6-2020

Public Perception of Engineering Technology: A Literature Review

Anne M. Lucietto
Purdue University, lucietto@purdue.edu

Shelly Tan
Purdue University

Liza Ann Russell

Mary E. Johnson
Purdue Polytechnic Institute

Lucietto, Anne M.; Tan, Shelly; Russell, Liza Ann; and Johnson, Mary E., "Public Perception of Engineering Technology: A Literature Review" (2020). *School of Engineering Education Faculty Publications.* Paper 61.
http://dx.doi.org/10.18260/1-2--35109

Public Perception of Engineering Technology: A Literature Review

Dr. Anne M Lucietto, Purdue University - Purdue Polytechnic Institute

Dr. Lucietto has focused her research in engineering technology education and the understanding of engineering technology students. She teaches in an active learning style which engages and develops practical skills in the students. Currently she is exploring the performance and attributes of engineering technology students and using that knowledge to engage them in their studies.

Ms. Shelly Tan, Purdue University

Shelly Tan is an undergraduate researcher working with Dr. Lucietto. She is currently pursuing a Bachelors of Science in Health and Disease at Purdue University, and began working with Dr. Lucietto in the summer of 2019 as part of the Summer Stay Scholars program. In addition to her biology coursework, Shelly is pursuing minors in Studio Arts and Chemistry. Outside the classroom, she enjoys writing creative fiction, making art both physical and digital, and moderating for her favorite online communities.

Liza Ann Russell,

Liza Russell is an Undergraduate Researcher working under Dr. Lucietto. She is a student at Purdue University, pursuing a Bachelors of Science in Mechanical Engineering. She began working under Dr. Lucietto in the summer of 2017 as a part of Purdue's Summer Stay Scholars program and has thus far continued her work. In addition to her Mechanical Engineering coursework, Liza is pursuing minors in Physics and Anthropology. Outside of class, she serves as Treasurer of Convocations Volunteer Network (CVN) and is a Tau Beta Pi member.

Prof. Mary E. Johnson, Purdue Polytechnic Institute

Mary E. Johnson earned her BS, MS and PhD in Industrial Engineering from The University of Texas at Arlington. After 5 years in aerospace manufacturing, Dr. Johnson joined the Automation & Robotics Research Institute in Fort Worth and was program manager for applied research programs. Fourteen years later, she was an Industrial Engineering assistant professor at Texas A&M - Commerce before joining the Aviation Technology department at Purdue University in West Lafayette, Indiana in 2007 as an Associate Professor. She is a Co-PI on the FAA Center of Excellence for general aviation research known as PEGASAS. Her research interests are aviation sustainability, data driven process improvement, and engine emissions. She is a full professor and associate head for graduate studies in the School of Aviation and Transportation Technology (SATT) at Purdue.

Public Perception of Engineering Technology: A Literature Review

Abstract

Engineering technology describes a field closely related to engineering in which practical application of learned concepts is emphasized over theoretical knowledge. Although an increasing amount of emphasis is being placed on the importance of this experiential learning in all engineering curricula, and the specifics of engineering technology's place among engineering and technical fields is becoming clearer, there are still significant gaps in our understanding of several key aspects of this field. One of these aspects is its perception by the general public, which is important in, among other things, determining the employability of engineering technology program graduates and encouraging the development of engineering technology curricula. Currently, existing literature on the subject is sparse, especially compared to the number and extent of similar studies done in related fields; the studies that are performed on the topic are generally restricted to a very specific demographic, and are not easily applicable to the entire population of engineering technology students and professionals. However, what information does exist suggests that this lack of research impedes the professional growth of those who are involved in engineering technology, including restricting the ability of faculty to recruit students interested in engineering technology programs, decreasing the effectiveness of guidance available to those students through advisors and outside programs, and preventing inequities currently present in the engineering field as a whole from being addressed. By acknowledging the gaps in current knowledge, direction for future research may be provided; thus, this review seeks to outline what research already exists on the public perception of engineering technology, and thereby highlight specific areas in which our understanding of this perception is particularly poor.

