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Perceptions of School District Curriculum Administrators Regarding K-12 Engineering Education

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PERCEPTIONS OF SCHOOL DISTRICT CURRICULUM ADMINISTRATORS

REGARDING K-12 ENGINEERING EDUCATION

By

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Abstract

The state of Nebraska recently adopted and implemented a set of Science standards that aligns with the Next Generation Science Standards which include engineering practices such as engineering design and the use of technology. Curriculum administrators throughout the state are responsible for the implementation of these standards including training for engineering teaching and learning. This exploratory study investigated curriculum administrators' (*n* = 43) perceptions of Engineering Education in four areas: Importance of Engineering Education, District Familiarity with Engineering Education, Characteristics of Engineering, and Barriers to Integrating Engineering Education. This exploratory study used one instrument to collect data: a modified Design, Engineering, and Technology (DET) Survey. Data were analyzed using descriptive statistics. The findings of this study revealed curriculum administrators express that the Science curriculum is an effective means to deliver engineering education and that engineering education content in pre-service teacher education programs and in-service teacher professional development to foster engineering education familiarity and best practices should be improved.

Acknowledgements

And whatsoever ye do, do it heartily, as to the Lord, and not unto men.

— Colossians 3:23 (King James Version)

I am grateful. I have had countless blessings in my life to be at this moment, this milestone. It is impossible for me not to think of those who have contributed to who I am and what I have experienced. My great-grandmother, Lillian Jackson, my grandfather, Elvin Williams, Sr., my great-uncle, Charles Williams, Sr., my great-aunt, Pearl Sigur, and my uncle, Roderick Williams, Sr., all imparted in me qualities that I exhibit every day. I love them all and they live on through me.

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Strive for perfection in everything you do. Take the best that exists and make it better. When it does not exist, design it.

— Sir Henry Royce

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Chapter 1
Introduction

Nebraska has experienced recent trends related to an increase in engineering career opportunities, and an increased enrollment of first-time freshman in engineering majors at state universities. Universities and industry have benefitted from one another to strengthen the workforce in Nebraska. The Nebraska Department of Education (NDE) has also contributed to Nebraska's well-prepared workforce. And, in the fall of 2017, NDE adopted the *Nebraska's College and Career Readiness Standards for Science* (NCCRS-S) which addresses science and engineering practices through "Engineering, Technology, and Applications of Science Connections" and "Engineering Design" across all grade levels (NDE, 2017a, p. 3-4). NCCRS-S is closely aligned to the nationally-recognized science standards set in the Next Generation Science Standards' Crosscutting Concepts, Science and Engineering Practices, and Disciplinary Core Ideas (NGSS Lead States, 2013).

NCCRS-S will be implemented within public school districts in the fall of 2018, and have its Nebraska Student-Centered Assessment System (NSCAS) Summative Assessment offered in the spring of 2021 (NDE, 2018a). School districts' curriculum administrators and Science curriculum supervisors are responsible for the dissemination, training, and evaluation of best practices to meet both the Fall 2018 rollout of these new standards and its Spring 2021 state assessment. In addition to the responsibilities pertaining to the implementing new standards, district curriculum administrators will familiarity with the engineering components within the newly adopted state Science standards will help facilitate an effective rollout to teachers such as through engineering education professional development and administrative supports. The implementation of an adequate and appropriate foundation in K-12 engineering education knowledge and skills can bolster the ability for Nebraskans to build upon recent trends in engineering-related opportunities. Engineering education is a means to actively engage students academically and affectively (Peters Burton et al., 2014).

K-12 engineering education has been addressed through some formal, selective curriculums within districts or in schools independently (e.g., magnet programs and/or curriculum vendors), elective courses, or informal after-school programs (National Academy of Sciences, 2010). As with many states, NDE had not directly addressed engineering education through standards prior to 2017, in part, due to the lack of an accepted definition and a set of recognized national standards (Carr, Bennett, & Strobel, 2012). NDE has provided Career Technical Education and Nebraska Career Readiness standards for secondary education (NDE, 2018b) which is a collaborative between NDE and Partnerships for Innovation™ to provide secondary courses in specific career and technical fields primarily fulfilled by certification programs, trade unions, and community colleges.

Another contributing factor to the lack of state-wide K-12 Engineering Education in schools is the cost for formal programs, curriculum resources, and professional development provided by curriculum vendors; and district and/or school administration support. Current changes in Nebraska state funding for education will have significant impacts on district allocation of funds for curricular content outside of the core disciplines and traditional elective courses for resources such as materials, program certification, professional development, and appropriate learning environments. Nebraska school districts will receive a 0.17% increase in state aid, overall, for the 2018-19 fiscal year (NDE, 2018c).

Existing formal engineering education programs and resources in Nebraska include Project Lead The Way (PLTW), International Baccalaureate® (IB), and Engineering Is Elementary® (EiE). PLTW is a 501(c)(3) non-profit organization that provides STEM education curriculum and teacher professional development in more than 6,500 K-12 schools nationwide (PLTW, 2017a). PLTW has annual per site participation fees of $750 each for elementary and middle schools, and $2,000-$5,000 for high school programs. PLTW-led professional development is required for first-time PLTW teachers: Elementary - $700, Middle School - $1,250 per course offered, and High School - $2,400 per course offered. Course curriculum update training are provided online at no cost (PLTW, 2018b).

International Baccalaureate® (IB) is an international non-profit educational foundation that provides an extensive curriculum and professional development that is consistent from one school to another within a district, state, or country (International Baccalaureate®, 2018). IB provides its own set of subject standards that includes Design for its Middle Years Programme and Design Technology in Science for its Diploma Programme. Schools are responsible to adhere to state, district, and IB standards. As a result, schools must attain and maintain authorization to be recognized as an authorized IB World School. Authorization requires a two-year probationary period of professional development and curriculum implementation. The candidacy fee for a school is $4,000. Upon satisfactory completion, the school is an authorized IB programme. IB offers four programmes: Primary Years Programme (PYP, ages 3-12), Middle Years Programme

(MYP, ages 11-16), Diploma Years Programme (DP, ages 16-19), and the IB Career-related Programme (CP, ages 16-19) with annual fees that range from $1,370 to $10,820. Individual schools purchase IB materials and training, as applicable, to maintain authorization. IB also provides optional electronic assessment services with annual, per site fees (per subject fee - $725, student fee - $70, and eAssessment fee - $70).

Engineering Is Elementary® (EiE) – developed by the Museum of Science, Boston – is a STEM curriculum designed specifically for elementary school children (Engineering Is Elementary, 2014a). It has two categories: Basic (grades 1-2) and Advanced (grades 3-5) and provides 20 units pertaining to a science topic and an associated engineering field. EiE only has materials' costs: content unit $408 (initial) and $100 unit refills (EiE, 2014b).

PLTW courses are typically offered as elective courses or career programs within Career Technical Education (NDE, 2018b). IB programmes provide teaching and learning best practices for required district courses and a process of design pedagogy for extant Design-themed courses (IB, 2018). School districts that previously lacked formal engineering education programs such as PLTW, design-based offerings as found in IB, or engineering resources such as those provided by EiE will have to research, select, organize, train, and monitor staff in the engineering concepts and practices required by NCCRS-S.

Background of the Problem

The United States Department of Education (DOE) reports that, despite the projected need for skilled workers in Science, Technology, Engineering, and Mathematics (STEM) career fields in the 2010-2020 timeframe, few American students strive to complete a STEM education (DOE, 2015). In addition, the department cites a shortfall in STEM-related education efforts to provide youth with engaging, high quality STEM material in the classroom. As a result, the United States currently finds itself ill-prepared to meet the demand for both STEM professionals and educators that the U.S. Department of Labor projects will rise by one million new jobs from 2012 to 2022 (Vilorio, 2014). The ultimate consequence of this trajectory is diminished global, national, and local academic and economic competitiveness. According to the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2010), students are not motivated to dream of “what can be,” and have no motivation to become the next generation of scientists and engineers who can address national problems such as national and homeland security, healthcare, energy production and distribution, environmental preservation, and economic growth, including the creation of jobs without a flourishing scientific and engineering community.

Efforts have been underway by several entities to address this need, or provide a means, to realize effective STEM education in classrooms and after school programs. Federally, the America COMPETES (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science) Reauthorization Act of 2010 produced the 5-Year Federal Science, Technology, Engineering, and Mathematics (STEM) Education Strategic Plan (H.R. 5116, 2010). Its five "Priority Investment Areas" are: Improve STEM Instruction, Increase and Sustain Youth and Public Engagement in STEM, Enhance STEM Experience of Undergraduate Students, Better Serve Groups Historically Underrepresented in STEM Fields, and Design Graduate Education for Tomorrow's STEM Workforce. The bill was reauthorized in 2015 to provide improved federal support and dissemination of information to state and local education agencies' STEM programs in academia (H.R. 1806, 2015). STEM education is regarded as an effective means to prepare students for 21st century societal and career demands (Holt & Colburn, 2014).

Mathematics and Science have been present at the core of elementary and secondary education in the United States for decades. Technology – from vocation education to computer sciences – has established itself as an innovative, relevant curriculum (National Academy of Sciences, 2010). However, engineering is relatively absent from K-12 curriculum (National Academy of Sciences, 2010). The first formal K–12 engineering programs in the United States emerged in the early 1990s (DOE, 2015). Since that time, about 6 million K–12 students have had any kind of formal engineering education. By contrast, the estimated enrollment in 2008 for grades pre-K–12 for U.S. public and private schools was nearly 56 million (DOE, 2015). The National Academy of Engineering states, "No standards have been set for engineering education, no state or national assessment has been adopted, and almost no attention has been paid to engineering education by policy makers. In fact, engineering might be called the missing letter in STEM (p. 20, 2009)". Effective implementation and meaningful outcomes of STEM education requires addressing Engineering in curricula.

According to the National Science Board, a 7% increase of engineers across all occupations in the United States occurred during 2003-2014 while in that same span the state of Nebraska realized a 12% increase (2016). In addition, the University of Nebraska-Lincoln Office of Institutional Effectiveness and Analytics reported a 32.3% increase in first-time freshmen engineering majors over the years 2003-2017 (2007, 2017). The United States Bureau of Labor Statistics projects a 7% growth in engineering and engineering-related occupations nationally for 2016-2026 (U.S. Department of Labor, 2018). The NCCRS-S will provide a means to foster these trends.

District curriculum administrators' responsibilities include reviewing relevant literature, assumptions, and philosophies; curriculum models and resources; national and state goal statements; and future projections of social, economic, and environmental conditions (Bratt, 1991). The effective implementation of engineering education, as required by NCCRS-S, will require cognizant, innovative administrative support (James, Lamb, Householder, & Bailey, 2000; Lesseig, Nelson, Seidel, & Slavit, 2016). Nebraska district curriculum administrators will have to familiarize themselves with, and prepared to implement, engineering education.

Conceptual Framework

Research has increased in the area of K-12 teacher self-efficacy regarding STEM education and integration, and of late, engineering education specifically. The increase can be attributed to an increased interest in using appropriate methodologies to develop valid and reliable instruments (Hong, Purzer, & Cardella, 2011; Yoon Yoon, Evans, & Strobel, 2014). One such instrument that has been developed, validated, and re-evaluated for psychometric soundness is the refined Design, Engineering, and Technology (DET) Survey (Hong et al., 2011).

