR2, sued for rear and side detection (AdaptIVe, 2017). The sensor was engineered to detect the approaching vehicles, bicyclists, motorcycles, and other vulnerable road users (VRUs) (Autonomoustuff, 2018b). In summary, this was engineered into the vehicle to assist the drivers with the blind spot experienced while operating the motor vehicle. This is similar to the Delphi ESR, with a significant difference. The SRR has one located on each side of the vehicle.

<div align="center">

Radar Attacks

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The radar sensor attacks are relatively direct, focusing on the radar's functionality and methods to trick the radar, providing false positives and false negative data points. These false points provide an issue which is required to be addressed for safety rationale. The humans within the vehicle have to know they are safe to ride within the vehicle. These false data points provide issues for the overall data pool and the vehicle's operations alone, and also with others as the vehicles become connected to a greater extent with the infrastructure as well as the other AD vehicles operating on the same roadway as the subject vehicle.

Jamming/Flooding

Two common and simple radar attacks are jamming and spoofing (Yan, Xu, & Liu, 2016). The sensors are able to be jammed with relative ease (Farral, 2018). As noted the bandwidth used ranges from 76-80 GHz. For vehicle radar, 76.5 may be used (Takefuji, 2018), however, this would need to be verified for the individual module being tested. For example, for short range, 79-81 GHz may be used, medium range 77-80 GHz, and long range 76-77 GHz (Yeh, Choi, Prelcic, Bhat, & Heath, 2016). The attacker could use a self-screening jammer to transmit the jamming signal. This would provide signals over the wide range of accepted bandwidth for the radar, which would lower the level of attack effectiveness. To increase the effectiveness, the attack may focus on 76-77 GHz for the jamming attack as the initial step (Yan, Xu, & Liu, 2016). To achieve optimal effectiveness, the researchers used a Keysight N5193 UXG Agile Signal Generator.

Spoofing/Ghost Vehicle

The Ghost Vehicle attack uses a digital radio frequency memory (DRFM) repeater (Petit & Shladover, 2014). The DRFM functions to digitize the signal from the target vehicle. This data is stored and the signal is rebroadcast to the target as a counterfeit signal (Park, Nam, Noh, 2018). This works to spoof the location of the ghost vehicle or other object. By adjusting the signal delay, the ghost vehicle or object would be closer or further away, dependent on the delay timing. With a longer delay, the vehicle or object would be perceived as being located far away. A shorter delay in the counterfeit signal would provide data to the AD vehicle of a much closer vehicle. The AD vehicle radar would register this as another vehicle or object of the attacker's choice and take evasive action, dependent on the rule set within the vehicle's system. This is differentiated from jamming as this method replays a series of radar waves to the target vehicle. The radar receives these and analyzes the data as an object. The jamming floods the sensor with data. While efficient, this attack is not as relatively simple as the others.

Material Penetration

The operating frequency for the radar sensors are publicly published. With this knowledge, the attacker has the initial point of analysis as a piece of the reconnaissance. The radar should be able to penetrate through certain materials and layers prior to detecting a target. For instance, the radar would penetrate a simple layer of cloth, while not penetrating and registering as an object the same cloth with other forms of materials incorporated. The attacker, to defeat the radar system, may use material of a sufficient depth or type (e.g. metallic) and place this at the opportune time in front of the vehicle in order to tamper with its operations. With a human to override this, the vehicle may continue to operate as expected. Without this understanding, which the radar sensor and analysis would not have, the radar and vehicle systems would be defeated. This would be analyzed as a critical object, while in reality being a cloth with other material purposefully chosen to be attached.

An alternative to this would be to deploy chaff in the front or side of the vehicle (Mears, 2006). This attack would disperse select material in select areas proximate to the vehicle. The material would be chosen to deflect the radar back to the sensor, in comparison to allowing the radar pulse to penetrate the fabric, thus not producing the data point. The minor amount of material may produce a sufficient layer of data for the sensor to recognize as a small vehicle or other object. This works to also increase the noise in the radar signature of other objects proximate to the vehicle.

Reconfigure the Sensor

The publicly accessible data for the sensors provides a large amount of usable data. One document noted the default IP address for the sensor was 169.254.145.71:5555. If this were to be still in use, another IP not chosen, and the default settings still in place, the default IP address would be an attack point and vulnerable. The attacker would need to access this, which generally is not a significant amount of effort. There are publicly available resources available detailing the steps to configure the sensor.

Also the sensor requires the radiate command to be sent over the CAN prior to data being sent for processing. The attacker may access the radar sensor, and tamper with the message. This may be flooding the CAN with the command, reconfiguring this such that the command would not be sent (Polysync.com, n.d.).

Defenses

The attacks for the radar are more mature and developed, as a greater amount of time has been available for testing and vulnerability exploit generation. With the level of radar technology in place at this time, the defenses are somewhat limited. One option for the target would be to change the channel allocations (Xu, Ma, Trappe, & Zhang, 2006). Effectually, this would change the signal from its current signal to another bandwidth, or change these periodically. These would still be required to remain in the allocated bandwidth. The changes would be narrow, as the approved range is limited. The change algorithm would be within the radar sensor. The attacker would be seeking a certain signal level for the attack, and not find this present for the attack. This would require additional work and processes, however the defensive posture is worth the effort.

Closing

In nations across the world, the AD vehicle is being developed, tested, and improved upon with each new iteration. While this initiative is improving and will be implemented at certain point in time, there are hurdles to overcome. The subject issue involves cybersecurity as applied to sensors. In particular, the radar sensors located in the vehicle. The attacks on these may produce false positives and negatives. These data points are relied on by the vehicle for the driving operations. To remove these is required, as the autonomous nature of the vehicle dictates it. There are a number of attacks dedicated to the radar sensor, along with mediations. With additional research and effort, there is the potential to limit these to an acceptable level, especially as part of a defense in depth for the AD vehicle's cybersecurity.

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Nikolas Upton has been conducting security research since 2011. Most of the time has been spent confirming the methodology and utility of different attack methods. Recent years have been spent applying this knowledge to secure autonomous cars and OEM parts.

Abstract

This article contributes to a growing literature on a lack of women in Information Technology (IT). The paper posits that IT institutions of learning need to apply corporate IT practices to increase the number of women IT graduates. Increasing the number of women IT graduates will increase the number of women entering the IT pipeline and, thereby, reverse the trend of a lack of women in IT. This paper suggests that when professors and mentors apply the classroom process model, AKA the Four Tenets, women students' performance improves in most cases. The paper validates The Four Tenets using grounded research and illustrates these recommendations with a classroom scenario. The results of this paper have implications for increasing the number of women entering the IT pipeline, thereby, reversing the trend of a lack of women in IT.

Keywords: women in IT, IT programs, gender, confidence, interventions

Increasing Women IT Graduates

This article contributes to a growing literature on a lack of women in Information Technology (IT). Infused by three streams of thought, this paper posits that IT institutions of learning need to apply corporate IT practices to increase the number of women IT graduates. This will increase the number of women entering the IT pipeline and, thereby, reverse the trend of a lack of women in IT. Based on the author's experience in corporate IT as well as in the classroom, and grounded by corporate practices taken from published literature, this paper suggests that when professors and mentors apply the classroom process model, the Four Tenets, women students' performance improves in most cases. The results of this paper have implications for increasing the number of women entering the IT pipeline, thereby, reversing the trend of a lack of women in IT.