Introduction

If engineers are the playwrights, then those in engineering technology are the actors. Although closely related to engineering, engineering technology focuses more on the application of knowledge, such as building the systems that engineers may design, or the day-to-day execution required to keep those systems functional. This heavy emphasis on experiential learning versus theoretical learning has made engineering technology an increasingly attractive option for many students. Especially as experiential learning becomes increasingly prevalent in curriculum design and further emphasized as an important educational tool, engineering technology is beginning to gain traction as both a career path and a field of study, particularly among those seeking to spend less time in the classroom. For instance, in 2014, there were over 34,000 students who graduated with 2-year engineering technology degrees, versus 4,409 students who graduated with 2-year engineering degrees, even though the number of graduates with 4-year engineering degrees remained substantially higher than those with 4-year engineering technology degrees [1].

As this growth continues, it is increasingly evident that more research needs to be done to increase both public awareness and perceived legitimacy of the field, particularly because such

awareness eventually impacts the ability of those in that field to pursue and sustain careers related to their degree. Further, the communication of what a given field is truly like to members of the general public remains a matter of utmost importance for attracting well-prepared students and generating enthusiasm for future growth. Although some research exists with regards to how engineering technology and those within the field are perceived by industry and other professionals, the difference between public and professional perception can be stark, and it is crucial that the gaps in public understanding of what engineering technology entails are understood so that they may eventually be better addressed through outreach efforts.

Extant Literature

Many of the long-term, linear studies in engineering technology have focused on specific subgroups of engineering technology graduates, such as graduates in rural communities [2] or African American women [3], touching on perception as an integral part of how their subjects are received in industry, their eventual job prospects, and where they go after graduation. Research that follows these graduates into the rest of their careers has also been performed [4]; however, such studies again tend to focus specifically on one specific demographic, such as one that follows a certain cohort of African American engineering technology graduates [5]. There is also some existing research on engineering technology graduates from specific countries, such as Malaysia [6]; however, most of these focus on employability [7] and the general availability of resources to these graduates within their industry (such as the state of their labs) rather than being directly about perception. In general, perception is discussed as a factor that affects the topic being researched, rather than being the subject of any studies itself, which often leads to most material centering on the perspectives of employers rather than the general public; this emphasis continues even outside those countries [8] [9].

In terms of pre-graduate perception, research has been done concerning how the field is perceived among people from a certain subgroup, like women who might be considering engineering technology as a career [10]; within the realm of undergraduate education in particular, some investigation has also been conducted regarding what needs to change and develop for engineering technology curricula in specific [11] [12] [13]. Although the question of perception within these studies is never directly addressed, the general conclusion is that by making the suggested changes, universities may attract more people into engineering technology majors (i.e. improve student perception of the field).

Identifiable Gaps

Engineering and engineering technology are very closely related, with some arguing that they may even be considered the same field [14], but the amount of perception research that has been done for engineering is far greater than that which has been done for engineering technology. By comparing the two, the gaps in our knowledge of how engineering technology is perceived become more apparent, especially with regards to what investigation has been performed in one field but not the other.

For example, most perception-related research in engineering technology has focused on graduates and professionals within the field, whereas many of the studies addressing the perception of engineering have instead studied younger students (often with a goal of ascertaining why more people are not choosing engineering as a career). The age range of study participants vary from early primary school students [15] [16] to 5th and 6th graders [17] [18] to later secondary school students [19] [20] to high school students and beyond [21]; many of them make heavy use of the "draw an engineer" tool, adapted from and often used in tandem with the version intended for gauging the perception of scientists [22] [23] [24]. Those studies that do not use this tool often design their own surveys to find the same information [25], or look towards the representation of scientists and engineers in existing media rather than surveying subjects. Van Gorp et. al., for example, examined the portrayal of engineers in Dutch fiction targeted towards younger audiences [26].