The DET Survey identifies four areas of familiarity with, and preparedness of, design, engineering, and technology: importance of DET, familiarity with DET, characteristics of engineers, and barriers in integrating DET (Hong et al., 2011). These four areas ("factors") were developed through a psychometric evaluation of an initial 69 questions either developed or modified from other instruments (Yaşar, Baker, Kurpius, Krause, & Roberts, 2006). Data from DET Surveys has provided insight for effective professional development for K-12 teachers and counselors (Hong et al., 2011; Beck, Diefes-Dux, & Reed-Rhoads, 2009; High et al., 2009; Pelletier, Desjardins, Chanlet, & Heymans, 2009). The four "factors" serve as supporting research questions to the main focus of this study (see Figure 1).

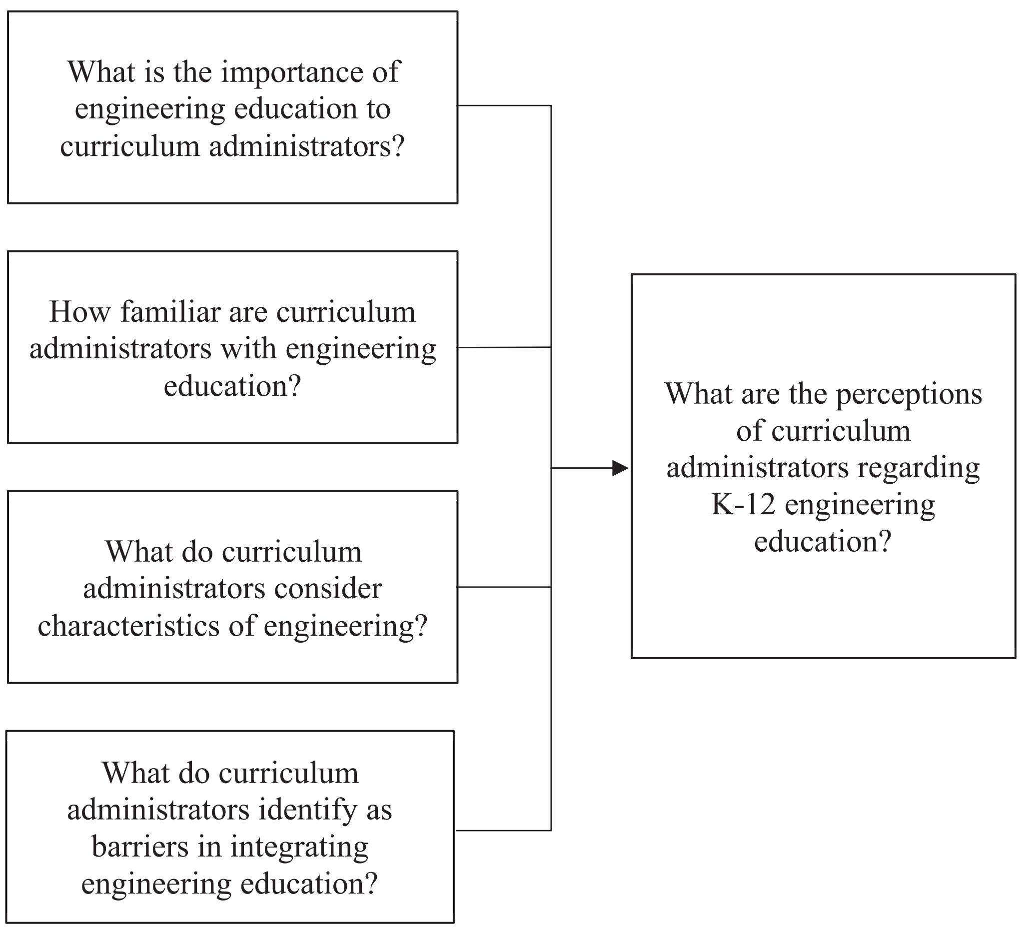


Figure 1. Study conceptual framework. Adapted from "A Psychometric Re-Evaluation of the Design, Engineering and Technology (DET) Instrument" by Hong, T., Purzer, Ş., & Cardella, M., 2011, *Journal of Engineering Education*, *100*(4), 800-818.

The principles of design, engineering, and technology in the DET Survey are the core of engineering education. The National Academy of Engineering (2009) defines engineering education as “Curriculum that teaches and assesses concepts and practices of engineering, design, the engineering design process, technology, and optimization.” The NCCRS-S integrates engineering concepts and practices. Educators’ knowledge of these engineering concepts and practices will serve as the foundation of their meaningful implementation in Nebraska classrooms. The effort to ensure a meaningful implementation of the NCCRS-S are guided by the NCCRS-S Implementation Toolkit (NDE, 2017b). The NCCRS-S Implementation Toolkit details four stages educators and district leaders will phase the standards into curriculum, instruction, and assessment. The stages include: Stage 1 – Exploration (2017-2018), Stage 2 – Transition (2017-2019), Stage 3 – Initial Implementation (2018-2019), and Stage 4 – Scale Up (2019-2020). The Transition stage states “Educators and district leaders engage in ongoing research and the building of personal understanding of the instructional shifts (innovations), phenomena driven three-dimensional learning, and NCCRS-S.” (NDE, 2017b).

Statement of the Problem

Thirty-four public schools of the 713 elementary, 146 middle, and 133 high schools which are public, state-operated, or non-public schools throughout the state (NDE, 2018d) are known to provide formal engineering education. There are 28 Project Lead The Way schools and one university affiliate at the University of Nebraska-Lincoln (PLTW, 2018) and six authorized International Baccalaureate schools (IB, 2018). PLTW and IB provide an engineering-based curriculum and engineering design process pedagogy, respectively. Therefore, hundreds of Nebraska public schools have little to no prior formal engineering education curriculum or programs.

The newly adopted NDE Nebraska NCCRS-S standards (2017a) requirements state:

> Connections to engineering, technology, and applications of science are included at all grade levels and in all domains. These connections highlight the interdependence of science, engineering, and technology that drives the research, innovation, and development cycle where discoveries in science lead to new technologies developed using the engineering design process. Performance indicators for the engineering design process are intentionally embedded in all grade levels. These indicators allow students to demonstrate their ability to define problems, develop possible solutions, and improve designs. These indicators should be reinforced whenever students are engaged in practicing engineering design during instruction. Having students engage in the engineering design process will prepare them to solve challenges both in and out of the classroom (p. 3-4).

The twelve school districts which contain the 34 formal engineering education or design-based schools will experience a cumulative decrease in state aid of 0.07% (NDE, 2017c). Seven of the districts account for 111,021 K-12 students and will incur a reduction of $22.2 million in state aid for 2018-19. The other five districts account for 56,593 K-12 students and will receive a $21.9 million increase (NDE, 2017c). More than 250 district curriculum administrators across Nebraska will be responsible for the training, implementation, and monitoring of engineering education to districts that have little to no formal engineering education background or reduced fiscal support. As a result, curriculum administrators' understanding of the NCCRS-S and their perception of engineering education – based on their familiarity and preparedness – will affect the extent of curriculum reform, the resources identified to meet the NCCRS-S, and the general support provided by the district to schools such as professional development. NDE (2017b) is developing a five-year plan that includes "exploration, initial implementation, scale up, deep implementation, and sustainability" to aid districts (p. 4).

Purpose of the Study

The purpose of this exploratory study is to address perceptions of school district curriculum administrators regarding K-12 engineering education for identifying areas to support district implementation of engineering education. The perceptions of school district curriculum administrators regarding K-12 engineering education may likely determine policy and practice promoted within districts regarding how to develop and implement engineering concepts and practices required by NCCRS-S in K-12 classrooms. In addition, curriculum administrators' perceptions may aid teacher education programs' preparation of pre-service and in-service teachers to meet the requirements of changing Nebraska curricula and classrooms.

Research Question

The purpose of this exploratory study is to address the following overarching question: What are the perceptions of school district curriculum administrators regarding K-12 engineering education? The following sub-research questions will guide the research:

Sub-Research Question 1 (SRQ1): What is the importance of engineering education to curriculum administrators?

Sub-Research Question 2 (SRQ2): How familiar are curriculum administrators with engineering education?

Sub-Research Question 3 (SRQ3): What do curriculum administrators consider are characteristics of engineering?

Sub-Research Question 4 (SRQ4): What do curriculum administrators identify as barriers in integrating engineering education?

The sub-research questions may provide answers, when taken collectively, that may identify the perception an administrator has toward engineering education and thus the measures that may be considered necessary to effectively implement engineering education into district curriculum.

Significance of the Study

The educational merit of this exploratory study will allow insight into perceptions of engineering education from district administrators state-wide. NDE (2017b) states that their implementation and educator support will include "guidance related to systems alignment, professional learning, curriculum, instruction, resources, and assessment" (p. 4). This study explores the perception those responsible for the implementation of the new engineering components in NCCRS-S including the importance of, and level of familiarity with, engineering education; the characteristics of engineering that may be modeled in curriculum, and any potential barriers in integrating engineering education in curriculum.

The Nebraska Department of Education (NDE) has developed and implemented a *STEM Approach* educational guide for K-12 educators to employ when interested in integrating STEM in their curriculum (NDE, 2017d). NDE's *STEM Approach* consists of a mission statement and STEM activity/product/program evaluation rubric (NDE, 2017d). Both serve as an aide to educators – primarily educators not served by an existing means for, and/or training in, STEM, but also as a method to attain feedback regarding the use of a STEM-based activity/product/program. This study's findings will provide input to NDE regarding their district administrators and engineering education. As a result, NDE has expressed interest in this study and its findings.

The academic merit of this study adds to the of the burgeoning field of engineering education research. The development of engineering education research has progressed over the last century from studying pedagogy, courses, and curricula by means of student satisfaction surveys and instructors' impressions, to empirical statistical comparisons between experimental and control groups, to the current utilization of social science methods and philosophies (Felder & Hadgraft, 2013). The latter has led to two divergent groups within engineering education research: theoreticians who seek to understand the learning process at a fundamental level, and practitioners who continue to focus their research on improving teaching structures and methods (Felder & Hadgraft, 2013). According to the National Academy of Engineering (2009):

> Even fewer quality data are available on the impacts of K-12 engineering education on student engagement, technological literacy, understanding of engineering, and interest in engineering as a possible career. The paucity of data reflects a modest, unsystematic effort to measure, or even define, learning and other outcomes. Before engineering education can become a mainstream component of K-12 education, this information gap must be filled. Without better

data, policy makers, teachers, parents, and others with a stake in the education of children will have no basis for making sound decisions. (p. 154)

The significance of this study will provide an analysis not only for district administrators but for state education administrators to assess the existing components that are necessary for the effective implementation of engineering education within districts. District administrators will be able to utilize the study's results to plan and implement in areas such as professional development and curriculum supports. Also, district administrators can develop dialogue with state administrators, pre-service teacher institutions, and industry stakeholders to meet the needs the 21st century learners in Nebraska.

Operational Definitions

- **Curriculum Administrator** – District-level personnel responsible for processes associated with curriculum, instruction and assessment (Nebraska Council of School Administrators, 2017).
- **Design, Engineering, and Technology** – Curriculum that addresses the ability to: 1) identify a problem or a need to improve on current technology; 2) propose a problem solution; 3) identify the costs and benefits of solutions; 4) select the best solution from among several proposed choices by comparing a given solution to the criteria it was designed to meet; 5) implement a solution by building a model or a simulation; and 6) communicate the problem, the process, and the solution in various ways (Yaşar et al., 2006).