The paper is structured as follows. The first section presents published literature along three streams of thought that have relevance to women in IT. The next section suggests a theoretical framework, the Four Tenets, for professors and mentors of IT institutions of learning for increasing women IT graduates. The Four Tenet is validated using grounded research and illustrated with a real-world scenario. The paper concludes with four recommendations for professors and mentors of IT institutions of learning

Literature Review

This paper is guided by three streams of thought from published literature. The three streams of thought are: benefits of workforce diversity, gender gap in confidence, and lessons learned in corporate IT. This section summarizes findings from these three streams of literature relevant to women in IT.

Benefits of Workforce Diversity

Research shows women in IT are under-represented (Kirton & Robertson, 2018; Quesenberry & Trauth, 2012). This deprives the organization of diversity of thought (Marhefka, 2018; Coder, Rosenloom, Ash & Dupont, 2009). According to CIOinsight (2012) and Woodfield (2002 p. 4), some of the values that women bring to the organization include better customer relationship and people orientation. Longer term, these contributions result in team cohesion and morale, customer loyalty, and a more open culture of communication for the purpose of learning. A culture of open communication and an organization of learning are two trademarks of an organization of innovation (White and Bruton, 2011). In today's fast-paced global economy, an organization must be able to innovate to maintain sustainable competitive advantage (Mone, 2017).

Gender Gap in Confidence

According to Carlin, Gelb, Belinne, & Ramchand (2018), IT organizations need to retain and promote women in order to maintain workforce diversity. For this to occur, managers need to gain fundamental insight into the gender gap in confidence. "Confidence" is defined as how an individual perceives their ability to succeed at a specified task (McCarty, 1986). It is a subjective estimate and may or may not be aligned with reality. Review of literature on confidence indicates that "feedback" seems to have an effect on women's perceptions of their abilities. This has interesting applications in situations where reinforcement, i.e. positive feedback, might be used to reverse effects of gender gap in confidence.

Lessons Learned in Corporate IT

Research from Corporate IT (Riemenschneider, Allen, Reid, 2006; Carlin, Gelb, Belinne, & Ramchand, 2018) suggests that failure to retain valued employees has economic and non-economic costs. Economic cost includes replacement and training costs; non-economic cost includes loss of organizational knowledge which is not easily replaced (Bharadwaj, 2000). A case study at Deloitte shows that an investment of $8 million saved $250 million in hiring and training costs as a result of increased retention in women (Carlin, Gelb, Belinne, & Ramchand, 2018). According to a senior partner at Deloitte, when the firm realized that women were on the march out the door at a significantly greater rate than men, they decided to change the male-dominated culture to reduce the turnover rate. One of the lessons learned at Deloitte include creating mentorship opportunities for women for the purpose of feedback, AKA reinforcement. The purpose of feedback is to provide mentoring that is targeted at gender gap behavior. In addition to coaching women to overcome gender gap behavior, such as voicing their opinions at meetings, mentors also discretely facilitate cultural changes to transition the organization to a gender-neutral culture whereby women are "heard" at meetings, and provided the same "opportunities" as men.

The Four Tenets

As discussed previously in Benefits of Diversity, diversity in the workplace improves the quality of product. Specifically, when there is a lack of women in IT, diversity in the workplace suffers. To address

this issue, this paper suggests a four-step classroom process model, AKA the Four Tenets, to increase women IT graduates.

As an overarching principle, professors and mentors need to gain insight into the "gender gap" issue. Gender gap, as discussed, is a tendency for women towards a lack of "confidence". Because of a lack of "confidence", women tend to be less demanding of themselves and their professors in getting a good or superior grade. At the same time, women tend to have "dual roles", i.e. living two lives (Griffiths & Moore, 2010; Kirton & Robertson, 2018 p. 25). Women view career and family as separate lives and often have to choose between the two lives, AKA "work-life balance" (Quesenberry & Trauth, 2012 p.3, 4, 7). In the classroom, "work-life" balance often manifests as a lack of performance, such as late andor below quality assignments. These two factors alone can put women students at risk. Often, these at-risk students, through sheer determination, will make it through with a borderline passing grade. However, as soon as Murphy's Law strikes, in the form of a personal or family emergency, these students will fail the course, and over time, disappear from the finishing line to make it into the IT pipeline for hire.

To reverse this trend, this paper suggests a mentoring model in the classroom for professors and mentors patterned after corporate IT. The mentoring model consists of four critical events in the classroom, the Four Tenets: (1) recognize the first signs of a lack of performance, particularly in women students, (2) initiate communication immediately with the student, (3) provide accommodation for the student to remediate the lack of performance, and (4) provide reinforcement throughout the process.

Approach and Method

Nascent impressions of the Four Tenets were incubated by the author from working in corporate IT. Having worked in both management and non-management capacities, the author observed both sides of the issue. From management's perspective, the incentive is to retain women so there is diversity in the workforce as well as lower cost in hiring and training replacements. From the non-management perspective, the incentive is for women to achieve work-life balance while maintaining a much-needed source of income. These two dimensions of the IT workplace are the same in the classroom. Professors and mentors in IT institutions of learning are incentivized to retain women graduate students in order to maintain program size. Similarly, women IT students are incentivized to complete the program so they may secure a good source of income.

Based on the author's fifteen years of corporate IT experience and ten years of classroom experience, the Four Tenets were crystallized from grounded research on published literature relevant to women in IT. Of special interest is the literature pertaining to corporate IT practices on increasing women in IT. The Four Tenets is a win-win strategy for professors and mentors as well as women IT students. To illustrate this model, the following section presents observations in the classroom from a graduate capstone course in IT at a graduate business school.

Scenario

To illustrate how an intervention process might occur in the classroom, a classroom scenario taken from a graduate IT capstone course is presented. The capstone course workload consists of weekly discourse assignments, three blog assignments, a mid-semester examination, one individual research paper and one group project. Because the course is online, it is a challenge for professor/mentor and students to communicate one-on-one without raising undue cause for alarm.

Of special interest is the Individual Research Paper which is a major assignment.   The individual research paper has a conference call milestone at mid-semester. In addition to reviewing the research proposal, this is an opportunity for the professor to discuss specific accommodations, such as research paper extension, and to provide reinforcement. Women students who are challenged with work-life balance issues respond particularly well to acknowledgement of work-life balance as an issue, and specific accommodations for assignments as necessary.

In this scenario, the student is a female graduate IT student struggling with full-time work schedule, 2 children and ailing parents. After an accommodation to one of the milestones in the research paper assignment, the student completed the individual research paper, submitted subsequent assignments in a timely manner, and went on to graduate from the IT master's program.

Recognize the first signs of a Lack of Performance

The first sign of a lack of performance was a late discourse posting, Diving Deeper, the first week of class.

> *"Just want to be able to maintain communication throughout the semester. Writing to let you know that I will post my Diving Deeper today. Sorry I am trying to do the best I can with deadlines/timelines. My days are very packed-fulltime work, 3 children, parents, and spouse who sometimes works 7 days a week. Again, thank you for your feedback and understanding."*

The lack of performance escalated as the student missed three conference call appointments to discuss the individual research paper.