Oftentimes, these studies reveal misperceptions or inaccurate stereotypes of engineers, propagated through mainstream media or general cultural diffusion, which may be corrected through further action in future research. One study, for instance, used examples of well-known engineers to successfully counter cultural stereotypes held by teachers in fields like environmental engineering and bioengineering [27] [28]. Extracurricular enrichments such as summer camps [29] or in-classroom hands-on projects for middle school students have also been used to positively influence the perception of engineering by a grade-school audience. Outreach programs that target specifically one, often underrepresented, demographic, such as secondary school girls, have also been developed and utilized [30] [31]. However, the existence of these stereotypes is only recognized due to previous research about the perception of engineers and the demonstration that those biases and preconceptions do exist, a body of work which does not exist for engineering technology.

Studies have also been performed on the perceptions of first-year engineering students who have already chosen to study within this field [32], because student perceptions and values of course affect whether they choose to stay within a field, and if they do, what kind of skills and information they value and prioritize learning during the course of their education. As mentioned previously, the recognition that student perceptions must be improved and that teaching styles and curricula need to be updated in order to do so exists, but the research on perception that would be required in order to appropriately make those changes has yet to be performed. Moreover, no studies have been done on specifically the ET students towards which those changes would be geared, only on graduates who have long since left the classroom.

Furthermore, although studies exist that track the development and experience of certain subsets of students or professionals working in engineering technology, such as graduates from rural areas or who are African Americans, there is almost no similar research that has been recently conducted for the entire population of those students and professionals as a whole. It is known that data from only one subset of a population usually cannot be reliably applied to another subset due to substantial differences in everything from their lived experiences to the resources

generally available to them; thus, attempting to extrapolate data gathered from one specific group of people in engineering technology to every person who works in engineering technology would likely be equally invalid.

In both engineering and engineering technology, there is also a notable lack of recent research performed on adults who are not in either field; in fact, the majority of studies cited by the articles used in this paper were performed over a decade ago [27] [28] [25]. Most recently, a single large report, performed 2007 via telephone sampling, aimed to cover many of the topics that had not already been touched on in previous studies (such as surveying the general public rather than a specific group of students) [33]. This skew towards examining student populations rather than adults outside of academia is likely due to the relative ease and simplicity of studying the former versus the latter. This is especially true for grade school students, the majority of whom are required to attend school and thus represent a relatively accurate sample of all children around that age.

In summary, most of the research on the perception of engineering technology is not much more than an afterthought; it exists because of research on other topics, rather than being its own standalone subject of inquiry. As a result, very little of it is widely applicable to the entire body of students and professionals in engineering technology, and equally little falls under the umbrella of public, rather than professional, perception. Especially when compared to research done in a similar, related field, the gaps in our knowledge become tremendously apparent, and the reasons to fill those gaps even more so.

Impact of Missing Literature

A lack of solid scientific data on a topic often encourages the growth of inaccurate perceptions, biased action, and poor policy decisions surrounding that topic. This is especially true regarding the existence and perception of an entire field of study, as this single core item affects many other aspects of that field. On a professional level, a lack of clarity about what the engineering technology curriculum entails and what those in the field are capable of has been demonstrated to cause salary disparities (despite equivalent levels of education), inequities in job classification, and increased difficulty in obtaining professional licensure [34]. On an academic level, inadequate information regarding how engineering technology is perceived leads to a corresponding lack of understanding of what students in the field may require from their education in order to be attractive to industry later on, or a lack of ability to establish an identity within (and thus enter) that field [35] [11]. Ultimately, declining interest may itself contribute to a decreasing resource availability and an increased cost of attendance for new students, further preventing effective growth of the discipline as a whole [12].

The importance of student perception of a field in the later development of that field holds true even for education before the university level, especially in secondary school and onwards. This has been demonstrated in related disciplines, such as engineering, wherein outreach programs even in primary schools have a direct impact on children’s perception of the topic through which

they are engaged [36]. What students hear early on in their academic careers ultimately does affect what they value and what they choose to study, and poor communication of what a career entails or what makes a certain field attractive may lead to lower numbers of students choosing eventually to enter that discipline [39] [37]. This effect is even more pronounced for historically marginalized groups in STEM education, such as women or people of color, who may often be hesitant to enter a field in which their ideas will be dismissed out of hand or their contributions not valued as highly [38]. Of course, in order to overcome these stereotypes and to effectively recruit more diversity into any discipline, specific tactics must be used to counter them, but without adequate research, the stereotypes themselves cannot be pinpointed for later targeting.