- **Engineering Design Process** – A highly iterative, multiple-solutions, application of science, mathematics, and technology through systems thinking, modeling, and analysis (National Academy of Sciences, 2010).
- **Engineering education** – Curriculum that teaches and assesses concepts and practices of engineering, design, the engineering design process, technology, and optimization (National Academy of Engineering, 2009).

Assumptions

The operational definition of engineering education – curriculum that teaches and assesses concepts and practices of engineering, design, the engineering design process, technology, and optimization (NAE, 2009) – contains the concepts and practices of design, engineering, and technology. Therefore, the assumption is that engineering education will be used in place of design, engineering, and technology (DET, as a platform).

The data was collected using a survey which relied on the accurate self-reporting of curriculum administrators in their familiarity with, and preparedness to, implement engineering education in their respective districts. The researcher designed the survey for this study based on the refined Design, Engineering, and Technology (DET) Survey (Hong et al., 2011). The refined DET Survey was modified for use in this exploratory study to represent questions respective of curriculum administrators whereas the source survey is respective of elementary teachers. An example of a modified survey item for curriculum administrators would be “Students should understand the use and impact of engineering education?”. The source survey item for elementary teachers is “I would like to be able to teach my students to understand the use and impact of DET.” (Hong et al., 2011, p. 4).

Delimitations

The delimitation of this study is that only district curriculum administrators in the state of Nebraska were studied. Curriculum administrators may also be the district’s superintendent, a school’s principal, or teacher based on the student population of the district. Also, the study was conducted in public Nebraska school districts only. The NCCRS-S are required for public schools, while non-public schools can operate autonomously from the NCCRS-S. The researcher did not study which non-public Nebraska schools utilize the NCCRS-S. Therefore, the study will not be generalizable to all districts (i.e., public, state-operated, and non-public).

Chapter 2

Review of Literature

The understanding, planning, and professional development structures policy makers and administrators develop regarding engineering education will impact teacher preparedness and execution of engineering education requirements in state standards, and student achievement on state summative assessments.

Progression of K-12 Engineering Education

Engineering education in K-12 schools is a relatively recent practice spurred by th growth of STEM education. Whereas national standards exist for science (NGSS Lead States, 2013), technology (International Society for Technology in Education, 2013), and mathematics (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010), national standards for engineering – in a K-12 environment – do not exist and have experienced a slow progression to today's status. The national status of K-12 engineering education is marked by four milestones.

In 1894, The Committee of Ten - an experienced group of educators – proposed education reform through lengthening the number of years for preparatory and high schools, standardizing secondary curriculum, and establishing college admission requirements (Mackenzie, 1894). The committee's report set the foundation for educational standards and, in turn, influenced many of the practices and programs in the nation's schools such as the Harvard Descriptive List for admissions which valued physics knowledge and skills (Bybee, 2009).

In the following decades, as the nation grew as an international competitor and influencer, the education system addressed the demands of industry and government for a workforce that can sustain the country’s growth. An example is President John F. Kennedy's "We Choose to Go to the Moon" speech in 1962 at Rice University in response to Russia's successful launch of Sputnik. That national charge contributed to an increase in STEM-related education and university research throughout the United States. The nation realized a 73% increase in STEM doctorates awarded the decade following the speech (National Science Foundation, 2006).

The National Commission on Excellence in Education, in 1983, published the report, *A Nation at Risk*. Two recommendations from that report set the stage for the development of educational standards: (1) strengthening the content of the core curriculum; and (2) raising expectations by using measurable standards for high school graduation in English, mathematics, science, social studies, and computer science. In 1989, the Education Summit was held and included then President George H. W. Bush and state governors. The summit produced the National Education Goals, which set directives for voluntary national standards in each core subject (Bybee, 2009). That same year, the National Council of Teachers of Mathematics published Curriculum and Evaluation Standards for School Mathematics and the American Association for the Advancement of Science (AAAS) published Science for All Americans (Bybee, 2009). Bybee (2009) states:

> The assumption was that voluntary national standards would be used by state education departments and local jurisdictions to select educational programs, instructional practices, and assessments that would help students meet the standards. An additional assumption was that undergraduate teacher education and professional development for classroom teachers would also be aligned with

the standards. The basic idea may sound reasonable, but in reality it did not work as envisioned (p. 58).

In 1993, the AAAS published Benchmarks for Scientific Literacy (based on Science for All Americans) and, in 1996, the National Research Council published National Science Education Standards. These documents provided recommendations and standards related to engineering and technology which included an increased recognition of engineering education (Bybee, 2009). In 2000, The International Technology Education Association published Standards for Technological Literacy. Bybee states “An important point about these standards is that they paid substantial attention to the idea of engineering design and underwent a thorough review and subsequent revision by the National Research Council with input and criticism from the National Academy of Engineering” (2009). Both the National Academy of Engineering and the National Research Council would have further influence on K-12 engineering education.

The 2000s witnessed several national efforts to address K-12 engineering education. In 2006, the National Academy of Engineering and National Research Council Center for Education established the Committee on K–12 Engineering Education (NAE, 2009) to analyze extant K–12 engineering curricula; conduct literature reviews of conceptual learning related to engineering, the development of engineering skills, and the impact of K–12 engineering education initiatives; and to collect preliminary information of select pre-college engineering education programs in other countries (Katehi, Pearson, & Feder, 2009). The committee recommended addressing the lack of key engineering concepts in curricula (e.g., constraints, analysis, and optimization); the lack of pre-service initiatives to produce K-12 engineering educators and the limited in-service opportunities for educators excluding existing engineering curriculum; the lack of culturally-relevant engineering education and experiences for underrepresented groups (e.g., minorities and females); and policy and program issues such as ad hoc infusion, stand-alone courses, and integrated STEM education (Katehi et al., 2009).

In 2007, the Committee on Prospering in the Global Economy of the 21st Century and the Committee on Science, Engineering, and Public Policy (2007) published *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. This congressionally-requested report examines the needs of United States to generate a means to create high-quality jobs and a focus on new science and technology efforts. In addition to addressing government, industry, and postsecondary education, the report details K-12 educational challenges including student academic performance and interest in engineering careers, and knowledgeable and skilled K-12 educators and exceptional curricular materials (2007).

Importance of Engineering Education

Engineering can be defined as the application of science and mathematics by which matter and energy in nature are made useful to humanity (Merriam-Webster, 2018). The concepts and practices developed throughout history for the numerous disciplines within engineering are indicative of the effective application of science, mathematics, and technology knowledge and skills to advance society. The application of knowledge and skills – the "what" and "how" – is as important as learning the knowledge and skills themselves (Kelley & Knowles, 2016).

Engineering education, as defined by the National Academy of Engineering (2009), is curriculum that teaches and assesses concepts and practices of engineering, design, the engineering design process, technology, and optimization. This entails an iterative process of knowledge acquisition, application by means of attained skills, and evaluation against given criteria. This often frames content application in “real-world” situations through authentic experiences in regard to context, task, impact, or affect (i.e., personal/value) (Strobel, Wang, Weber, & Dyehouse, 2013). These authentic experiences and social aspects of collaboration improves student engagement along with high expectations from the teacher for the students (Newmann, Wehlage, & Lamborn, 1992). Authentic experiences provide tangible products and their rewards (both intrinsic and extrinsic), a sense of ownership, and allow for differentiation (Newmann et al., 1992). The authors argue that students "step up" to the challenge of high expectations when they are supported, have a sense of purpose, and experience success (incrementally, more than in finality). Authentic activities utilize the knowledge and experiences students possess, and attain through the activities, and allow them to learn in a context that is relevant (Gay, 2002). This interaction is supported by cognitive apprenticeship.

Cognitive apprenticeship and situated cognitive theory. Cognitive apprenticeship embeds the learning of knowledge and skills in the functional and social context of their use (Collins, Brown, & Newman, 1988). The pedagogy of disseminating knowledge and training someone in a skill are proven practices in the fields such as trades, medicine, and law. As an instructional method, cognitive apprenticeship allows for the teacher to demonstrate skills in a realistic context and explains thinking processes associated with respective skills; and affords the student opportunities to practice skills in structured, coached environments, describe and reflect on learning processes, and explore varied problems applicable to the skills learned (Davis & Ulseth, 2013). The social relevance of cognitive apprenticeship is expanded through situated cognition theory.

Situated cognition theory expanded on cognitive apprenticeship through the affective component of culture. Situated cognition theory (Brown, Collins, & Duguid, 1989) posits that learning is a product of the knowledge and skills and the social, cultural, and physical contexts in which the knowledge and skills occur. Knowledge is constructed within and linked to the activity, context, and culture in which it was learned (Kelley & Knowles, 2016). Katehi et al. (2009) propose promoting engineering "habits of mind" which align with 21st century skills and include systems thinking, creativity, optimism, collaboration, communication, and ethical considerations. Engineering education provides a means to apply “content knowledge and cognitive processes to design, analyze, and troubleshoot complex systems in order to meet society’s needs.” (Brophy, Klein, Portsmore, & Rogers, 2008, p. 371).

Kennedy and Odell (2014) determined that effective implementation of STEM education in K-12 curriculums include (a) integration of technology and engineering into science and math curriculum at a minimum; (b) scientific inquiry and engineering design promotion, including rigorous mathematics and science instruction; (c) collaborative approaches to learning, connecting students and educators with STEM fields and professionals; (d) provide global and multi-perspective viewpoints; (e) incorporation of strategies such as project-based learning, provide formal and informal learning experiences; and (f) incorporation of appropriate technologies to enhance learning. In addition, two extant learning processes exist within STEM – the Scientific Method for Science and the Engineering Design Process for Engineering. Furthermore, engineering education can be supported by various instructional methods (i.e., project-based learning, design-based learning, inquiry-based learning, or problem-based learning) to fulfill learning from other curricula.

Engineering design process. The Engineering Design Process is a highly iterative, multiple-solutions, application of science, mathematics, and technology through systems thinking, modeling, and analysis (National Academy of Sciences, 2010). The analytical element of an Engineering Design Process (EDP) allows the of use mathematics and science inquiry to create and conduct experiments that will inform about the function and performance of potential design solutions before a final product is created (Kelley & Knowles, 2016). The authors propose that engineering design, thus the use of an EDP, allows students to build upon their own experiences and provide opportunities to construct new math and science knowledge through design analysis and scientific investigation, respectively.

The Massachusetts Institute of Technology revised its curricula to represent the engineering design process through teaching, and a study showed a connection between effective use of the prescribed engineering design process and the performance of the finished design for various industry-inspired open-ended problems (Khalaf, Balawi, Hitt, & Radaideh, 2013). Custer, Daugherty, and Meyer state that “Engineering design could provide the ‘portal’ for all other engineering concepts and themes appropriate for the secondary level.” (2010, p. 14). The basis for EDP has its roots in the professional domain, but all of K-12 education can utilize it in that it can be devised respective of cognitive development. PLTW has a six-step EDP for its high school courses (see Figure 2.1), NASA produced a six-step EDP for its Beginning Engineering, Science and

Technology middle school classrooms program (NASA, see Figure 2.2), and the Museum of Science, Boston developed a five-step EDP for elementary classrooms (EiE, see Figure 2.3).