> "*I really do not mean to inundate you with IMs. I did read the comment regarding alternate times to discuss the proposal and feedback. Would any these dates and times work for you: 1) today 10/23 at 7:15pm 2) Today 10/23 at 8:30pm 3) Wednesday 10/24 5:30pm, 6:30pm, 7:30pm. I know my times seem to edge towards the evening, only because of my work schedule".*

Initiate Communication Immediately

After the third missed conference call, the professor posted a grade of zero for the conference call assignment knowing that the student will challenge the grade. As expected, this initiated an angry email

from the student claiming she enrolled at the university because of the university's well-known policy of flexibility with students who are working full time and have families.

Provide Accommodation

The professor responded in an email reviewing the history of three missed conference calls. While one can argue "three strikes and you are out", the professor provided an accommodation through a series of question and answer emails to make up for the missed conference calls. The student replied that she had been overwhelmed and had not realized she had missed three scheduled calls. She apologized for her behavior and appreciated the accommodation.

Provide Reinforcement

Throughout the semester, the professor provided reinforcement to reverse any effects due to gender gap. For example, the professor seeks out opportunities to provide positive feedback to the student in the discussion forums.

Discussion

One consistent observation from the scenario, and similar situations over the author's ten years of classroom experience, is that women respond particularly well to communication and reinforcement. These two events in the Four Tenets are likened to "training wheels". Once the gender gap is managed, women will meet expectations without need for further accommodations.

While the Four Tenets suggests accommodation in the classroom, particularly for women IT students, there are situations where the Four Tenets may not apply. Therefore, the professor and mentor need to be discerning as to when to apply the Four Tenets. Above all, professors and mentors need to be flexible and equitable; and hold all students accountable for the syllabus. Towards this end, the following points are noteworthy.

- **Not all women require accommodation.** There are high achieving women who are juggling family, work, and personal issues quite successfully. In one of the conference calls, the author asked a high performing female student whether she has family and children. To the author's surprise, the student responded that she has family and children. She also confided that it is a constant challenge to find time for school.
- **Some women may need more than accommodation**. The author has observed situations where a student is just overwhelmed with competing priorities. After reasonable accommodation, the student may need to take a break from school.
- **Male students may require similar accommodations**. The author has observed a male student struggling with family issues and offered the student the same accommodation. In doing so, cross gender equity and fairness are maintained.

Conclusion

In order to reverse the trend of a lack of women in IT, there needs to be an increase in the number of women IT graduates. Increasing the number of women IT graduates will increase the number of women entering the IT pipeline and, thereby, reverse the trend of a lack of women in IT. This paper addresses the retention dimension of women IT students once they have entered an IT program. Corporate research literature shows that best practices in retaining women include training, such as mentoring, and timely communication. At Deloitte, these practices have saved $250 million in hiring and training costs for replacements. This paper suggests that the same practices apply in the classroom. First and foremost, professors and mentors have to gain insight into the gender gap in confidence. Based on the author's experience in corporate IT as well as in the classroom, and applying grounded research based on corporate IT literature, this paper crystallizes four events in the classroom, the Four Tenets, as a process model to increase women IT graduates. The Four Tenets suggests that professors and mentors need to: (1) recognize the first signs of a lack of performance, particularly in women IT students, (2) initiate communication immediately with the student, (3) provide some accommodation for the student to remediate the lack of performance, and (4) provide reinforcement throughout the process. When the Four Tenets are applied with proper discernment, in most cases, women students' performance improves, leading to successful completion of IT programs. The results of this paper have implications for increasing the number of women entering the IT pipeline, thereby, reversing a trend of the lack of women in IT.

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About the Author

Irene started her IT career working for IBM as a System Engineer and later joined Bell Laboratories as a Member of Technical Staff, and PepsiCo as a Project Manager. After fifteen years, Irene took a hiatus from corporate IT and, for the next ten years, taught Computer Science/Information Technology at IT institutions of learning, including Allentown College, PA. In 2001, Irene re-entered corporate IT as a J2EE developer at Chubb Insurance. After finishing her doctoral studies, Irene took early retirement and now devotes her time fully to teaching and research. Irene holds a B.A. in Mathematics (Barnard College), M.Sc. in Computer Science (Columbia University) and Ph.D. in Information Systems (New Jersey Institute of Technology). Irene is a certified Iyengar Yoga instructor and teaches Yoga as a community service. Irene can be contacted at iwong-bushby@faculty.umuc.edu (430-558-4928)

Assessment of a New Approach to Mentoring American Indian Students: Removing Guidance Barriers in Completing the STEM Degree

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Abstract

Effective mentoring is a critical component of academic success and contributes to higher retention and chance of success for underrepresented students pursuing a degree in the science, technology, engineering, and mathematics (STEM) fields. Historically, the statistics around degree completion and employment for American Indian (AI) student's pursuing STEM is significantly lower than their peers. Significant challenges and barriers exist for AI students pursuing postsecondary opportunities (Brayboy, Fann, Castagno, & Solyom, 2012). The purpose of this paper is to showcase the assessment of a new approach to mentoring AI students. This new approach aims to address removing navigational barriers and challenges for students who are working towards completion of a STEM degree—using the Community of Strengths Model as a framework and incorporation of the four components (community strength, learning experiences, authentic community voice, and goals) provided relevancy to AI students. The study was conducted with 19 participants who were primarily AI students attending a small tribal college in Wisconsin. Students met with a mentor on a bi-weekly basis and were asked to bring pictures that represented successes and barriers to their education. The findings of this study identified themes related to AI students perceived educational successes and barriers. The results from this study are significant as they can be used to inform educational leaders and postsecondary institutions serving AI students on the best supports and strategies that should be carried out on their campuses.

Key Words: Native American, Indigenous, Undergraduate, Advising, Student Success

Introduction

Science and engineering employment statistics are dismal for historically underrepresented individuals. According to the National Science Foundation's Science and Engineering Indicators report 2018, American Indian/Alaska Natives comprise 0.6% of the U.S. adult (21+) population, yet only makeup 0.3% of the science and engineering degree holders and only 0.2% of workers employed in science and engineering occupations. American Indian (AI) students' pursuit of educational opportunities is well below that of their White, Asian, Pacific American, or Black/African American peers (National Science Board 2018). Despite many efforts to identify student retention and success

strategies specific to AI students, the gap continues to grow between the dominant culture and students of color, as AI undergraduate graduation rates remain stagnant (Keith, Stastny, and Brunt 2016).

There is mounting evidence that points to the need for both academic and psychosocial support for underrepresented minority students (Keith, Stastny, and Brunt 2016). Many AI students are first-generation college students with limited knowledge of the higher education system and lack the navigational skills needed to meet the rigorous requirements of postsecondary institutions (Flynn, Duncan, and Jorgensen 2012). Research suggests mentoring is a key opportunity in addressing critical components needed for academic success and student participation in a supportive environment can significantly enhance motivation, learning, and confidence in degree attainment (Jackson, Smith, and Hill 2003). Understanding the role of mentoring in improving successes and removing barriers to AI student's degree attainment is critical. More specifically, this new understanding will assist the United States in broadening participation and increasing diverse perspectives in the science and engineering workforce.

