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Systematic Review of Engineering Technology Education Literature

Few engineering technology education research publications exist; those that do are often viewed through the lens of the engineering education researcher. More specifically, engineering technology education is examined in the same manner as engineering education. The lack of rigorous research focusing on the education of engineering technology students may be the result of diverse engineering technology programs, and smaller research populations as compared to engineering and other STEM fields. Educators in engineering technology programs are challenged by this lack of discipline-specific rigorous research.

The lack of engineering technology education research may be attributed to smaller numbers of engineering technology students vs. the larger numbers found in engineering. Regularly researchers include engineering technology students by broadly applying research findings from engineering and at times other STEM disciplines. A cursory review of existing engineering technology education research revealed that existing material is fragmented, most often focusing on course work and discipline-specific methodologies. Reviewing work in this area will provide engineering technology education researchers a source of existing research. This work will offer engineering technology academe a better understanding of authentic engineering technology education research, supporting work in and out of the engineering technology classroom.

Following the example set by researchers performing systematic reviews in other fields, the authors intend to perform a high-level systemic review of engineering technology education research literature. Ultimately this work will provide a better understanding of engineering technology education research, providing a clear access to deep conceptual knowledge, understanding of research methodologies used in previous engineering technology education research, concise review to support epistemology of engineering technology, informing of engineering technology practice, and supporting new directions in engineering technology education research. The presentation of this work at the conference using a higher level of initial review is intended to encourage discussion of known literature, and to further the engineering technology education community's understanding of the more obscure or little-known research in this area. Future work, including input gathered at the conference, is expected to contribute to an in-depth systematic review of engineering technology research literature, which is expected to encourage the expansion of rigorous engineering technology research.

Introduction

Systemic reviews have been done in the medical field[1] for decades, in conjunction with other fields, such as education[2], psychology[3], and more recently, engineering education[4]. Such a review is, in general, an attempt to summarize and appraise existing literature to aide researchers in their quest to stay current amongst a large number of existing and recently-published articles.[5] While reviewing engineering technology education research, we found that the material is fragmented. To work in this area of research such a review is necessary to inform researchers of current practice and findings. It should be noted that Christie[6] developed a systemic review in engineering technology education research, specifically in persistence and institutional interventions. Our work in engineering technology education research will move beyond the very specific and provide a high-level understanding of what literature exists. Taking it to the

conference setting is intended to encourage further discussion prior to applying for funding to commence on a full-scale systemic review of this literature.

Literature Review and Approach

Systemic reviews take many forms. This one is an abbreviated study of literature in engineering technology education, reviewing select articles using methodologies that adapt well to our field. Cook and West[1]use a seven-step approach to reviewing medical education literature, while others define a homogenized framework for review.[6]

We have defined an area of study, which is engineering technology education. It is our intent to eventually answer the following question:

> *What published engineering technology education research exists, focusing on the epistemology of engineering technology and intent on informing engineering technology practice?*

As a broad and involved question, a systematic review is appropriate for this investigation. Other disciplines have experienced large increases in systematic reviews, as well as publications. The medical field finds it helpful to perform systematic reviews of particular conditions and associated practices.[4] As noted previously, the number of systematic reviews has increased, thus supporting our work to develop a systematic review of literature in engineering technology education. As noted by Cook and West[1], the next step is to assemble a team of researchers and develop the study. We have assembled a small team to do the initial review and intend to expand in order to proceed further based upon the results and conversation at the conference.

Cursory review of the available literature provided us with a couple of articles to review as part of the case study. The first is an article published in 2000 that focuses primarily on the introduction of use of literacy skills in the classroom.[7] This article is like others that were found, and is very much considered part of the "Scholarship of Teaching and Learning."[8] Involvement in this form of scholarship usually begins with faculty interest in student learning in the classroom.[9] As "engineering technology education" was researched, it became evident that much of the work in this area is focused on the Scholarship of Teaching and Learning rather than moving into rigorous engineering technology education research. The second article has an entirely different focus as it surveys second-year students in a required class using the Myers-Briggs Type Indicator[10,11] to further delve into potential differences of engineering technology students from those in engineering, showing a significant difference in these populations.[12] These two articles represent some of the research done in engineering technology education research, providing an example of work found in this area. While searching current literature, the high-level review provides material for an initial conversation with like-minded researchers.

Discipline based education research[13] (DBER) is a relatively new area of research where fields that are assumed to be affiliated are evaluated. The disciplines found in this research generally follow unique paths, but are similarly related to parent disciplines via their characteristics.[13] Per other discussions regarding engineering technology education, there appears to be confusion, with terminology often using engineering and engineering technology interchangeably, while

very distinct populations represent both. Discussion found in DBER literature clearly cites shortcomings of amalgamating such populations, using findings from a single course or very small population[13], thus validating our systemic review of rigorous engineering technology education research.

Method

While there are many methods used to perform systemic reviews of literature, we chose to evaluate at a high level and gain a better insight into engineering technology literature. Ultimately, this will provide us with an understanding of the scope of work required to complete a full systemic review on work in this area.

The initial search generalized on the topic search of "engineering technology education research." Emphasis during this search was placed on engineering technology in the Journal of Engineering Technology, as well as larger repositories like ProQuest, ERIC, EBSCO, and others.