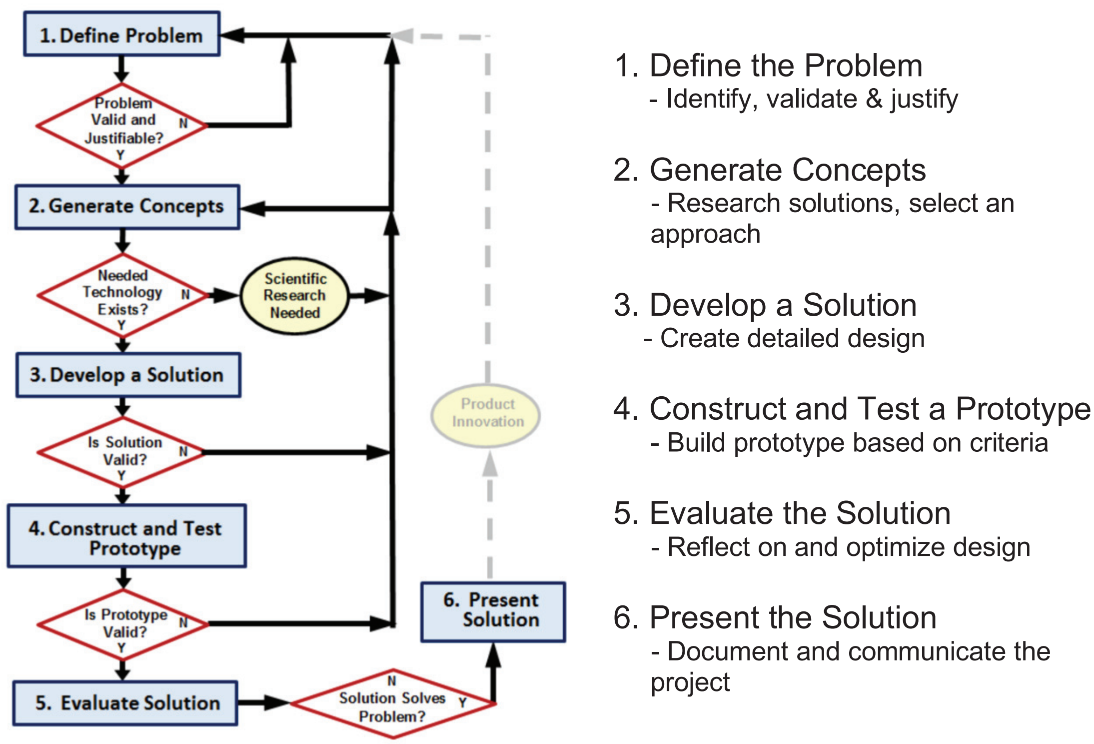
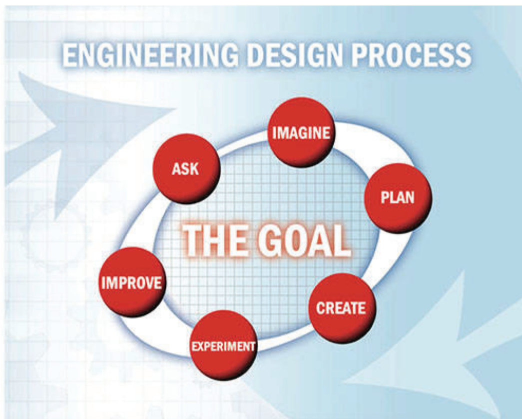


Figure 2.1. Project Lead The Way design process. Adapted from PLTW. (2012). *Design Process: Introduction to Engineering Design*. Retrieved from https://westcampus.scusd.edu/sites/main/files/file-attachments/designprocess.pdf.

The engineering component of STEM, thus engineering education, according to Kennedy & Odell (2014):

> puts emphasis on the process and design of solutions instead of the solutions themselves. This approach allows students to explore math and science in a more personalized context, while helping them to develop the critical thinking skills that can be applied to all facets of their work and academic lives. Engineering is

the method that students utilize for discovery, exploration, and problem-solving. (p. 254)



ASK: Students identify the problem, requirements that must be met, and constraints that must be considered.

IMAGINE: Students brainstorm solutions and research ideas. They also identify what others have done.

PLAN: Students choose two to three of the best ideas from their brainstormed list and sketch possible designs, ultimately choosing a single design to prototype.

CREATE: Students build a working model, or prototype, that aligns with design requirements and that is within design constraints.

TEST: Students evaluate the solution through testing; they collect and analyze data; they summarize strengths and weaknesses of their design that were revealed during testing.

IMPROVE: Based on the results of their tests, students make improvements on their design. They also identify changes they will make and justify their revisions.

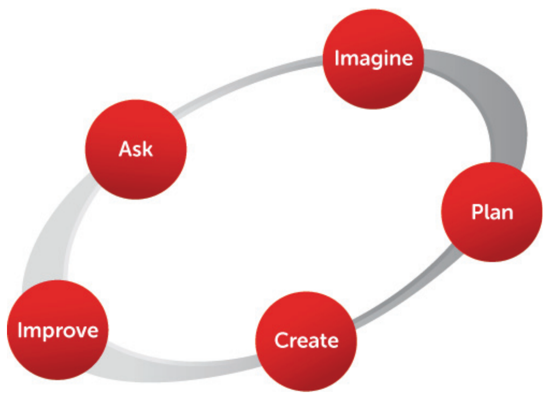
Figure 2.2. NASA's BEST engineering design model. Adapted from NASA. (2018). *Beginning Engineering, Science and Technology Engineering Design Process*. Retrieved from https://www.nasa.gov/audience/foreducators/best/edp.html.

Engineering education can ensure that high school graduates possess a level of STEM literacy sufficient to be gainfully employed or attain a post-secondary education, or both; and be prepared to be competent contributors in this technology-driven society (Katehi et al., 2009).

Familiarity with Engineering Education

Engineering education, in K-12 schools, is a recent incarnation compared with other traditional and non-traditional curricula given its start in the 1990s (Katehi et al., 2009). As a result, there are few teacher preparation programs in engineering education.

Research shows STEM education teaching is enhanced when the teacher has sufficient content knowledge and domain pedagogical content knowledge (Fayne. 2009; Capobianco & Rupp, 2013; Yoon Yoon et al., 2014; Nadelson, Pfiester, Callahan, & Pyke, 2015). Schools, and their districts, are challenged with offering innovated and engaging STEM opportunities taught by knowledgeable and skilled educators. Traditional and non-traditional pre-service programs and professional development fulfill the need for knowledgeable and skilled educators.



ASK: What is the problem? How have others approached it? What are your constraints?

IMAGINE: What are some solutions? Brainstorm ideas. Choose the best one.

PLAN: Draw a diagram. Make lists of materials you will need.

CREATE: Follow your plan and create something. Test it out!

IMPROVE: What works? What doesn't? What could work better? Modify your design to make it better. Test it out!

Figure 2.3. A five-step process: engineering design process. Adapted from Engineering Is Elementary. (2018*). The Engineering Design Process*. Retrieved from https://www.eie.org/overview/engineering-design-process.

Pre-service programs. According to Len Litowitz (2014), "Technology & engineering teacher preparation programs across the United States have been in a state of decline for more than four decades. There are currently only 24 undergraduate technology & engineering teacher preparation programs in the United States with an enrollment of 20 students or more." (p. 80). Research by Johnny Moye (2017) reported that in 1995-96, 815 Technology (and Engineering) Teachers graduated from undergraduate programs while 206 graduated in 2015-16. As a result, efforts to increase the number of STEM education graduates have been addressed by teacher preparation programs such as UTeach and ATOMS.

UTeach is a university-based teacher preparation program created at the University of Texas – Austin in 1997 to increase the number of qualified science, technology, engineering, and mathematics (STEM) teachers in U.S. secondary schools (UTeach, 2018). UTeach integrates a secondary teaching certification with traditional four-year STEM degrees without adding time or cost, and has been adopted at 45 universities in 22 states and the District of Columbia (UTeach). UTeach has produced more than 3,000 STEM educators through 2016 (UTeach Institute, 2017) comprised of comprised of Mathematics – 44%, Science – 32%, Other STEM – 8%, Other Non-STEM – 5%, Non-Degree Seeker – 5%, Education – 4%, Computer Science – 1%, and Engineering – 1%. A poll (*n* = 2,351) of UTeach graduates' K-12 teaching placement revealed that 1,611 are in high schools, 553 are in middle schools, 59 are in elementary schools, and 128 are "Unknown" (UTeach Institute). Backes, Goldhaber, Cade, Sullivan, & Dodson (2018) states, "Students taught by UTeach teachers perform significantly better on end-of-grade tests in math and end-of-course tests in math and science by 8% to 14% of a standard deviation on the test, depending on grade and subject." (p. iii). Although end-of-grade tests gains are reported exclusively in math and science, the researchers emphasize evidence of the primary goal of UTeach to increase the number of STEM teachers from partner universities, and that the UTeach condensed 4-year certification degree plan does not result in detrimental performances of first-year STEM educators (Backes et al., 2018).

The Accomplished Teachers of Mathematics and Science (ATOMS) is a National Science Foundation funded program started in 2011 at North Carolina State University. ATOMS is a 27-credit hour pre-admittance teacher education program for elementary education – which includes an engineering design methods course – that measures teacher instructional practice, content knowledge and pedagogical content knowledge, and teacher efficacy and epistemological beliefs (DiFrancesca, Lee, & McIntyre, 2014). Researchers (Thomson, Difrancesca, Carrier, & Lee, 2016) conducted a longitudinal study of the ATOMS program and revealed that pedagogical content knowledge (PCK) could be more important for the development of elementary pre-service teachers' mathematics and science efficacy beliefs than their domain knowledge (DK). Thomson et al. (2016) state, "Because the elementary teachers are trained as generalists, their mathematics and science PCK and DK might be weaker compared with their counterparts, middle and secondary teachers, who are trained and are specialized in one content area only (e.g. mathematics or science or history)." (p. 16).

Researchers request implementation of research-based program models to increase or improve teacher preparation programs (Lumpe, Czerniak, Haney, & Beltyukova, 2012; Lee, Walkowiak, & Nietfeld, 2017). In addition to pre-service teacher preparation programs, engineering education professional development for in-service teachers provides a viable option to prepare educators for the knowledge, skills, and pedagogy necessary for the field.

Professional development. Research over the last few decades regarding effective professional development for teachers of science and mathematics has yielded an extensive selection of professional development programs for science and math educators (Reimers, Farmer, & Klein-Gardner, 2015). The researchers recommend the need for similar research into the nature of effective professional development for engineering educators given the current emphasis on connections between science, technology, engineering, and mathematics.

Nadelson, Pfiester, Callahan, & Pyke (2015) studied the use of engineering design professional development for elementary teachers. The study focused on teacher affect and capacity to teach engineering design through a three-day summer institute consisting of presentations, workshops, activities, curriculum development, and an assessment of student and teacher responsibilities for decision making to determine the structure of the design elements. The assessment, the *Level of Design Rubric*, revealed that teachers utilized, or focused on, certain aspects of engineering design more (e.g., understanding the problem and building a solution) than others (e.g., generating ideas, selecting a solution, presenting results, and evaluation) (Nadelson et al., 2015). The findings were used during follow-up in-class support to improve the use of the engineering design process in classrooms. The subsequent results indicated that the professional development significantly influenced teacher knowledge of the engineering design process (Nadelson et al., 2015).

In a study by Capobianco and Rupp (2013), a cohort of middle level STEM teachers' lesson plans were reviewed and teaching of science concepts using the engineering design process were observed. The summer-long professional development, Science Learning through Engineering Design (SLED) Partnership, is facilitated by university STEM faculty. The researchers utilized the *SLED Implementation Plan Analysis Instrument* (lesson plans) and the *Engineering Design-based Classroom*

Observational Rubric (EDCOR, teaching). EDCOR aligns with Next Generation Science Standards engineering design standards. The study found that teachers made strong attempts at planning for meeting science standards and using engineering design, but did not implement the engineering design process to the fullest (Capobianco & Rupp, 2013). Upon the second teaching of an EDP-lesson, all planning measures improved, but teaching using the EDP did not meet a satisfactory level to demonstrate an effective use of the EDP. The researchers determined that the instruments be used for STEM teachers' professional development, and to identify areas and practices for improvement.

