Critical Thinking;Is that going to be on the test

Dr. E. Shirl Donaldson, Purdue University, West Lafayette

E. Shirl Donaldson received a doctorate of philosophy in Industrial Technology from Purdue University December of 2012 and is currently a clinical assistant professor teaching mechanical engineering technology and electrical engineering technology courses. A strong advocate of inclusionary practices in education and business, she encourages students to work to their strengths while constantly expanding their skill sets and prospective of life. She has mentored several graduate and undergraduate students in areas of progression and transition from undergraduate to graduate studies, research, and study abroad. Her research agenda and commitment to intellectual growth is driven by her life experience. While completing her Master's degree and for several years after, she worked in a family owned manufacturing firm. As a doctoral student, Shirl was recognized as an AGEP scholar and received the Bilsland Fellowship. Outstandingly, she collaborated in the creation of an innovation course and taught the initial offering. Until August 2014, she was a post-doctoral fellow researching entrepreneurship, innovation, and diversity. Today Dr. Donaldson's research interests include entrepreneurship, innovation, manufacturing, technology management, and diversity in STEM (science, technology, engineering, and mathematics) fields of study. She examines how academic and industrial environments enable effective learning, discovery, and realization of new and transferred knowledge

Dr. Anne M Lucietto, Purdue University, School of Engineering Technology

Dr. Lucietto has focused her research in engineering education and the understanding of engineering technology students. She teaches in an active learning style which engages and develops practical skills in the students. She is currently exploring the performance of engineering technology students and better ways to teach in an authentic manner. Her focus is on students studying thermodynamics and fluid mechanics.

Critical Thinking

Is that going to be on the test?

The current generation of college students is a result of the “No Child Left Behind Act”. Educators at the university level are seeing the unintended result of high stakes testing in student attitudes towards learning and study. The K– 12 educational system in the US focuses on mastering tests and accruing points in a course, most often “teaching to the test.” These tests are standardized and critical to promotion and later acceptance into college. It is this activity that provides a basis for student perception of how learning and assessment take place.

When these students are challenged with higher order learning or problems that may have more than one correct solution, they become uncomfortable and often retreat. The concept of not being given direct instructions at every level of an activity or an all-encompassing rubric is perceived as being “unfair”. University educators are challenged to support “test-trained” students in a setting that moves the learning activities up to the higher levels of Bloom’s Taxonomy. The educators are further challenged to encourage critical thinking and problem solving in the classroom to as most employers expect these students to graduate with these skills.

A professor at a large Midwest land grant institution gave a senior level quality course an activity that challenged the students to define critical thinking and demonstrate it. The results and potential implications are discussed in this article. Eighty- two percent of the students were scheduled to graduate at the end of the semester. Fifty- seven percent did not adequately define critical thinking or demonstrate it. Twenty percent of the students had received offers of employment two months before graduation. The lack of job offers could be reflective of a competitive job market or a lack of readiness of the students for the workforce. We will develop recommendations and further research goals in an attempt to recommend ways to master critical thinking and develop problem solving skills throughout the curriculum in an engineering technology program.

Introduction

This research emerged from a professor’s classroom experience in a senior level quality systems course. Twenty-six of the 32 students in the class were scheduled to graduate at the end of the semester. The remaining six students were scheduled to graduate the following semester. All of the students were completing their last required courses and job hunting concurrently.

During a class discussion of the upcoming first exam several students requested more specific information in reference to questions on the exams. The instructor was using the third edition of the textbook. Half of the students had the third edition of the textbook like the instructor. The other half of the students had the fourth edition, a newer version, of the textbook. A student asked the professor to match the chapters of the older version of the textbook to the chapters of th

newer version of the textbook. The professor was surprised at this request. After three years of college, it should be a manageable task for an accomplished student to match chapter titles and subject matter between two consecutive versions of the same textbook. Additionally if the student had an issue with the textbook or assigned material, questions should have arisen earlier in the semester, not the day before the exam.

After discussing the differences in the versions of the textbooks, a student made a request of the instructor to move the study guide to a different folder on Blackboard, the electronic educational materials management system, for greater convenience. The course material was arranged by weekly modules in order of presentation and learning objectives. The logic behind the organization of the material was explained to the class. Next, the students asked more questions about material to be covered on test. The questions were not for clarification of concepts, theories or subject matter. The questions focused on format of the questions and what the minimal requirements were to pass the exam.

The department in which this course is taught has increased its' focus on active learning and is moving away from traditional lectures as the primary method of conveying information to students. The departments' goal is to encourage creativity and develop problem solving skills. However, students are seeking the most efficient ways to garner top grades on exams. Where does this leave the development of critical thinking with respect to the classroom when students are more focused on grades than subject matter mastery?