Background and Literature Review

A Historical Perspective on American Indian Education

There is a longstanding history between tribal nations and the United States federal government, including treaties over land, promises of access to health care and educational services, the passing of public laws that gave state governments jurisdiction over reservations, termination of rights (Brayboy et al. 2012). As white colonists expanded westward and colonized AIs and their lands, they also removed many AI children from their homes. The children were often forced into boarding schools so they could be "educated." However, this resulted in "cultural, emotional, and integration struggles" among the children who were being forced to assimilate into Western culture (Brayboy et al. 2012, 37). When AI students are given the opportunity to engage in activities specific to their culture, they experience a sense of balance, which aligns with their cultural values, where the mental, physical, emotional, and spiritual domains are equally incorporated and acknowledged (Harrington and ChiXapkaid 2013, Thompson, Johnson-Jennings, and Nitzarim 2013, Tippeconnic and Tippeconnic Fox 2012). Institutions that possess an AI focus, or provide a culturally responsive approach to schooling generally produce outcomes that lead to a higher level of AI academic and enhanced self-esteem (Castagno and Brayboy 2008).

The history of AI higher education has been characterized by the requirement of Westernized methods of learning, recurring attempts at eradicating tribal culture, and high AI student dropout rates. In response to these obstacles, AI tribal leaders were convinced that the creation of postsecondary opportunities on the reservation could "strengthen reservations and tribal culture without assimilation" (Consortium, 1999). This belief resulted in the creation of federally recognized Tribal Colleges and Universities (TCUs), which are tribally controlled postsecondary institutions. TCUs were established to meet higher education needs of AI students, especially for AI students located in geographically isolated areas with limited means of accessing education beyond high school. Although TCUs are uniquely suited to meet the needs of AI students, there are still many challenges that exist. The reservations, on

which a majority of tribal colleges are located, face high unemployment rates, low per capita income levels. Most AI students attending TCUs are first-generation college students (Consortium 1999). According to McDonough's (2005), parents who have a lower socioeconomic status, such as those of AI families, frequently lack a postsecondary education; which as a result they typically lack the knowledge required to assist their children in navigating the challenges of postsecondary education. In addition, many AI students experience personal and emotional issues and face barriers and challenges that impact their ability to be successful in postsecondary education endeavors (Flynn, Duncan, and Jorgensen 2012). Given the role TCUs play in educating AI higher education students, TCUs provide a unique perspective in voicing the successes and struggles faced by tribal communities as well as provide the necessary cultural and understanding necessary to empower tribal college students towards degree completion.

Academic Persistence

The literature on AI academic persistence is grouped into three categories including, sociocultural, academic, and personal factors (Jackson, Smith, and Hill 2003). First, sociocultural factors (including social-emotional and psychological-social factors) have been identified as critical barriers limiting AI students' academic performance and completion (Gloria and Kurpius 2001). These factors are commonly associated with feelings of isolation due to mainstream colleges' inability to accommodate AI culture (Ovink and Veazey 2011, 371). McDonough's (2005) research suggested that finding mentors and participating in support groups are of great benefit. Brown and Kurpius (1997) found that positive faculty interactions and family encouragement inspire AI students to have greater persistence in college. Second, are academic factors. Here, research has found a significant correlation between persistence and academic preparation. Thereby implying, AI students would benefit from increased access to study skills and college preparation training as they enter a postsecondary setting (Dias 2017, Gibbons and Woodside 2014). Third, concerns personal factors, Brown and Kurpius's (1997) showed a relationship between AI students' academic aspirations and persistence in college; specifically, the authors found that lack of persistence was associated with lower levels of financial support, academic aspirations, part-time college attendance and being a GED recipient. Other research has identified limited academic guidance as a challenge for AI students (Ovink and Veazey 2011, 371).

Conceptual Model – Community of Strengths

This study is grounded in Eady's (2016) Community of Strengths Model, which is a cyclical model that serves as a means for researchers to begin to conceptualize the collective process of learning that occurs within an Indigenous culture; where "being true to Indigenous knowledge and Indigenous ways of learning is imperative to successful outcomes" (Eady 2016, 22). Eady's (2016) model evolved as a result of research that she completed with the Point Pearce Indigenous Community in South Australia. Eady's (2016) study aimed to connect and compliment "longstanding sociological and cultural theories of learning with a new model of e-learning that was influenced by Indigenous culture" (p. 23).

The Community of Strengths Model was used in part because of the specificity to Indigenous communities and the model's recognition and value of strengths. The Community of Strength Model has four components that can be generalized and used in various educational contexts; and is cyclical,

which allows for continued progression and communication, sharing of knowledge, and community growth. The four components of Eady's (2016) model included: community strength, learning experiences, authentic community voice, and goals, directions, and development, as shown in Figure 1.

Figure 1. Community of Strengths Model (Eady 2016)

The first component is community strength, which exists in all Indigenous communities. Community strength is shown in many ways both during celebrations and during struggles. The second component is an environment that is conducive for shared learning experiences to take place. Eady (2016) includes a list of learning strategies and preferences for adult learners (e.g., learning through doing, an aspect of personal and face-to-face instruction, emphasis on people and relationships). Her research found that shared learning experiences became meaningful for community members when they were given an opportunity to share their concerns in a safe and non-threatening environment. Authentic community voice is the third component which, includes elements of a safe environment for people to express themselves in their Indigenous ways of knowing and within their culture. The final component is goals, directions, and development which focuses on creating relevant and manageable goals and directions that lead to community development and accountability. As communities move forward with community goals and directions, members are motivated to move further towards setting other educational and community goals, and as the circle iteratively continues the community continues to strengthen (Eady, 2016).

Purpose of Study

The purpose of this study is to provide an overview of the implementation and assessment related to anew approach to mentoring AI students. This new approach aims explicitly to address removing navigational barriers and challenges in completing the STEM degree. The data analysis and results will identify themes related to students' perceptions of navigational barriers and successes that shaped their educational experiences. The strategies and implications identified as a result of this study will inform

postsecondary institutions, minority-serving institutions, counselors, and high schools of the importance of providing essential navigational, social, and academic skills to AI students to support student success in postsecondary educational pursuits. The guiding research question is as follows:

> *What are students perceived navigational barriers and successes related to their postsecondary education experience?*

Method

Participant (Subject) Characteristics

Participants were recruited from a federally recognized Tribal College and University located in northern Wisconsin, U.S.A, with an approximate enrollment of about 400 students. In January 2018, students were recruited to participate in a mentoring program using a campus-wide email. All students were eligible to participate regardless of ethnicity, gender or major. Due to the funding provided by the National Science Foundation, preference was given to historically underrepresented students (including minorities and females) enrolled full-time in a STEM major. Upon acceptance into the program, participants met with the researchers, reviewed expectations, had an opportunity to ask questions, and signed the IRB approved participant consent form. A breakdown of key student participant demographics is as follows: 53% female, 48% male; 79% minority (American Indian and Hispanic/Latino), 21% non-minority. All student participants were enrolled full time and identified as a minority, female and/or STEM student.

Program Design

The mentoring program was designed to incorporate the four components of the Community of Strengths Model including community strength, learning experiences, authentic community voice, and goals, directions, and development. The components of the Community of Strengths Model provided a framework in which to ensure relevancy and consideration to Indigenous learners.