And, of course, the question of money is inescapable in modern research. The fields of study that ultimately receive the most funding are those that are perceived most positively, especially regarding how "mature" a discipline is, or how much progress is assumed to be made within that field. Those fields perceived to have high societal impact or "breakthrough potential" are often allocated more resources than those that do not, and poor communication of what a discipline entails may lead to loss of resources and opportunity for later developments [40].

Future Research Direction

In order to address these issues, the basic groundwork for studying public perception in engineering technology must be laid. One of the most glaring differences between the research conducted regarding the perception of engineering versus the research conducted regarding the perception of engineering technology is the subject groups that have been studied (i.e. grade school students versus college graduates and industry personnel); it thus follows that such gaps in who has versus who has not been surveyed would need to be filled. Although they are not necessarily members of the general public, undergraduate engineering technology students are also distinctly underrepresented in current research regarding perception, which hinders progress regarding the development of course curricula and thus the ability of advisors to effectively assist students with making choices concerning their education.

Obviously, creating an effective survey tool is a necessary component of determining perception on any level. However, specifically developing a version of the widely-used "Draw an Engineer" test and adapting its corresponding coding systems for engineering technology would also provide a powerful mechanism for studying public perception, especially among groups like primary school students who may not always be able to reliably interpret other survey tools [41]. Another interesting method of surveying perception indirectly is through the usage of metaphors, a technique which has been used successfully to study how scientists are perceived, particularly by groups such as student teachers who have already demonstrated the required language proficiency [42].

It is almost inevitable that surveys will reveal misconceptions or inaccurate biases regarding engineering technology due to simple lack of public awareness, which may then be corrected in one of several ways. Summer camps and outreach programs within local schools, for example,

have already been demonstrated to be effective for improving the perception of science and engineering [29], and some research has also been conducted on methods (such as the “5E approach) for designing activities within those programs to minimize student frustration and maximize engagement [43]. The literature and media available to the public is also known to have a significant impact on their perception of the concepts represented therein [26]; thus, working with authors and artists to create media that more accurately represents what engineering technology truly entails would also likely be an effective method of improving public perception.

References

[1] National Academy of Engineering, "Engineering Technology Education in the United States," The National Academies Press, Washington, DC, 2016.

[2] D. Beals, *The Lived Experience of Rural Community College Applied Science Engineering Technology Graduates,* Fort Collins, Colorado: Colorado State University, 2015.

[3] J. Blakley, *A Qualitative Study of African American Women in Engineering Technology Programs in Community Colleges,* Clemson, South Carolina: Clemson University, 2016.

[4] A. M. Lucietto, "Who is the engineering technology graduate and where do they go?," in *Frontiers in Education Conference,* Erie, 2016.

[5] R. D. Dempsey, *The Role of Engineering Technology as a Pathway for African Americans Into the Field of Engineering,* Atlanta: Georgia Institute of Technology, 2018.

[6] K. M. Ismail, K. R. Salim, H. N. Haon, N. H. Hussain, R. Ali, M. Abdullah and Z. Mohamed, "Evaluation of Laboratory Facilities for Engineering Technology Programs in Malaysian Technical Universities," *International Journal of Social Science Studies,* vol. 6, no. 5, p. 65, 2018.

[7] Z. I. A. Karim and S. M. Maat, "Employability Skills Model for Engineering Technology Students," *Journal of Technical Education and Training,* vol. 11, no. 2, 2019.

[8] P. Appiah-Kubi and C. Brion, "Effects of Service Projects on the Perceived Skills of Engineering Technology Students," *International Journal for Service Learning in Engineering,* vol. 14, no. 1, 2019.