Literature Review

The development of critical thinking skills is the "primary goal of higher education" [1]. Surveys of faculty have demonstrated that more than 90% of faculty supports this assertion. [2,3] Based upon Douglas'[1] findings, there appears to be very little research in the study of critical thinking in engineering. He attempts to further our understanding in this area by developing two pilot studies intended to compare critical thinking skills in graduate and undergraduate students in engineering. Using a standard critical thinking instrument, Douglas found that undergraduate students outperformed graduate students. He attributes it to test taking skills, others may attribute it to a disconnect between industry and academia.

Engineering employers require employees to think critically and use skills developed while in the academic setting. [4] The premise of Ahern, et. al's. [4] work is that there is a disconnect defining critical thinking between those in industry and those in academia. The research was limited to academics and the findings demonstrated that across disciplines there was a similarity in the definition of critical thinking, however there were broad differences between the levels of formulation of the definition. [4] Development of critical thinking in engineering is relatively new, engineering educators have developed definitions and initial research on techniques to enhance critical thinking skills so that engineering and engineering technology graduates are well prepared for the work place.

Further examination of critical thinking in engineering and engineering technology is now more available, but not necessarily focused on students in engineering technology. Claris and Riley [5] assert that critical thinking in engineering should involve more than critical thinking in other disciplines. This would include the use of open ended problems, presentation of multiple perspectives in a variety of situations, and incorporating how humanities and/or the social impacts of technology. ABET [6] clarifies the definition of engineering vs. engineering technology as "Engineering programs often focus on theory and conceptual design, while engineering technology programs usually focus on application and implementation" (http://www.abet.org/engineering-vs-engineering-technology/). In the case of these researchers the engineering technology program incorporates [7]activities and materials that promote a very active learning environment. This setting provides many opportunities to incorporate a more immersive student experience.

The intent of this work is to begin the development of research on the improvement of critical thinking and problem solving skills. Research focused in this area will provide faculty with tools intended to aide students in the mastery of critical thinking skills, while developing problem solving tools throughout the curriculum.

Methodology

The survey method, applied as an in class activity, was used in this study. Thirty-two students in a senior level course were given a "quiz". The number of participants in this study was too small for statistical analysis. As a pilot study it is large enough to detect trends and justify future larger investigations.

Two of the quiz questions were "Define critical thinking" and "Why is critical thinking important in quality assurance?"

Students were also questioned about permanent employment offers given that graduation was less than 3 months away for 85 % of them. Previously in class, during other activities, the student's often stated that they were ready to graduate and go to work.

After gathering responses about understanding of critical thinking and status of permanent employment a comparison was made.

The research questions:

1. Are the students that can define and understand "critical thinking" more likely to be employed or employed sooner?
2. Is this lack understanding only evident in the classroom, not in interviews? Many applicants are chosen for interviews based on the stated GPA on their entry level seeking resumes. The lack of critical thinking skills will eventually become evident in an industrial environment or a professional setting.

The students in this course typically seek positions as manufacturing engineers, quality managers, quality engineers, design engineers, purchasing agents, process improvement specialist, and other degree requiring, related roles. They also expect to earn professional level salaries to start paying off education debt.

This method and question are justified by trends observed over the last several years. A recent survey of employers [8], found that is generation of college graduates are not as prepared as the workforce needs them to be in a globally competitive environment. An online survey was completed by 400 employers and 613 college juniors and seniors. Employers reported that students need more skills not just information before they enter the workforce. In contrast the students stated that they were ready. The best example of the divide was in the area of "Critical or Analytical thinking". Both groups were asked to rate the new employees skill level on a Likert scale ranging from 1 to 10. The student average self-ranking was computed at approximately 6.2. In contrast the employers ranking of the students averages closer to 2.2.