- Community Strength: The mentoring program was intentionally designed to identify individual student strengths to encourage continued motivation towards student success. As such, regular mentor meetings were proposed to allow recognition and celebration of student successes related to the common goal of successfully meeting course learning requirements. Also, students were prompted to leverage those same strengths during times of resistance. Thus, during times of personal struggle and challenges, the mentor meetings planned for students to discuss the barriers and potential implications for their education.

- Learning Experiences: The mentoring program was intentionally designed to integrate opportunities and an environment to promote shared learning experiences to occur between the student and mentor. Example learning strategies incorporated into the program include learning through doing, learning from real-life experiences, contextual learning, constructivist learning, and one-on-one face-to-face instruction. These shared learning experiences were proposed to allow for meaningful knowledge transfer and creation between the student-mentor team, resulting in a co-developed personalized plan for each student.

- Authentic Community Voice: The mentoring program was intentionally designed to allow for students to have an authentic voice which was nurtured through creating a safe space for students to reflect and share. The development of a safe space was proposed to encourage students to speak freely and openly on thoughts, insights, inquiries and personal experiences. Allowing for an authentic individual

voice was thought to provide participants an opportunity to feel valued and to share their Indigenous ways of thinking, learning, and doing. Then, as a result, the mentor could better assist students in understanding their feelings, actions, likely consequences, and potential next steps.

- Goals, Directions, and Development: The mentoring program was intentionally designed to incorporate manageable goals, plans for moving forward, and personal development. Personal development was proposed to occur through regular goal setting and accountability check-ins and would allow for empowerment and professional development, not only during the program but from a lifelong learning perspective.

Data Collected

Throughout the semester, participants met with a faculty mentor eight times. For three of the meetings, students were required to complete homework (submit photos and narrative responding to the prompts in Table 1), and then met with the faculty mentor to further discuss the challenges and barriers.

All participants were provided a Wi-Fi enabled, unlocked Smartphone which included a 5-megapixel camera. In addition, participants were asked to write a one-sentence description for each picture. At their follow-up mentor meeting, participants met with the faculty mentor and were asked a series of questions using the SHOWED method (Shaffer 1985) to further elicit reflection on their successes and barriers to their education. As a result, a written narrative was co-constructed with their faculty mentor. The mentor typed as the participants reflected and shared their thoughts and understanding of the barrier or success that the picture represented. Once the narrative was complete, the narrative was read out loud to ensure the accuracy of participants' responses and for them to provide consent on the final version.

Table 1. Mentoring Prompts

Week	Prompt
Two	You are currently at the beginning of the semester. Reflect back over the last few weeks and take pictures to identify (a) two challenges or barriers that negatively impact your educational experience at Midwest Tribal College and (b) two successes or motivations that positively impact your educational experience at Midwest Tribal College.
Eight	You are currently in the middle of the semester. Reflect back over the last few weeks and take pictures to identify (a) two challenges or barriers that negatively impact your educational experience at Midwest Tribal College and (b) two successes or motivations that positively impact your educational experience at Midwest Tribal College.
Fifteen	You are currently at the end of the semester. Reflect back over the last few weeks and take pictures to identify (a) two challenges or barriers that negatively impact your educational experience at Midwest Tribal College and (b) two successes or motivations that positively impact your educational experience at Midwest Tribal College.

A total of 120 photographs and written narratives were collected over the semester. **Error! Reference source not found.** outlines the number of narratives collected specific to participants successes and motivation. For example, during week two, 21 participants were asked to identify the

successes and barriers to their educational experiences during the second week of the semester and produced 42 photographs and written narratives. One student dropped out of school at week four of the semester, and as a result, there were only 40 photographs and written narratives collected during week eight. Another student was unable to continue classes and meet other school responsibilities due at the end of the semester, so for week 15, there was a total of 38 photographs and written narratives.

Table 2. Data Collection Details

Photovoice Week	Motivation: # of Narratives	Barriers: # of Narratives	Total
Two	21	21	42
Eight	20	20	40
Fifteen	19	19	38

Analysis

The NVivo 11 qualitative analysis software was used to analyze the photos, narratives, and transcripts. All data documents were imported into NVivo and the researchers read through the documents several times. The documents were coded, and themes were identified. Due to the qualitative nature of the study, the goal of analysis for the open-ended questions was to explore potential themes within the data.

Initial coding or more specifically "open coding" was used for the preliminary analysis. Initial coding allowed the researchers to reflect on the contents and distinctions of the data and to begin taking ownership of them (Saldaña 2013). Additionally, open coding allowed for a period of digesting and reflecting on the data, as well as providing a starting point for continued coding (Saldaña 2013, 115). In this study, data were analyzed and coded separately by successes and barriers to each week.

After initial content analysis, a codebook was developed individually, the researchers collaboratively reviewed the content and codes. The second round of analysis was conducted, new codes were created, and a second meeting was held where a consensus was established through discussion. The relationships between codes were established and themes were generated. Additionally, photographs and written narratives were shared with an Elder to ensure that the themes were appropriate and culturally sensitive.

Results and Discussion

Student Successes

In this section, the overall findings for the three prompts, themes related to successes and barriers to tribal college students' educational experiences throughout the semester are presented.

There were four themes related to positive educational experiences and motivators, which are included below;

1. Engaging and supportive campus environment.
2. Family members encouragement and setting an example.
3. Structure, stability, and organization are key factors for student success.
4. Prior academic success promotes confidence and accomplishment.

Theme 1: Engaging and supportive campus environment.

The first theme that was identified to be central to participant's success was the inclusion of American Indian (AI) culture on a small campus which primarily serves non-traditional and AI learners. In general, students' participation in AI traditional activities provided balance during a hectic semester.

> *"Being a student at [College X] has given me an opportunity to express my native worldview and be accepted and not have to change into a Western Worldview."*
>
> *"Knowing that I get to participate in my traditional ways keeps me on track with my work and keeps me in balance."*

Many of the participants acknowledged that small class sizes and highly motivating, engaging professors were important factors. In addition, participants liked faculty who were explicit about expectations and who provided timely feedback on assignments and grades.

> *"I feel like coming to [College X] has been a great experience; it is a smaller community and people have been helpful, and as a non-traditional learner I felt comfortable as many of my fellow students are similar to me and we have much more in common."*
>
> *"A huge motivator for me this semester has been the high energy communications professor and his willingness to break things down. This class has become a motivator for me because that kind of teacher motivates me."*

Many of the participants acknowledged the importance of having access to a computer and internet as contributing to their success.

> *"[My laptop] gives me access to sources that I can use that helps in communicating with teachers, complete assignments, and turning them in on time. My laptop makes things better because it is always accessible and available to me."*
>
> *"It is a place where I have access to a computer with the internet where I can complete my homework. For my math class, we have to do our homework online and it is easier to do my math homework on the computer at the computer lab than on my phone."*

In summary, participants noted the importance of being able to express their Indigenous Worldview as well as a means of maintaining balance. Participants appreciated that they could express their Indigenous ways of knowing in and out of their classes through smudging, participating in campus pow wows, and through classroom discussions centered on Indigenous perspectives. Additionally, they noted a campus environment which includes engaging faculty members and access to resources is a motivating factor for many students.

Theme 2: Family members encouragement and setting an example.