Andrea Burrows (2015) states that effective professional development best practices include "clear communication, hands-on activities, planned time for reflection and discussion, and intentional partnership building" (p. 35). The researcher studied 31 K-12 teachers participating in 19 days (13 summer days and 6 Saturdays during the academic year) of professional development, using pre-/post-affective assessments (quantitative and qualitative measures), for integrating Astronomy in their respective classrooms. Results of the professional development yielded increases in content knowledge (16% to 84%) and making partnership connections and collaborations (26% to 90%).

The researcher directly attributes the study results to the professional development team's intentional consultations before and after each session that provide participant-sensitive, responsive instruction for effective professional development to meet participants' needs. In regard to content knowledge, 74% of the K-12 teachers reported the anticipated use of content from the professional development sessions in their classrooms. Burrows also attributes an increase in content interest, interactions, discussions, collaborations, and public expression of personal or group expectations or goals to the professional development team and sessions' structure.

Yoon Yoon et al. (2014) studied the preparedness of teachers of K-12 engineering education courses in response to the rise of STEM curricula in K-12 education. The researchers developed and validated the Teaching Engineering Self-efficacy Scale (TESS) which evolved from previous teacher self-efficacy frameworks, to a Science-based self-efficacy framework, then to a Technology-based self-efficacy framework, to its administered iteration. TESS was administered to 434 teachers of K-12 engineering education courses in 19 states. Results of the validation study provide for a final TESS of five constructs through 23 questions: Engineering pedagogical content knowledge self-efficacy, Engineering engagement self-efficacy, Engineering disciplinary self-efficacy, Engineering outcome expectancy, and Teaching engineering self-efficacy. The TESS, along with other pre-/post-assessment instruments (e.g., Burrows) can be used as a guide for professional development planners and facilitators.

Characteristics of Engineering

What is engineering? Describe an engineer. These are introductory questions to this discipline. And the answers can be varied. Therefore, it is necessary to inform students about engineering as a discipline, career field, and aspect of society. The Committee on K-12 Engineering Education (2009) states:

> It is unrealistic to expect that the challenges facing U.S. innovation can be addressed solely by boosting the number and diversity of K–12 students interested in technical and scientific fields. But broadening the appeal of engineering and

related careers to American pre-college students will almost certainly be part of the solution. (p. 45)

K-12 educators, particularly K-12 engineering educators, must be able to elaborate on the field of engineering and its attributed characteristics.

Multiple perspectives methodology was researched to create a meta-inquiry system for those studying engineering (Adams, Evangelou, English, Figueiredo, Mousoulides, Pawley, Schifellite, Stevens, Svinicki, Trenor, & Wilson, 2011). The research was categorized into themes including Engaging, Future, and Engineers. The researchers recommended, “to be open to different ways of thinking and communicating to imagine a new innovation landscape for engaging future engineers” (p. 54). Schifellite posits that engineers should “take into account the desires, aims, and ideas of the communities they serve” (p. 69).

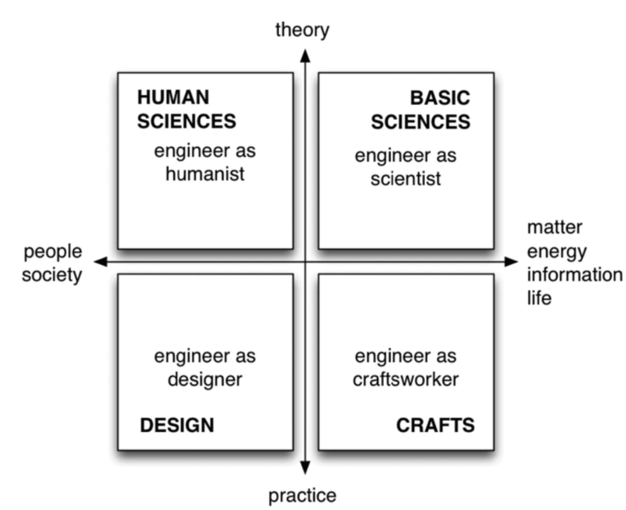


Figure 2.4. The four dimensions of engineering. Adapted from “Multiple Perspectives on Engaging Future Engineers” by Figueiredo, A. D. (2011). *Journal of Engineering Education*. 100. 48-88. 10.1002/j.2168-9830.2011.tb00004.x. (p. 66).

Figueiredo reports "what is" engineering through four dimensions that include the basic sciences, human sciences, design, and the crafts (see Figure 2.4). Characteristics of engineering can be formed from the cognitive, social, and physical actions and resources utilized by an engineer. K-12 educators can use these four dimensions to explore students background knowledge, establish new knowledge and skills, and foster critical thinking.

Each of the 50 U.S. state's academic standards were studied for the presence of engineering or its "big idea", i.e., concepts and terminology (Carr et al., 2012). The study was conducted by manual and electronic content analysis which identified key engineering skills and knowledge. Of the 50 states, 41 states were found to have engineering skills and knowledge "big idea" requirements within their standards. Most were contained in Science or Technology/Vocational standards. Some contained explicit engineering standards, usually based on a national engineering instructional program (e.g., PLTW or ITEEA). One state implemented engineering knowledge and skills through Mathematics. The researchers established that engineers use systematic processes, mathematical tools, and scientific knowledge to develop, model, analyze and improve solutions to problems. In addition, they included the concept of the engineering design process as dynamic and with a basis in phases of problem definition, problem solving, testing, and iteration.

Barriers in Integrating Engineering Education

Difficulties K-12 educators may face in integrating engineering education trend along common themes: teacher preparation/development, best practices, and applicable material and financial resources (Kelley & Wicklein, 2009; Brown, Richards, Parry, Zarske, & Klein-Gardner, 2012; Moore, Stohlmann et al., 2014). A case study by Jacob

Foster (2009) details the Massachusetts Department of Education’s development and implementation of integrating technology/engineering standards and programs in state standards, districts, and schools. The author further identified five "lessons learned": determine the focus of the standards early (e.g., engineering or technology concepts, or both), determine how subjects will be classified early on (i.e., incorporated into core courses, stand-alone electives, career/vocational tracks, etc.), if incorporated into a course, will it be its own subject or a "technological design" component, provide examples to monitor for quality and alignment, and promote/nurture interdisciplinary and professional relationships and collaboration. An additional area of difficulty for K-12 STEM educators is the active engagement of students.

Cothran & Ennis (2000) studied students and their teachers' perceptions of engagement at three urban high schools of predominately African-American. The researchers study found that students’ engagement was dependent on the teacher's vestment in them and the content. This vestment was identified as demonstrations of clear communication, caring, and enthusiastically presenting active learning opportunities. The researchers proposed teachers actively prepare for, and provide, a means for students to access educational engagement and social membership to attain achievement and personal/social development, respectively. They recommended reforms in curricula, school policies, and teacher preparation and professional development.

An analysis of several national studies regarding engagement of secondary students of low socioeconomic and/or underrepresented groups was conducted by Appleton, Christenson, & Furlong (2008). The researchers proposed, based on the findings of the analysis, an additional component – academic (e.g., achievement, time on task) – be added to the traditional three-component model of engagement: affective, behavioral, and cognitive. The authors discussed that dropping out of school is not an instantaneous event, but a process; therefore, engagement is key to reducing dropout rates. The researchers utilize self-determination theory to present the proposal of the concept of motivation for teachers to support engagement by viewing the student as a decision maker and a creator of meaning.

Conner & Pope (2013) examined student academic engagement in 15 high achieving schools (*n* = 6,294). Findings show that two-thirds of students at these schools are not regularly ‘‘fully engaged’’ in their academic schoolwork which is defined as affective, behavioral, and cognitive engagement. Students lacked affective and cognitive engagement. Based on their findings, the researchers suggest affective and cognitive dimensions of engagement correlate with positive outcomes. The researchers propose that teachers provide structure (clear goals and immediate feedback), autonomy-support (student voice and choice), and opportunities for involvement (caring, supportive relationships) to facilitate "full" student engagement. This proposal corroborates engagement studies by Newmann et al. (1992) and Strobel et al. (2013).

The four factors of perceptions of engineering education: the importance of engineering education, familiarity with engineering education, characteristics of engineering, and barriers to integrating engineering education (Hong et al., 2011) are determinants in effective development and implementation of engineering education in K-12 schools. The academic and administrative infrastructure necessary for engineering education may be impacted by administrative perceptions of engineering education. This infrastructure has been addressed.

Moore, Glancy et al. (2014) formulated a K-12 engineering education framework that can be used by administrators to plan and evaluate the integration of engineering into extant curricula. The researchers created the framework through a highly iterative design-based research methodology using existing theories such as the design-research model of Hjalmarson & Lesh (2008) and engineering education criteria from the Accreditation Board for Engineering and Technology, Inc., the National Research Council, Massachusetts Science and Technology/Engineering Learning Standards, engineering-specific standards from 11 states, the International Technology and Engineering Educators Association, and the science standards from all 50 states (Moore, Glancy et al., 2014).

Key Indicators of Quality Engineering Education
• Processes of Design – Problem and Background – Plan and Implement – Test and Evaluate • Apply Science, Engineering, and Mathematics • Engineering Thinking • Conceptions of Engineers and Engineering • Engineering Tools • Issues, Solutions, and Impacts • Ethics • Teamwork • Communication Related to Engineering
Figure 2.5. The framework for quality K-12 engineering education. "A framework for quality K-12 engineering education: Research and development." by Moore, T., Glancy, A., Tank, K., Kersten, J., Smith, K., & Stohlmann, M. (2014). *Journal of Pre-College Engineering Education Research*, 4(1), 1–13. (p. 4).

The researchers state:

> The framework was created in order to meet the growing need for a clear and concise definition of quality K-12 engineering education to be used in guiding development of curricula, classroom implementation, standards, and policy around engineering in integrated K- 12 STEM education settings (p. 12).

The resultant framework is comprised of 12 key indicators (see Figure 2.5) that present concepts, practices, and skills exemplary of quality engineering education for all students throughout their K-12 education (Moore, Glancy et al., 2014).

Three of the four factors of perception toward engineering education (Hong et al, 2011) can be reinforced by The Framework for Quality K-12 Engineering Education key indicators (Moore, Glancy et al., 2014) such as the importance of engineering education (Processes of Design; Apply Science, Engineering, and Mathematics; and Ethics), familiarity of engineering education (Engineering Tools and Communication Related to Engineering), and characteristics of engineering (Engineering Thinking, Conceptions of Engineers and Engineering; Issues, Solutions, and Impacts; and Teamwork). The key indicators focus on the entirety of a K-12 engineering education curriculum (Moore, Glancy et al., 2014). As a result, the fourth perception factor (barriers of integrating engineering education) is not reinforced explicitly by the key indicators given that barriers included details such as a lack of teacher knowledge, training, and administrative support (Hong et al., 2011). Although essential to an effective engineering education curriculum, these details are independent of the content of the curriculum.