Results

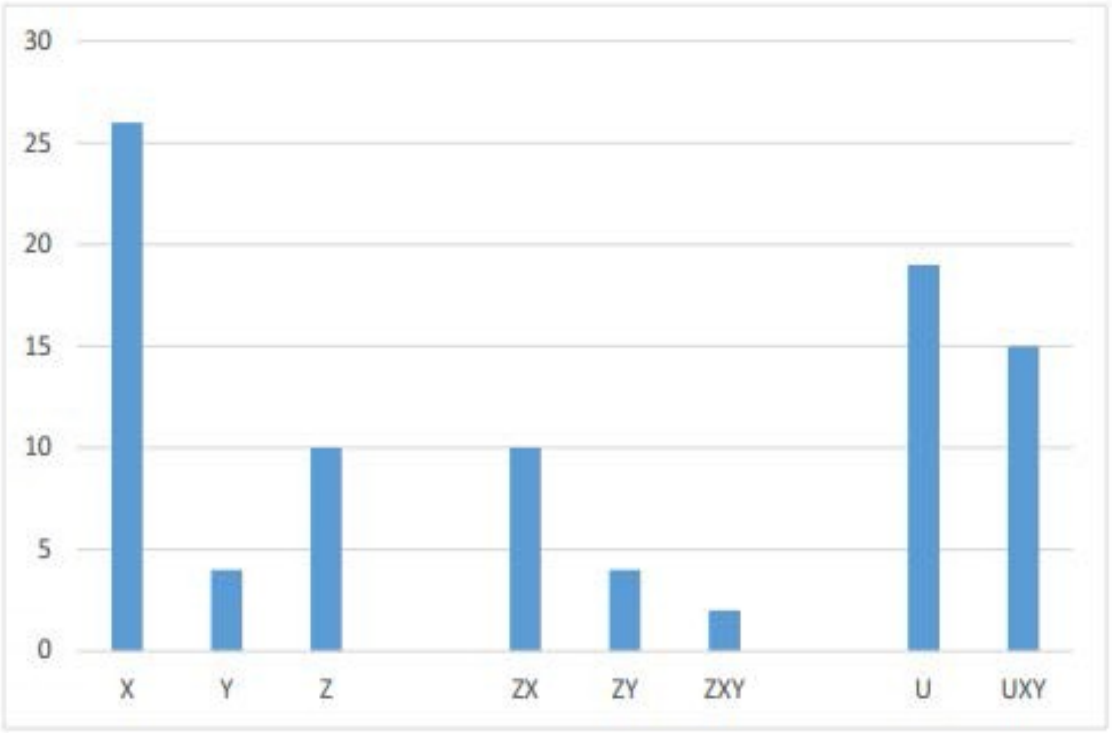
Students gave various definitions of "critical thinking". Although several were obviously unsure of the exact definition many of them knew why it was important. Table 1 displays the results of the two questions on the quiz, further demographic and job data is also presented.

Table 1. Student Responses for Critical Thinking Questions and Job Status

	Quantity	Total
Description	Correct	Quizzed
Reported Correct Definition	26	29
Explained Why It was Necessary in Quality Setting	4	29
Had Permanent Job offers	10	29
Reported Correct Definition and Had Job Offer	10	29
Explained Adequately and Had Job Offer	4	29
Answered Both Parts of the Question Correctly and Had Job Offer	2	29
Did Not Have Job Offers	19	29
Did not have Permanent Job Offers and Got Question Wrong	15	29
Total Students (No Data For Three Students)		29

For ease of comparison, Figure 1 is provided to clearly display the contrast of results in this "quiz."

Figure 1. Results of Critical Thinking "Quiz"



Review of this data and carefully considering the questions posed to the students a few considerations become evident.

Discussion

As asserted by Claris and Riley [5] the development of critical thinking skills is one that is fragmented and is a result of achieving ABET learning outcomes. It is then appropriate to question if engineering technology is challenging the students to think critically or are the students aware of the fact that they are learning critical thinking skills throughout their curriculum. We also need to question who develops the material that is used to meet ABET learning outcomes and are they successful in imparting critical thinking skills as they do this, we may also want to ask if those preparing the course materials consider this as a function of the material they prepare.

This leads us to analyze the material that was gathered in this classroom of senior level students. One possibility is that the students understand critical thinking, but chose not to apply it in the academic setting? Downey [9] poses the concept that while engineers are known for their logic and skills of analyzing situations very analytically, have they the skills to think critically? This suggests that incorporating the practice of critical thinking skills into coursework throughout the curriculum may have the consequence of students skilled in the practice of critical thinking.

Claris and Riley [5] suggest that over the last ten to fifteen years the discussion has included the term "critical thinking skills." Quite likely students have become familiar with the definition, but due to the pedagogies used may not be competent enough to explain the application of critical thinking skills. Considering various taxonomies and concepts researched over the last fifty years or so list numerous aspects of critical thinking. In particular Elder & Paul [10] and Ennis [11] who

describe critical thinking skills as having two parts, one is cognitive skills and the other affective disposition. The latter being the application of the cognitive skills in situations and problem solving. All of which is often either ignored or not known by educators that are teaching in familiar ways.[12,13]

Employers have provided information through survey's administered by Hart Research Associates.[8] They state that employers are concerned about a variety of shortcomings of today's graduates, one of which is critical thinking skills and the ability to apply those skills to situations in the work place. This may not be evident during job interviews, because students believe they are prepared for the work place and exude greater confidence due to those beliefs. Employers are then disappointed by the lack of performance in the areas that students are confident.

Conclusion

This research has provided the researchers with more insight than anticipated. The data derived from the classroom "quiz" indicated that students had heard of critical thinking, but were not clear about its use. This may be attributed to the use of the term in many settings where the students may of heard it and thought they understood what it meant. Clearly as these students, who were confident of their preparation for the workplace may not perform as anticipated by the employers as cited by Hart Research Associates. [8]

It becomes apparent as this topic has been researched, survey results reviewed, and the results of the "quiz" given in class that students need a greater exposure to critical thinking exercises in a large variety of situations and over their entire academic experience.

Future Research

To support the widespread, intentional inclusion of critical thinking exercises though the engineering technology programs more research at varying times in the student's program is required. Assessments intended to quantify program success in imparting critical thinking skills would be necessary to determine the success of the exercises used by engineering technology students.

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