The second theme was regarding the importance of family members as key motivators for participants in pursuing and progressing toward their education. Participants expressed the importance of family members as critical factors in their motivation but were also highly motivated to use their education as a means to create better opportunities for their families. Participants were highly motivated to pursue their education as they believed they were being role models and setting a good example for their children.

> *"This picture represents each of the children that I have in my life (six) and the reason that I am in school. It motivates me to do well in school because I want them to do well in school."*

> *"I want to finish school and get my degree to set a good example for my children because I did not have that as a child. I want to show them that education is important, and you can do what you want to do if you work at it."*

> *"My son is the top reason I am attending school. His future and the example I set, I think, are very important. Education at an early age can be very beneficial for them and introduces them to social structure and highly increases the chance they will attend higher education."*

Having family members pursue educational opportunities also provided motivation for participants to believe in themselves and to continue working hard in pursuing their degree.

> *"A motivator for me was watching my husband complete his course to be NHLA (National Hardwood Lumber Association) certified. It only motivated me to want to continue to work hard in school."*

> *"[My dad] passed away on Christmas Eve (2017) and it has been the hardest on me. I think knowing my dad wanted me to go to school and always asked me how I was doing and what I would do when I graduated keeps me going forward."*

In summary, participants shared how their families were a source of motivation in their decision to pursue an education. Some participants noted that one of the reasons they were pursuing their education was because they wanted to create better opportunities for their children and provide them with an aspirational model.

Theme 3: Structure, stability, and organization are key factors to student success.

The third theme was related to the importance of structures and a stable environment. Participants expressed the importance of having a stable environment and a place that they could call home, as well as having routines and organizational methods which kept them focused and motivated to continue throughout the semester.

> *"I have been a homeless college student for a semester and a half and having my own space to do homework is so important to my success. Having our own home enables me to be more organized and to feel at peace and feel enabled to do my homework successfully."*

> *"Seeing the organizational chalkboard on my fridge whenever I grab a snack helps to keep me on track with my goals. My chalkboard allows me to structure my days to maximize productivity."*

> *"[On my front door] I have my grocery list, bills list, and school stuff listed and all the things I need to take care of (payment plans). This organization system keeps me sane and motivates me as it helps me remember everything I have to do."*

Participants also noted the importance of recognizing time management and organization as a key to getting things done and staying in good academic standing. In addition, participants recognized their need for having a stable home environment to come home to; which included having a home to call their own as well as a place that is created to promote order.

> *"Things might be hectic for 18 weeks for the semester however if I just stay persistent and on track, it will pay off. You can do anything for a short period of time and not everything will always be so hectic."*

> *"In order for me to proceed with [Project X], I need to be in good academic standing. This includes doing homework, attending class, turning assignments on time, and plan ahead of time."*
>
> *"I am so particular about everything in my house and I want everything to be a certain way. This makes me feel good because I can control everything in my house. This motivation impacts my life because it is something that I look forward to every day."*

In summary, participants expressed their need to have a stable place to call home as well as an environment that was structured and conducive for homework completion and to have provided comfort and safety. Having organizational systems in place at home helped motivate participants to stay organized and focused on school.

Theme 4: Prior academic success promotes confidence and accomplishment.

The final theme was regarding the importance of prior successful experiences on academic success. Successful experiences, grades, and honors contributed to a heightened confidence level and a feeling of accomplishment among participants, which generated motivation to continue pursuing educational opportunities. Also, the goal of graduating at the end of the semester and the motivation of pursuing better opportunities for better paying jobs. This motivation pushed students to work harder toward being successful in progressively completing their classes.

> *"This is a photo of the award that I received at [Student Conference X] for being chosen as [College X] student of the year. This picture represents my peer's recognition of my hard work and dedication to my studies and this school. This motivates me to keep doing what I am doing."*
>
> *"I am really excited to be graduating this year. It pushes me harder to get my work done and I want to graduate with good grades, so it pushes me harder to do well in my classes. Graduating college will impact my life because it will allow me to get a better paying job."*
>
> *"This quiz score is a result of my reading the material, comprehending the material, and demonstrating my understanding of the material thru a great quiz score. This quiz grade motivates me to get out of bed each morning, strive to gain more knowledge, and continue with my dedication to my coursework."*
>
> *"This photo represents that I received high honors last semester. That is a big motivator for me as I want to do better than I did last semester and it drives me to try harder. I need to continue what I am doing right now; making it to class on time, doing my work, making time at home to study, and doing the best that I can. I am studying a little bit more and showing up a little bit earlier before class so that I can skim through the book."*

In summary, participants expressed their pride and motivation as a result of their academic successes; whether from receiving awards, good quiz grades, or high honors. These successes contributed to participants' drive and desire to work diligently to continue to persist and pursue further education.

Student Challenges

In addition to the themes related to participants' successes, analysis of the photographs and written narratives led the researcher to identify four themes related to challenges and barriers.

1. **Lacking time management and organizational skills.**
2. **Distractions, procrastination, and lack of motivation.**

3. **Challenges with stressful life circumstances due to limited financial resources.**
4. **The Institutional and instructional barriers.**

Theme 1: Lacking time management and organizational skills.

The first challenge-related theme was related to participants' inability to manage their time and organize their schedule to meet the demands of their many responsibilities. Participants noted the challenge with organizational skills needed to manage work schedules, attend school, complete homework, and keep up with family responsibilities.

> *"This picture I constructed for the challenge I have with time management. A lot of times I get overwhelmed with the number of things going on and the different directions I am being pulled. It is hard to stay balanced and get everything done and keep everyone happy sometimes."*
>
> *"This picture represents a calendar and how I need to find a way to balance out and organize my schedule. Between school, work, family, and extra hobbies it is really tough to do everything I need to so I can be successful."*
>
> *"The clock is a representation of a challenge, or time constraint, that comes with the deadlines students experience in education. School can be full of deadlines and time constraints which can make it difficult to be a good student."*

Several participants noted that when they added work to their schedule, they had a difficult time focusing on their school assignments, which then became a barrier, and had a perceived negative impact on their education.

> *"This is where I work. I think it is a challenge to work so much and not have the time to focus on my studies like I used to. But bills must be paid."*
>
> *"This picture represents the challenge that I had at the beginning and the middle of the semester was working at [Campus Job X]. I had plans and momentum at the start of the semester but once I started working it became a negative factor. I was putting off homework so that I could attend work."*
>
> *"Working for the [Campus Job X] has put a bump in the road for my educational experience. Working impacts my life because it is a commitment that limits my time devoted to schoolwork. This is a work study position that I agreed to work at however I couldn't have predicted how much of an impact it would have had on my school life."*

Beyond the participant's challenges with organization and time management, participants felt they were pulled in too many different directions and were often overwhelmed. They found it difficult in finding balance and creating a schedule that allowed for the completion of homework and managing other responsibilities while keeping everyone happy. Juggling work, family, and school was a challenge for many. The participants, as a result, noted the challenge they had in finding balance and getting everything completed.

Theme 2: Distractions, procrastination, and lack of motivation.

The second theme that emerged as a barrier to participants' educational experience was a general lack of motivation. In addition, participants listed the distractions that also prevented them from completing schoolwork.

"This is a picture of myself and it represents the person that is in the way of my success right now because I feel like I am lacking motivation and commitment to school. I procrastinate and do not put school first often."