Chapter 3

Methodology

Introduction

While research has increased in the area of perceptions of elementary teachers regarding engineering education (Hong et al., 2011; Beck et al., 2009; High et al., 2009; Pelletier et al., 2009), few, if any, studies have examined school district administrators' perceptions of engineering education. Therefore, the purpose of this exploratory study was to investigate the perceptions of school district curriculum administrators' in regard to engineering education in the state of Nebraska. Curriculum administrators in Nebraska were identified as a result of the drafting and adoption of new state standards that integrated engineering concepts, practices, and design as items to be taught and assessed across all grade levels through Science, as opposed to secondary elective courses exclusively.

Curriculum administrators throughout the state of Nebraska will complete the Engineering Education Survey (Appendix C). Statistical and descriptive analysis of the survey data will be conducted.

This chapter includes the procedures that will be used to gather the data for the study as well as the methods to be used to analyze the collected data. The chapter describes the following: (a) the research design to be used in this study, (b) the research questions, (c) setting and selection of the sample for the study, and (d) the data collection and data analysis procedures.

Research Design

Nebraska district curriculum administrators was studied using a modified extant survey that gathered data on educators' perceptions regarding K-12 engineering education.

A large-scale assessment using a cross-sectional survey design will be implemented to examine Nebraska curriculum administrators' perceptions regarding K-12 engineering education. The cross-sectional survey design will provide a means to study trends in attitudes and opinions (Creswell, 2015) of school district curriculum administrators. An examination of the responses of individual district curriculum administrators will provide trends among variables such as district size and geographic location.

Research Questions

This exploratory study will address the research question: What are the perceptions of school district curriculum administrators regarding K-12 engineering education? The following sub-research questions guide the research:

Sub-Research Question 1 (SRQ1): What is the importance of engineering education to curriculum administrators?

SRQ1 addresses the perceptions of curriculum administrators in regard to the affective, cognitive, and societal impacts of Engineering Education for students and teachers.

Sub-Research Question 2 (SRQ2): How familiar are curriculum administrators with engineering education?

SRQ2 addresses the existing professional development opportunities and instructional supports within the district, and past pre-service experiences of curriculum administrators in Engineering Education.

> **Sub-Research Question 3 (SRQ3):** What do curriculum administrators consider are characteristics of engineering?

SRQ3 addresses perceptions of district curriculum administrators in regard to stereotypical beliefs of engineering such as general, math, and science knowledge and skills, and collaboration and expressive abilities (e.g., speaking and writing).

> **Sub-Research Question 4 (SRQ4):** What do curriculum administrators identify as barriers in integrating engineering education?

SRQ4 addresses issues in implementing engineering education into the current curriculum. Proposed issues include the lack of teacher preparation and engineering knowledge, administrative support, and engaging historically underrepresented students in engineering (i.e., minorities and females).

Setting and Sample

The source of the statistical and descriptive data is K-12 district curriculum administrators in the state of Nebraska. There are 245 operational public school districts comprised of 318,853 students (NDE, 2018e). Based on a population of 260 district curriculum administrators, the anticipated sample size is 133 respondents (90% confidence interval, 5% margin of error).

Instrumentation

The Engineering Education Survey (Appendix C) is a modified refined DET Survey. The original DET Survey is a 46-question ordinal closed-ended (four-point

Likert scale) instrument to measure K-12 teachers' perceptions of and familiarity with design, engineering, and technology (Yaşar et. al., 2006). The items of the instrument are grouped in four factors (*Importance of DET, Familiarity with DET, Stereotypical Characteristics of Engineers,* and *Characteristics of Engineering*). The DET Survey has been implemented since 2006 to provide researchers and administrators critical information regarding K-12 teachers' perception of engineering and their familiarity with teaching design, engineering, and technology. The DET survey was initially administered to 98 K-12 teachers in the state of Arizona (Yaşar et. al., 2006). The survey was also administered to 69 elementary teachers during a week-long summer professional development workshop consisted of teachers from Florida, Indiana, Maryland, Michigan, and Texas (Hsu, Purzer, & Cardella, 2011).

The DET Survey was re-evaluated psychometrically to improve validity evidence for the original DET survey based on a new larger and more diverse group of participants (*n* = 405) surveyed over five years by testing the factor structure of the survey through a confirmatory factor analysis (CFA), an exploratory factor analysis (EFA), and an item analysis and examining the internal consistency of the instrument (Hong et al., 2011). The researchers state "The main purpose of this study was to validate and refine the DET instrument to ensure it is conceptually and empirically consistent with the latent construct defined in the prior study" (p. 810). The prior study's latent construct was K-12 teachers' familiarity with and perceptions of engineering (Hong et al., 2011).

The findings of the CFA demonstrated that the original DET Survey four factors (*Importance of DET, Familiarity with DET, Stereotypical Characteristics of Engineers,* and *Characteristics of Engineering*) did not fit the data based on the applied model-data fitting indices: comparative fix index, root mean square error of approximations, and the standardized root mean square residual (Hong et al., 2011). The CFA findings prompted an empirical refinement of the instrument.

The EFA explored the reliability and validity of the survey as a result of the CFA. The EFA attempted to provide a discernable factor structure where each item would have a high factor loading on one factor and very low factor loadings on all other factors based on the eigenvalues, parallel analysis, scree plot (elbow point), and percent of explained variances of the observed variables (Hong et al., 2011). The results of the EFA maintained four factors, as previously assigned in the original DET Survey, however several survey items were reassigned factors including a factor that was named according to its constituent items (Hong et al., p. 807, Table 1).

Table 1

Factor Changes Based on EFA Results

Item	Original Factor	Refined Factor
How important should pre-service education be for teaching DET?	Importance of DET	Dropped
DET has positive consequences for society.	Characteristics of Engineering	Importance of DET
Barrier in integrating DET – lack of teacher knowledge.	Familiarity with DET	Barriers in Integrating DET
Barrier in integrating DET – lack of training	Familiarity with DET	Barriers in Integrating DET
Barrier in integrating DET – lack of time for teachers to learn about DET	Familiarity with DET	Barriers in Integrating DET

Barrier in integrating DET – lack of administration support.	Familiarity with DET	Barriers in Integrating DET
Most people feel that minority students can do well in DET.	Stereotypical Characteristics of Engineers	Barriers in Integrating DET
Most people feel that female students can do well in DET.	Stereotypical Characteristics of Engineers	Barriers in Integrating DET

An item analysis was conducted on the items of the refined survey (i.e., *Importance of DET, Familiarity with DET, Stereotypical Characteristics of Engineers,* and *Barriers in Integrating DET).* The analysis included a screening of individual items for descriptive statistics, item-total correlation to identify which items contribute to the overall functioning of each factor, and the calculation of internal reliability estimates (Hong et al., 2011). The item-total correlation for *Barriers in Integrating DET* was weak. And, although the Cronbach's alpha (i.e., reliability) for two of the factors (i.e., *Barriers in Integrating DET* and *Stereotypical Characteristics of Engineers*) were weak (0.68 and 0.77, respectively), the overall reliability of the four factors were acceptable (i.e., 0.86). Hong et al. states "Overall, compared to other alternatives with no or little psychometric evidence in engineering education, DET is still a strong theory-based instrument with a promisingly stable and robust factor structure" (p. 815).

The refined DET Survey (Hong et al., 2011) was modified for use in this exploratory and descriptive study to measure school district curriculum administrators' perceptions of engineering education in districts in the state of Nebraska. This study's survey represents questions respective of curriculum administrators whereas the source survey is respective of elementary teachers. This customization for the type of respondents who will be asked to complete the survey is based on Tailored Design of surveys (Dillman, Smyth, and Christensen, 2014).

The modifications of survey items pertain to Factor 1, Factor 2, and Factor 3 (therefore, Sub-Research Questions 1, 2, and 3) which originally addressed in-service elementary teachers exclusively, such as “Was your pre-service curriculum effective in supporting your ability to teach DET at the beginning of your career?” (Hong et al., 2011, p. 4). An example of this question modified for this study was “Pre-service curriculum is effective in supporting teachers’ ability to teach engineering education at the beginning of their career?” (Appendix A). In addition, Hong et al. state “We recommend that a revised version of the DET instrument include a ‘neutral’ category in its scale to increase its psychometric quality and suggest that additional analyses are conducted with a larger sample size” (2011). All items were categorized on a five-point Likert scale to include “Neutral”.

Data Collection

Research data was collected through an on-line survey developed using Qualtrics® which was disseminated to Nebraska K-12 district curriculum administrators via e-mail using respective e-mail addresses from the Nebraska Department of Education. Survey results was stored on a secured, hosted platform on University of Nebraska at Omaha servers.

Data Analysis

Descriptive data analysis occurred through statistical analysis of ordinal Likert scaled questionnaire items using Qualtrics®. Descriptive data analysis included frequencies and percentages. Findings were reported in applicable tables and graphs.

Conclusion

Research results will provide an overview of Nebraska school districts' curriculum administrators familiarity with and perceptions of K-12 engineering education. The state may consider the results in relation to its implementation and educators supports for aiding districts with regard to the NCCRS-S.

Chapter 4

Research Findings

Introduction

This exploratory study of district curriculum administrators in the state of Nebraska was conducted to examine their perceptions of K-12 engineering education through four factors which form the basis for the research question. The survey, Engineering Education Survey (Appendix C), collected data to address this study's four sub-research questions for analysis of participants' perceptions of K-12 engineering education.

Participants were solicited through a contact list from the Nebraska Department of Education (NDE, 2017f). The list provided pertinent contact information such as name, district, position, and e-mail address for self-identified district/school administrators or faculty responsible for district curriculum, instruction, and/or assessment. The survey was disseminated via e-mail to 260 individuals from the list provided by NDE. E-mails were sent Blind Carbon Copy (Bcc) in blocks of five recipients to prospective participants to maintain anonymity of all recipients. No other contact information from the list was used in this study.

The initial request for participation was sent August 3, 2018, followed by a reminder request on August 31, 2018, then a final reminder/request on September 23, 2018. Fifty-seven (57) participants began the survey and 43 completed the survey.

The survey gathered non-identifying participant demographics which included: Position as Curriculum Administrator, Curriculum Level, Experience as Curriculum Administrator, District Enrollment, and District Geographic Location (see Table 4.1).

Table 4.1

Frequencies and Percentages of Participants on Engineering Education Survey

		N (43)	%
Position as Curriculum Administrator			
	Superintendent	10	23.3
	Assistant/Associate Superintendent	2	4.7
	District Coordinator	13	30.2
	District Coordinator and other	5	11.6
	Principal	13	30.2
Curriculum Level			
	Elementary	7	16.3
	Middle/Junior High	3	7.0
	High School	1	2.3
	Elementary/Middle/Junior High	1	2.3
	Middle/Junior High/High School	3	7.0
	Elementary/Middle/High School	28	65.1
Experience as Curriculum Administrator			
	0-5 years	14	32.6
	6-10 years	8	18.6
	11-15 years	9	20.9
	16-20 years	9	20.9
	21+ years	3	7.0
District Enrollment (Students)			
	1-250	16	37.2
	251-500	12	27.9
	501-1,000	4	9.3
	1,001-1,500	2	4.7
	1,501-2,500	3	7.0
	2,501-5,000	4	9.3
	5,001-10,000	1	2.3
	10,001+	1	2.3
District Geographic Location			
	Northeast	10	23.3
	East Central	11	25.6
	Southeast	7	16.3
	North Central	1	2.3
	Central	4	9.3

South Central	3	7.0
Panhandle	5	11.6
Southwest	2	4.7

NOTE: "District Coordinator and other" comprised three Principals, one Assessment Specialist, and one Enrichment Teacher.