[9] R. Taraban, M. Ceja, J. Suarez, D. Ernst and E. E. Anderson, "Building an Engineering Technology Workforce," *Journal of Engineering Technology,* vol. 35, no. 1, pp. 30-38, 2018.

[10] J. Gallaher and F. Pearson, "Women's Perceptions of the Climate in Engineering Technology Programs," *Journal of Engineering Education,* vol. 89, pp. 309-314, 2013.

[11] J. D. Burns, R. J. Budreau, G. L. Harding, W. M. Pace, M. E. Prygoski and J. A. Piller, "A Redesigned Engagement and Recruitment Strategy for Engineering Technology Programs at a Regional Campus," in *ASEE IL-IN Section Conference*, West Lafayette, 2018.

[12] R. L. Mott, G. P. Neff, M. J. Stratton and D. C. Summers, "Future directions for mechanical, manufacturing, and industrial engineering technology programs," *Journal of Engineering Technology,* vol. 19, no. 1, pp. 8-15, 2002.

[13] S. Zakani, B. Frank, R. Turner and J. Kaupp, "Framework for the Transferability Between Engineering and Technology Programs," Ontario Council on Articulation and Transfer, Toronto, 2016.

[14] R. E. Land, "Engineering Technologists are Engineers," *Journal of Engineering Technology,* vol. 29, no. 1, pp. 32-39, 2012.

[15] K. Park and H. Lee, "Elementary Students' Perceived Images of Engineers," *The Journal of the Korean Earth Science Society,* vol. 35, no. 5, pp. 375-384, 2014.

[16] I. Mallen-Ruiz and M. T. Escalas, "Scientists Seen by Children: A Case Study in Catalonia, Spain," *Science Communication,* vol. 20, no. 10, pp. 1-26, 2012.

[17] B. Fralick, J. Kearn, S. Thompson and J. Lyons, "How Middle Schoolers Draw Engineers and Scientists," *Journal of Science Education and Technology,* vol. 18, no. 1, pp. 60-73, 2009.

[18] F. O. Karatas, A. Micklos and G. M. Bodner, "Sixth-Grade Students' Views of the Nature of Engineering and Images of Engineers," *Journal of Science Education and Technology,* vol. 20, no. 2, pp. 123-135, 2011.

[19] M. D. Balçın and A. Ergün, "Perceptions and attitudes of secondary school students towards engineers and engineering," *Journal of Education and Practice,* vol. 9, no. 10, pp. 90-106, 2018.

[20] Ü. Kőycű and M. J. de Vries, "What preconceptions and attitudes about engineering are prevalent amongst upper secondary school pupils? An international study," *International Journal of Technology and Design Education,* vol. 26, no. 2, pp. 243-258, 2016.

[21] Y.-J. Shin and S.-K. Han, "A Study of the Elementary School Teachers' Perception in STEAM (Science, Technology, Engineering, Arts, Mathematics) Education," *Journal of Korean Elementary Science Education,* vol. 30, no. 4, pp. 514-523, 2011.

[22] M. Knight and C. Cunningham, "Draw an Engineer Test (DAET): Development of a Tool to Investigate Students' Ideas about Engineers and Engineering," in *ASEE Annual Conference & Exposition*, Salt Lake City, 2004.

[23] G. Knezek, R. Christensen, T. Tyler-Wood and S. Periathiruvadi, "Impact of environmental power monitoring activities on middle school student perceptions of STEM," *Science Education International,* vol. 24, no. 1, pp. 98-123, 2013.

[24] D. Reeping and K. Reid, "Student Perceptions of Engineering after a K-12 Outreach - a "STEM Academy"," in *ASEE North Central Section Conference*, Cincinnati, 2014.

[25] C. P. Lachapelle, P. Phadnis, J. Hertel and C. M. Cunningham, "What is Engineering? A Survey of Elementary Students," in *2nd P-12 Engineering and Design Education Research Summit,* Washington, DC, 2012.