In order to sort the literature into specific categories, it is helpful to understand the content of an article published in 2007 by Streveler, Borrego, and Smith[14] which asserted that engineering was ready to move into the realm of engineering education research. This was based upon the beginning of more rigorous studies in engineering education, where engineering faculty were engaging in research regarding how students learn engineering, studying education research methods, able to fully understand education research, and what it entails. What the authors did find in "engineering technology education research" was that articles focused heavily on Scholarship of Teaching and Learning and many do not approach more rigorous study including knowledge and the acquisition of that knowledge[15].

Research reviewing existing engineering technology education research continued, focusing on a large number of search terms used engineering technology. This was an attempt to garner more articles that focused on engineering technology students, how they learn, what they study, demographics, etc. At this point, the authors have found that engineering technology education has not moved into the same realm as engineering education. Based upon the lack of findings it is imperative that a discussion take place at the conference and further inquiry lead to a well-rounded discovery of literature that may involve studies that are more rigorous.

Results

In order to showcase the literature found representative of the established criteria and that will begin answering the research question, case studies have been prepared that outline the research findings. The chosen articles represent many of the findings from this high-level search and are intended to stimulate initial conversation regarding literature in this area. Two articles representing many of the engineering technology research articles were reviewed for the following content: study design, participants, and outcomes.

Two articles representing many of the engineering technology research articles were reviewed for the following content: study design, participants, and outcomes. The first article is representative of papers firmly placed in Scholarship of Teaching and Learning.

Case 1[7]

The purpose of this paper was to study the integration of technical communication skills into the curriculum without removing anything from the current curriculum.

The study was designed to include a pre-test, post-test, and review of student comments regarding the assignment designed to develop literacy skills in freshman engineering technology students. Students were given a pre-test that was designed to assess their knowledge of available research materials in the library. The assignment required students to choose a relevant topic from the lab materials in the freshman Materials Course, they then researched as a team materials to support an oral presentation to the class. The second phase of this assignment terminated in the sophomore Strength of Materials Course. A post-test was given with the intent to determine student skill improvement and their thoughts regarding the assignment. There were fifty-five freshman and sophomore engineering technology students in this study.

This study included a few outcomes and conclusions that would be helpful to engineering technology education practitioners, they include:

- At the start of the research only 10% of the engineering technology students knew how to find technical information in the library.
- Reflective comments and post-test results indicated that the assignment exposed all of the students to literacy skills, with most exhibiting skill improvement.
- Students practicing the newfound skills earlier in the project were more successful in demonstration of those skills than students that waited.
- Unstructured topics were difficult for these students to deal with; some were concerned about the quality of their chosen topic.
- Students believed that the assignment helped them gain library research skills.

The second article focused on the personality traits of engineering technology and engineering students.

Case Study 2[12]

This study investigates the similarities or differences of personality traits in engineering technology and engineering students.

The author used Myer's Briggs Type Indicator, which classifies those using the instrument according to psychological type. The instrument uses dichotomous scales where measurements indicated if students were more prone to extraversion or introversion (EI), sensing or intuition [16], thinking or feeling (TF), and judgment or perception (JP).[12] The results of this study was a comparison of data taken in 1983 and then compared to data that appeared in conference proceeding in 1985.[17] The study population included one hundred and ninety engineering technology students consisting of sophomores in a required machine elements course and junior/senior elective machine elements course.

The findings in this research show that:

- For both EI and SN, engineering technology students have a higher percentage when compared to other engineering students. This provides evidence that engineering technology students are more introverted than their peers in engineering, and indicates that they prefer practical application in classroom activities and experiences.

- When compared to engineering students, the population of engineering technology students exhibiting TF and JP tendencies is much smaller. Evidence supports that engineering technology students are less judgmental and able to make decisions objectively when solving problems compared to their peers in engineering.

The comparison of data taken from sophomore and junior ranked students in both required and elective courses supports the conclusion that there is a significant difference between engineering technology students and engineering students, most significantly in the way these students learn and in their decision-making processes.

Conclusion

While these two papers are not the extent of engineering technology education literature, they represent some of the work done in this area. Case Study 1 illustrates the Scholarship of Learning and Teaching concept, representing most of the literature found thus far in engineering technology research. While Case Study 2 extracts information in the mid-1980's from both engineering technology and engineering students and provides evidence that these two groups of students are different.

The information in the case studies provides evidence that engineering technology and engineering students are different and that there has been issues with literary and communication skills for some time. The authors have found that much of the work in this area appears to be somewhat obscured by material that includes engineering technology students in the greater engineering student population, or excludes engineering technology students from studies altogether. Christie and Feldhaus[6] conclude their systemic review with an assertion that the engineering technology community does not have the high quality discipline based research to make the "T" in STEM significant. Therefore, care when reviewing material in technology or engineering technology is imperative, as we have found the delineation of topics in this area are not always clear. Thus, further discussion of what engineering technology education is, will be helpful in delineating and finding all of the current literature in this area, ultimately working toward research that will address the challenges engineering technology students encounters.

Continuation of This Work

Systemic review of any work requires the synthesis of existing research in a particular area or study. The methodology for doing a synthesis evolves with both the researchers' findings and the publishing venue used for the topic being studied. The purpose of this work was to complete a high-level review using methodologies supported by work done in a variety of fields.[1,4,18] The

intent of this product is to initiate conversation at the conference and then embark on a full-scale systemic review of engineering technology education research literature.

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