Thirty-five percent (35%) of participants served exclusively in the role of Curriculum Administrator as an Assistant/Associate Superintendent or District Coordinator while 65% of Curriculum Administrators had additional responsibilities of positions such as Superintendent, Principal, and Teacher. In addition, 65% of participants who served as their respective district's curriculum administrator across all grade levels (i.e., elementary, middle level, and high school) correlates to the 65% of participants who represented school districts with enrollments of 500 or fewer students.

Sixty-five percent (65%) of participants represented the eastern third of the state, while 19% represented the central third of the state, and 16% represented the western/panhandle third of the state. This geographic representation of participants is comparable to the state's regional population densities (see Table 4.2).

Table 4.2

State Regional Distribution Comparison

	Population Density		Survey Participants	
	N (1,920,076)	%	N (43)	%
West	154,406	8.0	7	16.3
Central	256,933	13.4	8	18.6
East	1,508,737	78.6	28	65.1

U.S. Census Bureau. (2018). Vintage 2017 Population Estimates. Retrieved from https://www.census.gov/search-results.html?q=nebraska+population&page=1&stateGeo=none&searchtype=web&cssp=SERP&_charset=UTF-8

Findings

This exploratory study addressed the research question: What are the perceptions of school district curriculum administrators regarding K-12 engineering education? This question was based on the following sub-research questions:

- (SRQ1) What is the importance of engineering education to curriculum administrators?
- (SRQ2) How familiar are curriculum administrators with engineering education?
- (SRQ3) What do curriculum administrators consider are characteristics of engineering?
- (SRQ4) What do curriculum administrators identify as barriers in integrating engineering education?

Descriptive statistics, (i.e., frequencies and percentages) were analyzed for sub-research question survey items which were ordinal Likert Scale measures.

Sub-Research Question 1 (SRQ1)

SRQ1: What is the importance of engineering education to curriculum administrators?

Sub-Research Question 1 addressed curriculum administrators' perceptions of the importance of engineering education within their respective districts. SRQ1 was addressed by 19 survey items (see Table 4.3).

Table 4.3

What is the Importance of Engineering Education to Curriculum Administrators?

Item	Response (%)* SD	D	N	A	SA
To what extent do you agree that students should understand the use and impact of engineering education?	0	0	18.6	53.5	27.9
To what extent do you agree that students should understand the science underlying engineering education?	0	0	7.0	62.8	30.2
To what extent do you agree that students should understand the design process?	0	0	4.7	46.5	48.8
To what extent do you agree that students should understand the types of problems to which engineering education can be applied?	0	0	4.7	58.1	37.2
To what extent do you agree that the science curriculum should promote an understanding of how engineering education affects society?	0	0	4.7	55.8	39.5
The district can learn more about engineering education through in-service?	0	2.3	13.9	60.5	23.3
To what extent do you agree that students should understand the process of communicating technical information?	0	0	4.7	51.2	44.2
To what extent do you agree that the science curriculum should prepare young people for the world of work?	0	2.3	2.3	39.5	55.8
To what extent do you agree that the science curriculum should promote an enjoyment of learning?	0	0	0	30.2	69.8
Engineering Education should be integrated into the K-12 curriculum?	0	4.7	20.9	39.5	34.9
The district can learn more about engineering education through workshops?	0	0	2.3	69.8	27.9

The district can learn more about engineering education through college courses?	0	4.7	9.3	60.5	25.6
Through the Science curriculum, it is important to include using engineering in developing new technologies?	0	2.3	7.0	30.2	60.5
The district can learn more about engineering education through peer training?	0	0	4.7	62.8	32.6
To what extent do you agree that the science curriculum should help students develop an understanding of the technical world?	0	0	2.3	53.5	44.2
To what extent do you agree that the science curriculum should educate scientists, engineers and technologists for industry?	0	4.7	2.3	51.2	41.9
Through the Science curriculum, it is important to include planning of a project?	0	0	4.7	18.6	76.7
Pre-service education is important for teaching Engineering Education?	7.0	2.3	7.0	34.9	48.8
How strongly do you agree that Engineering Education has positive consequences for society?	0	0	2.3	74.4	23.3

*SD = *Strongly Disagree*; D = *Disagree*; N = *Neutral*; A = *Agree*; SA = *Strongly Agree*

An analysis of Sub-Research Question 1 resulted in three themes including: students' benefits, district's role, and teacher's preparation (see Figure 4.1). Curriculum administrators responded with a very high level of agreement that students benefit from the principles and practices of engineering education (93% Agree or Strongly Agree). A very high level of agreement (93% Agree or Strongly Agree) was determined regarding the district's role to implement engineering education effectively through the Science curriculum. Similarly, a high level of agreement was calculated in regard to district curriculum administrators' perceptions that teachers can be prepared to teach engineering education through in-service professional development and continuing education (89% Agree or Strongly Agree).

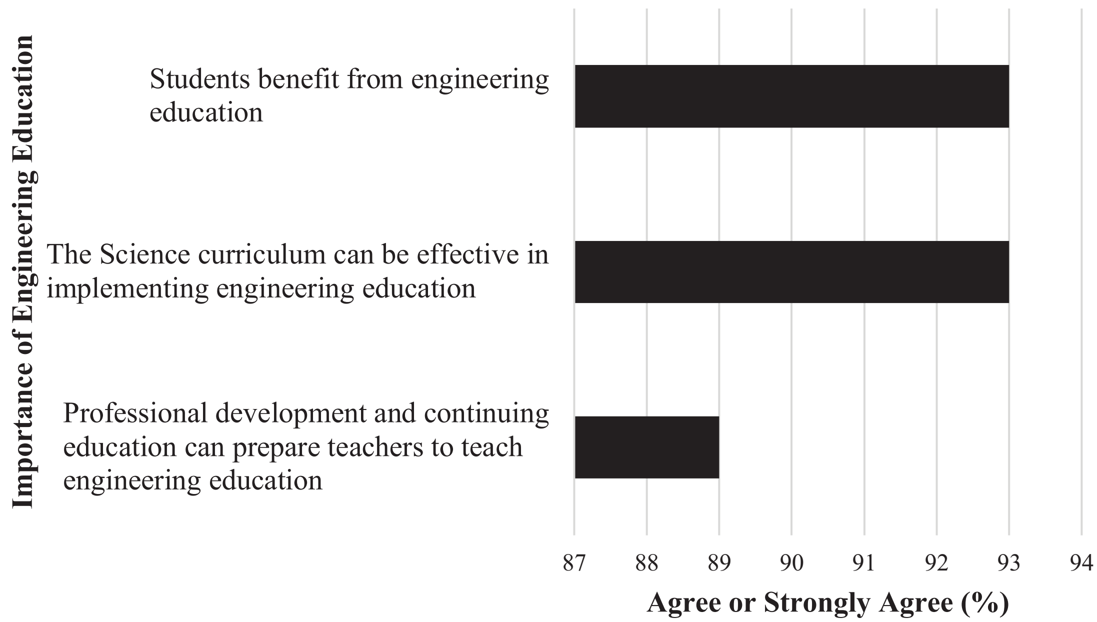


Figure 4.1 Percentage of curriculum administrators that agree or strongly agree with respective themes regarding the importance of engineering education.

Sub-Research Question 2 (SRQ2)

SRQ2: How familiar are curriculum administrators with engineering education?

Sub-Research Question 2 addressed curriculum administrators' familiarity with engineering education, professionally and within their respective districts'. SRQ2 was addressed by eight survey items (see Table 4.4).

Table 4.4

How Familiar Are Curriculum Administrators with Engineering Education?

Item	Response (%)*				
	NA	NR	N	S	VM
How familiar are you with Engineering Education?	11.6	32.6	16.3	30.2	9.3
Have you had any specific Engineering Education courses outside of your pre-service/in-service curriculum?	55.8	32.6	4.7	4.7	2.3

How confident do you feel about integrating more engineering education into your district's curriculum?	9.3	18.6	25.6	34.9	11.6
Current pre-service curricula is effective in supporting teachers' ability to teach Engineering Education at the beginning of their careers?	23.3	44.2	25.6	7.0	0
Current pre-service curriculum includes aspects of Engineering Education?	34.9	37.2	18.6	9.3	0
Engineering Education activities are in the district's curriculum?	7.0	34.9	9.3	39.5	9.3
How much do you know about the state science standards related to Engineering Education?	2.3	27.9	23.3	37.2	9.3
The district supports Engineering Education activities?	2.3	7.0	25.6	37.2	27.9

*NA = *Not at All*; NR = *Not Really*; N = *Neutral*; S = *Somewhat*; VM = *Very Much*

The analysis of Sub-Research Question 2 (see Figure 4.2) provided three themes including: curriculum administrators' pre-service experiences and/or knowledge in regard to engineering education, district-provided engineering activities, and pre-service teacher's preparation. In this analysis, curriculum administrators expressed a moderately low level of familiarity of engineering education (35% Somewhat or Very Much). A moderate level of curriculum administrators thought that their respective district has, or supports, engineering education activities (57% Somewhat or Very Much). And, an extremely low level (8% Somewhat or Very Much) conveyed that pre-service programs prepare teachers for roles teaching engineering education.

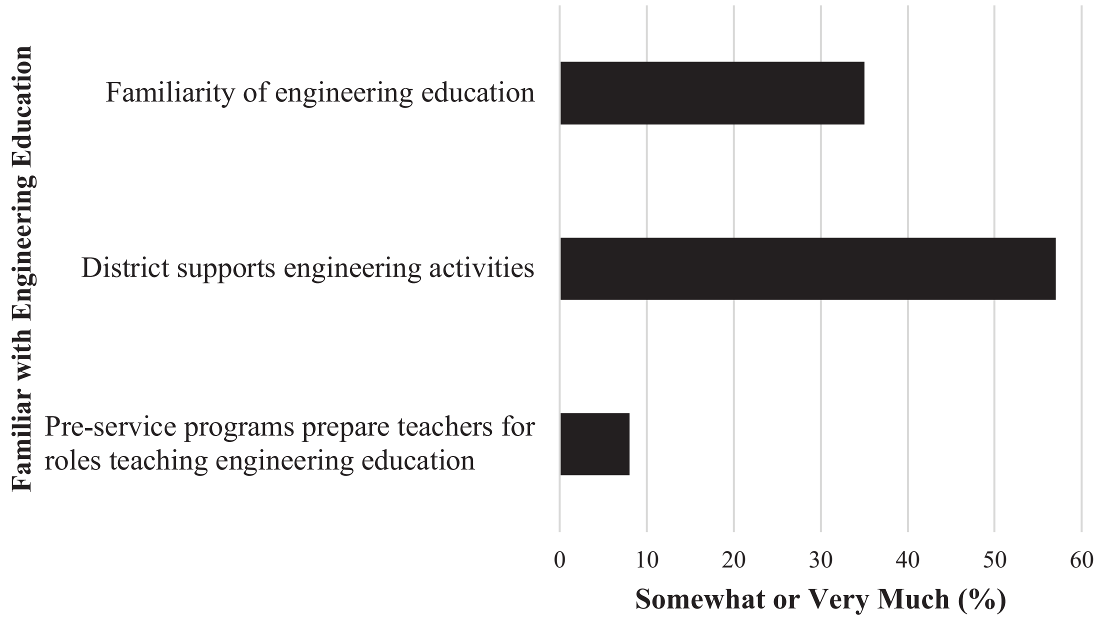


Figure 4.2 Percentage of curriculum administrators that are somewhat or very much familiar with engineering education in regard to respective themes

With respect to years of experience in the role of curriculum administrator, the rate of participants with ten years or less of experience (51.2%) was nearly identical for those with 11 years or more experience (48.8%). Curriculum administrators with 10 years or less experience expressed a moderately low level of familiarity of engineering education (40% Somewhat or Very Much). Curriculum administrators with 11 years or more experience expressed a low level of familiarity of engineering education (30% Somewhat or Very Much). Both groups of curriculum administrators thought that their respective district has, or supports, engineering education activities (57% Somewhat or Very Much). Curriculum administrators with 10 years or less experience conveyed an extremely low level (9% Somewhat or Very Much) of confidence that pre-service programs prepare teachers for roles teaching engineering education. Similarly, curriculum administrators with 11 years of more experience conveyed an extremely low level of confidence (7 % Somewhat or Very Much) (see Tables 4.5 and 4.6).