"[My procrastination] makes me lazy and keeps me from doing my homework. I could do my homework, but I would rather sit on the couch and watch TV."

"I feel that I am not good enough for college. I procrastinate, am disorganized, and lack any structure in achieving my goals. As a result, I have a poor routine, unhealthy eating, and numerous other challenges."

Participants identified the casino as being a distraction, however, they also noted that being at the casino provided a sense of connection and a place to go and hang out with friends.

"The casino is where I feel whole. A lot of people that work at the casino are my friends and they talk to me and make jokes with me."

"This is a picture of the life of a partier or a person that once used to club way too much at one time. It represents the person that had their perspective way off. It shows the person that chose to go out or have an extra drink instead of studying."

"My schedule is too open; and sometimes it gets me in trouble because I have no responsibility and leads me to doing things that I shouldn't be doing late at night and then it starts all over again the next day."

In general, participants acknowledged several challenges and barriers to their education as a result of distractions that they faced, as well as feelings of procrastination and a lack of motivation to complete schoolwork. In addition, several participants noted not having anything to do or having a schedule was detrimental to them taking the time to complete their homework and/or study.

Theme 3: Challenges with stressful life circumstances due to limited financial resources.

The third theme was related to the impact of "life circumstances" had on participants and their families. Unfortunately, "life circumstances" led to the participants' inability to focus on school and required energy that otherwise would have been directed towards their studies. As an example of life circumstances that participants faced were related to things like homelessness, health challenges, transportation issues, as well as relationship troubles which created stress and time away from focusing on school.

"The homeless shelter has been a barrier due to how you are forced to live while you are there homeless. The shelter has a rule that you cannot bring in your own pillow or blankets you must use what they give you to use which does not include a pillow just a camping cot and some blankets."

Transportation and vehicle difficulties were problems as well because Wisconsin's winter weather was a significant barrier to the participants ability to focus on school and to be present for classes.

"This is a picture of my non-working car that sat in the parking lot for the week, which left me without transportation for the week for school. This represents the uncertainty of a working vehicle each time I get in I wonder if it will start."

"This picture represents one of my barriers that I have and impacts my ability to be successful at school. Having to take the transportation bus is an inconvenience. It is winter and on a cold winter night when it is -20 below and is no fun waiting to catch a bus that is never on time or always late."

Participants faced numerous challenges in their lives that prevented them from being able to fully focus on their school responsibilities and provided an added stress to an already challenging semester.

Theme 4: Institutional and instructional barriers.

The fourth and final theme that emerged as a barrier to participants' education was related to the institutional and instructional barriers that impacted students' educational experiences. Participants noted a lack of instructor engagement and teaching style as a challenge to understanding the content.

"Some of my instructors have become barriers to my education because I find their teaching style ineffective with myself. Due to the fact that I am unable to engage with my instructors teaching styles has created a massive barrier which has caused huge setbacks in my educational experience this semester."

"I feel that as the semester goes on Statistics is getting harder and harder. There is a lot of note-taking and I cannot seem to get ahead of myself in the chapters to be able to study like I want to. I am always a chapter behind because I am always trying to get caught up. It is not just the note-taking as the class goes on and the content gets a lot more difficult, I am struggling with it more. The instructor is intimidating, and I feel like he tries to explain but for me to understand it I need to hear it several different ways."

Finally, participants mentioned that the limited healthy food options on campus created a challenge by constraining food choices. As a result, participants would either have to eat from campus vending machines or leave campus to obtain healthier options.

"Eating from the vending machine is the only option here at [College X]. For a college student, the quality of food available is not always to the highest of standards. It has not helped my health and my weight. I am working on changing my eating habits and it is difficult for me. I use food to calm my stress."

"This picture represents that the food options are slim to none at [College X]. This challenge was something that stood out to me because I was working in the library before class and when I felt hungry, I had to pack up my things and leave campus for about a half an hour and rush to make it back to class."

Institutional and instructional barriers had a significant impact on participants education experiences. Instructor teaching styles or lack of engagement impacted students' motivation and for some, created setbacks in their educational experience. Limited institutional course and program offerings, as well as perceptions of limited access to advising and limited food options, also impacted participants' educational experiences.

Conclusion

Summary

The findings of this study are informative in identifying themes related to American Indian (AI) students perceived educational successes and barriers. Furthermore, these findings are significant for

individuals and leaders in higher education who work with American Indian students. Indigenous perspectives on learning consider the students, their teachers, mentors, peers, and community members all an integral part of their educational community. The results gathered from this study are important as they may inform educational leaders and postsecondary institutions serving AI students on how to be supportive and to suggest strategies for implementation in academia. Additionally, the results of this study also provided insights and preliminary evidence that AI students seeking postsecondary opportunities deal with limited financial and material resources that prohibit student's full focus on pursuing their education.

Social support is a powerful non-cognitive factor influencing non-persistence decisions in AI students. A central dimension of social support is family support (Jackson, Smith, and Hill 2003), staff/faculty mentorship and peer mentoring (Guillory 2009). Faculty and staff members need to be encouraged to connect informally and formally with AI students in and out of the classroom which provides increased student confidence and a meaningful personal connection to the college (Jackson, Smith, and Hill 2003). By providing opportunities for AI students to participate in support/social groups and peer mentoring would allow for students to increase their sense of community as well to decrease the students sense of isolation as they matriculate into college life (Gallop and Bastien 2016). Lastly, enlisting family support and encouragement would be positively related to AI student's commitment to furthering their academic achievement (Jackson, Smith, and Hill 2003).

Practical Significance

Pursuing postsecondary education is a learning experience that entails navigating facets of interconnected and complex informational capital. This process requires navigational and informational skills, course advising, career counseling, and psychosocial skills. While these components are inextricably intertwined and critical to student success, the purpose of this research was to examine what the impact of having a mentoring relationship would be on the academic guidance skills and individual informational capital. More specifically, as a result of participating in a semester-long mentoring program, AI students saw a change in student self-efficacy, more specifically in the relation of providing much-needed skills in academic and coping efficacy.

Limitations

This study had a few limitations which should be noted. First, the sample size was small and included a group of nineteen students from one small college which primarily serves AI students. The small single sample size limits the generalizability of the study. Second, the length of the study was limited to one semester and lacked a longitudinal perspective. Lastly, the study was qualitative and could unintentionally bring in the bias of the researchers. That being said the researchers had no prior relationship with the participants and were not instructors during the research period.

Future research should consider how postsecondary institutions deliver mentoring programs, how they can present a challenge and how to evaluate traditional models of mentoring and suitability with

students of color. In addition, future research should examine the impact of critical reflection on mentoring, academic guidance, and social-emotional skills particularly for students of color.

Acknowledgements

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Genesis of Academic Credit for Modern Commercial Nuclear Training

Dr. Richard P. Coe

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Abstract

Training in the commercial nuclear field has come a long way in the last 40 years. The partial melt down of the Three Mile Island facility prompted the need and the development of a more formalized, structured curriculum based approach to this training. This article presents the components of this training and the process used to develop and implement today's commercial nuclear training programs.