[26] B. Van Gorp, E. Rommes and P. Emons, "From the wizard to the doubter: Prototypes of scientists and engineers in fiction and non-fiction media aimed at Dutch children and teenagers," *Public Understanding of Science,* vol. 23, no. 6, pp. 646-659, 2014.

[27] Y. K. Hoh, "Using Biographies of Outstanding Women in Bioengineering to Dispel Biology Teachers' Misperceptions of Engineers," *The American Biology Teacher,* vol. 71, no. 8, pp. 458-463, 2009.

[28] Y. K. Hoh, "Using Notable Women in Environmental Engineering to Dispel Misperceptions of Engineers," *International Journal of Environmental and Science Education,* vol. 4, no. 2, pp. 117-131, 2009.

[29] R. Hammack, T. A. Ivey, J. Utley and K. A. High, "Effect of an Engineering Camp on Students' Perceptions of Engineering and Technology," *Journal of Pre-College Engineering Education Research,* vol. 5, no. 2, pp. 10-21, 2015.

[30] R. Hammack and K. High, "Effects of an After School Engineering Mentoring Program on Middle School Girls' Perceptions of Engineers," *Journal of Women and Minorities in Science and Engineering,* vol. 20, no. 1, pp. 11-20, 2014.

[31] P. Molina-Gaudo, S. Baldassarri, M. Villarroya-Gaudo and E. Cerezo, "Perception and Intention in Relation to Engineering: A Gendered Study Based on a One-Day Outreach Activity," *IEEE Transactions on Education,* vol. 53, no. 1, pp. 61-70, 2010.

[32] F. Karataş, B. GM and S. Unal, "First-year engineering students' views of the nature of engineering: implications for engineering programmes," *European Journal of Engineering Education,* vol. 41, no. 1, pp. 1-22, 2016.

[33] H. Marshall, L. McClymont and L. Joyce, "Public Attitudes to and Perceptions of Engineering and Engineers," The Royal Academy of Engineering, London, 2007.

[34] K. Burbank, "ET Graduates are Treated Unfairly," *ASEE Prism,* vol. 27, no. 8, p. 23, 2018.

[35] R. King, "Engineers for the Future: Addressing the Supply and Quantity of Australian Engineering Graduates for the 21st Century," Australian Council of Engineering Deans, Sydney, 2015.

[36] B. M. Capobianco, H. A. Diefes-dux, I. Mena and J. Weller, "What is an Engineer? Implications of Elementary School Student Conceptions for Engineering Education," *Journal of Engineering Education,* vol. 100, no. 2, pp. 304-328, 2011.

[37] J. Cohn, "Kids Today! Engineers Tomorrow?," in *International Solid-State Circuits Conference*, San Francisco, 2009.

[38] S. S. Metz, "Attracting the Engineers of 2020 Today," in *Women and Minorities in Science, Technology, Engineering, and Mathematics: Upping the Numbers*, Northampton, Edward Elgar Publishing Ltd, 2007, pp. 184-209.

[39] F. S. Becker, "Why don't young people want to become engineers? Rational reasons for disappointing decisions," *European Journal of Engineering Education,* vol. 35, no. 4, pp. 349-366, 2010.

[40] C. Glagola, "What is the Public Perception of Civil Engineering?," *Leadership and Management in Engineering,* vol. 4, no. 3, pp. 85-86, 2004.

[41] N. Weber, D. Duncan, M. Dyehouse, J. Strobel and H. A. Diefes-Dux, "The Development of a Systematic Coding System for Elementary Students' Drawings of Engineers," *Journal of Pre-College Engineering Education Research,* vol. 1, no. 1, 2011.

[42] M. Dikmenli, O. Cardak and D. Yener, "Science student teachers' metaphors for scientists," *Energy Education Science and Technology Part B: Social and Educational Studies,* vol. 4, no. 1, pp. 51-66, 2012.

[43] A. Gilbert and K. Wade, "An Engineer Does What Now?: A 5E learning activity that compares engineering to science," *The Science Teacher,* vol. 81, no. 9, pp. 37-42, 2014.