Keywords: commercial nuclear training, nuclear occupational tracks

Throughout the 1960-70's commercial nuclear training was pretty much memorization of basic nuclear theory, volumes of technical plant operational manuals, walkabout plant tour lectures, Q&A and basic recall written exams. This all came to a halt early morning in March 1979 when the US nuclear industry suffered its first catastrophic accident, the partial melt down of the Three Mile Island Unit 2 core. Many post-accident investigations cited the lack of depth and rigor in operator training (Kemeny Commission)

The industry rallied with a massive dedication of resources; upgrade technology, installation of new plant safety systems and most notable the massive overhaul and upgrade operator/support personnel training, instructor training and training facilities. The industry also formed the Institute of Nuclear Power Operations (INPO), which issued its National Standards for Operations Excellence and Safety. INPO also launched the National Academy for Nuclear Training (NANT) who issued national training standards of excellence and required all commercial nuclear generating plants to accredit all site operations/support training programs to the national standards. Accreditation had to be renewed every 4 years. (1)

The late 1990s also brought the increased avocation for senior nuclear plant personnel to hold a technical associate and/or baccalaureate degree. (2)

Dr. JoAnn D. Rolle, then Dean of the School of Business and Technology at Excelsior College, received a proposal from her Industrial Advisory Committee IAC; to review and assess ten INPO accredited programs for academic credit;

- Senior Reactor Operator SRO
- Reactor Operator LO
- Shift Technical Advisor STA
- Non-Licensed Operator NLO

- Engineering personnel EP
- Radiological Technician RT
- Chemistry Technician CT
- Electrician E
- Instrument and Control Technician ICT
- Maintenance Mechanic MM

An assessment team of technical and academic Subject Matter Experts (SME) were assembled and funded to visit five commercial nuclear generating stations. Dr. Jane LeClair, with academic, accreditation and nuclear plant experience, joined the team.

The team developed a matrix the university nuclear engineering, radiation protection and technical support programs learning outcomes LO's and a matrix for the INPO guidelines for accreditation of the ten programs. A comprehensive review/evaluation of the ten training/qualification programs in the classroom, the plant, equipment/labs and the replica simulator was conducted. Lesson plans, operational and emergency procedures were also reviewed. This review included interviews with many of the nuclear plant instructors and qualified students.

After an extensive amount of plant training data collection, a mapping was made between the plant program matrix and the university nuclear engineering, radiation protection and support training programs learning outcomes LO's with recommended credit in each of the Science Technology Engineering and Math (STEM) areas. A select number of the nuclear faculty were asked to review and validate the recommendations. The validated report was submitted to Dean Rolle who sent it to the entire technology faculty for formal approval.

The Education and Training Division of the American Nuclear Society (ANS) awarded Dr. Rolle the prestigious Training Excellence Award for this visionary and pioneering contribution to nuclear training and education.

To date many colleges/universities have adopted this credit assessment model. Numerous programs accepting assessed nuclear credit have become ABET accredited. Countless thousands of students have achieved Associate/Baccalaureate degrees using this academic review process.

The below listed chart summarizes amount of credit and the academic level (U – upper level, L – lower level) an individual can be awarded when successfully qualifying for any of the positions.

•• Dr. Rolle is currently Dean of Business - Medgar Evans College, City University of New York

(1) [Nuclear Utility Training through INPO's National Academy for Nuclear Training](#)

- Chemistry Technician
- Electrical Technician
- Engineering Support Personnel
- Instrumentation and Control Technician
- Maintenance Mechanic Technician
- Non-Licensed Operator Training and Qualification Program
- Radiological Protection Technician
- Reactor Operator Training and Qualification Program
- Senior Reactor Operator Training and Qualification Program
- Shift Technical Advisor

(2) Since 1990, when the American Council on Education (ACE) evaluated the US Navy Nuclear Power School, TESU et al have been awarding credits to students applying for degree study in Nuclear Engineering Technology.

NUCLEAR UTILITY OCCUPATIONAL TRACKS

COURSES	STA	SRO*	LO	NLO	EP	RT	CT	E	ICT	MM
Electrical Theory	3L	3L	3L	2L	2L	2L	2L	2L	2L	2L
Reactor Heat Transfer, Thermodynamics, and Fluid Mechanics I (EGM-331)	3L	3L	3L	3L	3L	1L	3L	1L	2L	2L
Reactor Heat Transfer, Thermodynamics, and Fluid Mechanics II (EGM-321)	3L	3L	3L							
Nuclear Materials	3U	3U	3U		2U		2L	2L	2L	2L
Radiologica1/Biological Effects	3U	3U	3U			3U				
Radiation Detection and Protection				2L		6U	3U			
Reactor Fundamentals	3U	3U	3U	2U	3L	1L	1L	1L	1L	
Plant Systems (NUC-308)	3u	5U	3u	4U	2U	2U	3U	2U	2U	2U
Intro to Nuclear Plant Operations	2L	2L	2L	2L	2L	2L	2L	2L	2	2L
Radiation Worker Lab	1L	1L	1L	1L	1L	1L	1L	1L	1L	1L
Radiation Safety	1L	1L	1L	1L	1L	1L	1L	1L	1L	1L
College Algebra I	3L	3L	3L	3L		3L	3L	3L	3L	3L
Trigonometry	3L	3L	3L			3L	3L			
Physics I	3L	3L	3L	3L	2L	2L	2L	2L	2L	2L
Physics II	2L	2L	2L	2L	2L	2L	2L		2L	
Nuclear Plant Chemistry	3L	3L	3L	2L	2L	3L	4L	1L	1L	1L
Atomic and Nuclear Physics	3L	3L	31	2L	21	2L	2L	1L	1L	1L
Reactor Operations (NUC-423)	3U	3U	3U	2L						
Instrumentation and Control	3L	31	3L		1L			2L	3L	
Practicum (satisfies one Lab)				4U		6U	6U	6U	6U	6U
Reactor Simulator (Lab)	3U	3U	3U							
Mechanical Engineering					3L					
Human Performance/Error Reduction, Group Dynamics	1L	3U	3U	1L	1L	1L	1L	1L	1L	1L
Supervisory Skills		4L								
Subtotals	**54**	**60**	**56**	**36**	**29**	**41**	**41**	**28**	**32**	**26**

NATIONAL ACADEMY FOR NUCLEAR TRAINING NUCLEAR UTILITY OCCUPATIONAL TRACKS

STA   Shift Technical Advisor

SRO   Senior Reactor Operator

LO   Licensed Operator

NLO   Non-Licensed Operator

EP   Engineering Personnel

RT   Radiological Technician

CT   Chemistry   Technician **E**   Electrician

JCT   Instrumentation and Control Technician

MM   Maintenance Mechanic

About the Author

Richard P. Coe, Ph.D.

Dr. Coe has been Assistant Dean, School of Applied Science and Technology, Thomas Edison State University since 2012. A career educator, he has taught at the Richard Stockton University, Excelsior College, South Carolina State University, Fairfield University and the International Atomic Energy Agency in Spain, Japan, Austria and Korea. He continues to serve as a distinguished visiting professor and docent at the Obninsk State University for Nuclear Power Engineering in the Russian Federation. For 20 years Dr. Coe was in the nuclear energy industry as the Director of Training and Education at GPU Nuclear, now 1st Energy, and Director of Training and Education at the US Department of Energy Nuclear Weapons Facility in Hanford, Washington.