Table 4.5

How Familiar Are Curriculum Administrators with Engineering Education (10 Years or Less Experience)?

Item	Response (%)* NA	NR	N	S	VM
How familiar are you with Engineering Education?	9.1	31.8	18.2	31.8	9.1
Have you had any specific Engineering Education courses outside of your pre-service/in-service curriculum?	54.6	22.7	9.1	9.1	4.6
How confident do you feel about integrating more engineering education into your district's curriculum?	13.6	13.6	18.2	50.0	4.6
Current pre-service curricula is effective in supporting teachers' ability to teach Engineering Education at the beginning of their careers?	27.3	45.5	22.7	4.6	0
Current pre-service curriculum includes aspects of Engineering Education?	45.5	22.7	18.2	13.6	0
Engineering Education activities are in the district's curriculum?	9.1	36.4	4.6	45.5	4.6
How much do you know about the state science standards related to Engineering Education?	4.6	18.2	27.3	40.9	9.1
The district supports Engineering Education activities?	4.6	0.0	31.8	31.8	31.8

*NA = *Not at All*; NR = *Not Really*; N = *Neutral*; S = *Somewhat*; VM = *Very Much*

Table 4.6

How Familiar Are Curriculum Administrators with Engineering Education (11 Years or More Experience)?

Item	Response (%)* NA	NR	N	S	VM
How familiar are you with Engineering Education?	14.3	33.3	14.3	28.6	9.2
Have you had any specific Engineering Education courses outside of your pre-service/in-service curriculum?	57.1	42.9	0.0	0.0	0.0

How confident do you feel about integrating more engineering education into your district's curriculum?	4.8	23.8	33.3	19.1	19.1
Current pre-service curricula is effective in supporting teachers' ability to teach Engineering Education at the beginning of their careers?	19.1	42.9	28.6	9.52	0
Current pre-service curriculum includes aspects of Engineering Education?	23.8	52.4	19.1	4.8	0
Engineering Education activities are in the district's curriculum?	4.8	33.3	14.3	33.3	14.3
How much do you know about the state science standards related to Engineering Education?	0.0	38.1	19.1	33.3	9.5
The district supports Engineering Education activities?	0.0	14.3	19.1	42.9	23.8

*NA = *Not at All*; NR = *Not Really*; N = *Neutral*; S = *Somewhat*; VM = *Very Much*

Both groups expressed low levels of agreement overall (see Figure 4.3), in regard to that they were familiar with engineering education and that pre-service teachers were prepared to teach engineering education. However, curriculum administrators with 10 years or less experience had a higher percentage of participants who believed they were familiar with engineering education and that pre-service programs were preparing teachers to teach engineering education compared to their colleagues with 11 years or more of experience.

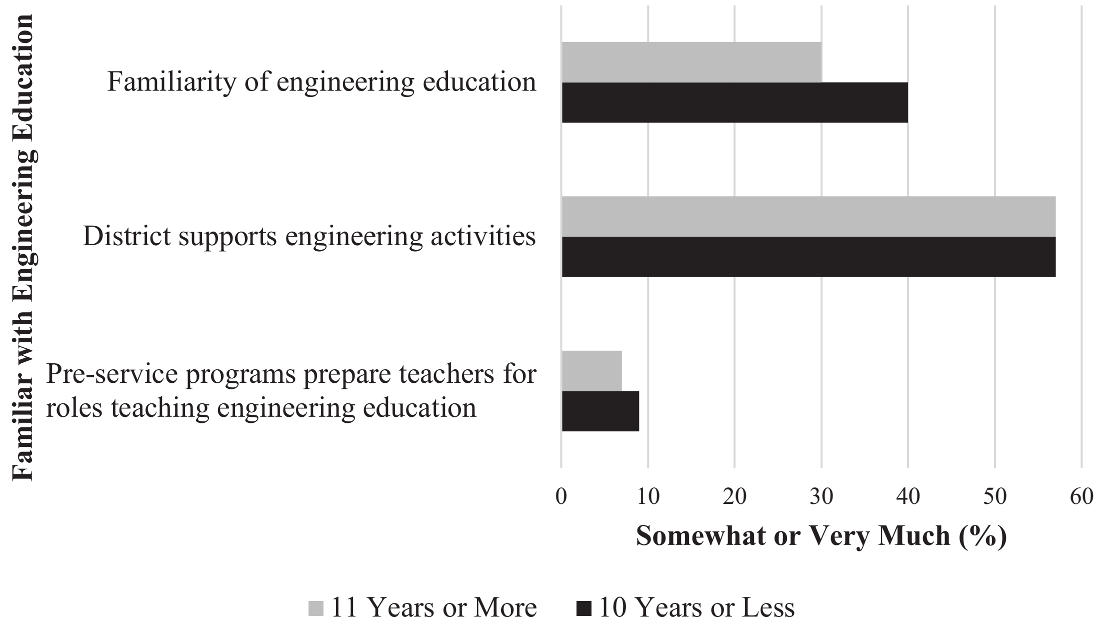


Figure 4.3 Percentage of curriculum administrators that are somewhat or very much familiar with engineering education in regard to respective themes by years of experience

Sub-Research Question 3 (SRQ3)

SRQ3: What do curriculum administrators consider are characteristics of engineering?

Sub-Research Question 3 addressed district curriculum administrators' stereotypical beliefs of engineering characteristics such as general, math, and science knowledge and skills, and collaboration and expressive abilities (e.g., speaking and writing). SRQ3 was addressed by seven survey items (see Table 4.7).

Table 4.7

What Do Curriculum Administrators Consider Are Characteristics of Engineering?

	Response (%)*				
Item	SD	D	N	A	SA
To what extent do you agree that engineering requires good verbal skills?	0	0	2.3	48.8	48.8
To what extent do you agree that engineering requires an ability to work well with people?	0	0	2.3	46.5	51.2

To what extent do you agree that engineering requires good writing skills?	0	0	2.3	51.2	46.5
To what extent do you agree that engineering requires doing well in science?	0	0	7.0	48.8	44.2
To what extent do you agree that engineering requires good math skills?	0	0	2.3	18.6	79.1
To what extent do you agree that engineering provides a means to earn good money?	0	0	2.3	48.8	48.8
To what extent do you agree that engineering requires an ability to fix things?	0	4.7	14.0	51.2	30.2

*SD = *Strongly Disagree*; D = *Disagree*; N = *Neutral*; A = *Agree*; SA = *Strongly Agree*

An analysis of Sub-Research Question 3 resulted in three themes including: positive outcomes, “soft” skills, and “hard” skills (see Figure 4.4).

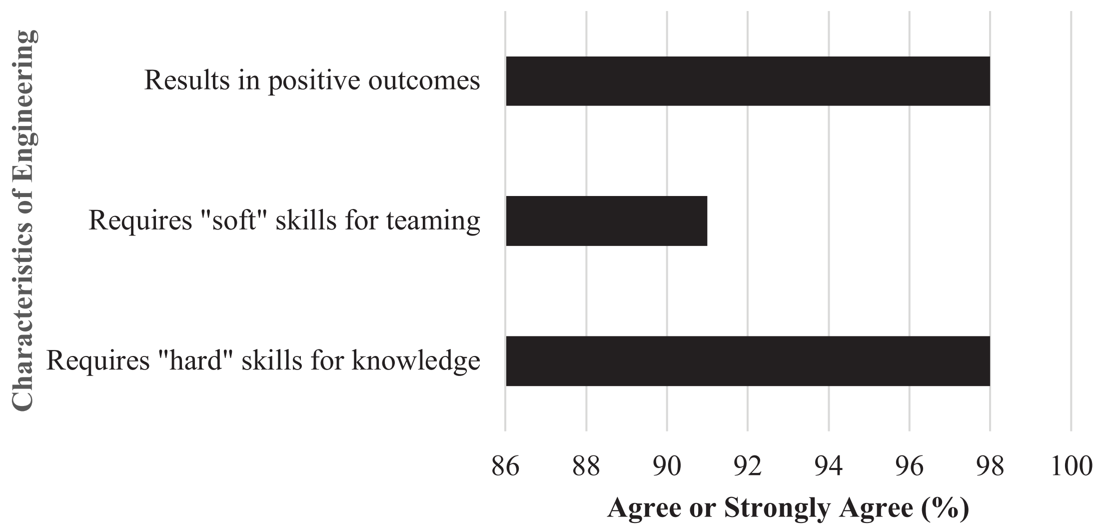


Figure 4.4 Percentage of curriculum administrators that agree or strongly agree with respective themes regarding characteristics of engineering

Curriculum administrators nearly all expressed that engineering provides good salaries (98% Agree or Strongly Agree). Good verbal and writing skills, along with an ability to work with others, were expressed as “soft” skills necessary in teaming (91% Agree or Strongly Agree). Also, curriculum administrators expressed an extremely high level of agreement that engineering requires hard skills in math, science, and the ability to problem solve (98% Agree or Strongly Agree).

Sub-Research Question 4 (SRQ4)

SRQ4: What do curriculum administrators identify as barriers in integrating engineering education?

Sub-Research Question 4 addressed barriers in integrating engineering education into curriculum. Sub-Research Question 4 was addressed by six survey items (see Table 4.8).

Table 4.8
What Do Curriculum Administrators Identify as Barriers in Integrating Engineering Education?

	Response (%)*				
Item	SD	D	N	A	SA
In the district, a barrier in integrating Engineering Education is a lack of teacher knowledge?	0	2.3	7.0	53.5	37.2
In the district, a barrier in integrating Engineering Education is a lack of training?	0	0	9.3	51.2	39.5
In the district, a barrier in integrating Engineering Education is a lack of time for teachers to learn about Engineering Education?	0	4.7	7.0	55.8	32.6
In the district, a barrier in integrating Engineering Education is a lack of administration support?	9.3	37.2	34.9	16.3	2.3
Most people feel that minority students can do well in engineering education?	0	9.3	16.3	39.5	34.9
Most people feel that female students can do well in engineering education?	0	7.0	18.6	34.9	39.5

*SD = *Strongly Disagree*; D = *Disagree*; N = *Neutral*; A = *Agree*; SA = *Strongly Agree*

The analysis of Sub-Research Question 4 (see Figure 4.5) provided three themes including: lack of teacher preparation and engineering knowledge, administrative support, and engaging historically underrepresented students in engineering (i.e., minorities and females).

A very high level of curriculum administrators responded that a lack of teacher preparation and engineering knowledge exists (90% Agree or Strongly Agree). Curriculum administrators' beliefs regarding administrative support and teacher training were expressed by a moderate level of agreement that a lack of administrative support and teacher training is a barrier to integrating engineering education (55% Agree or Strongly Agree). A moderately high level of curriculum administrators agree that historically underrepresented groups can be successful in engineering education (74% Agree or Strongly Agree).

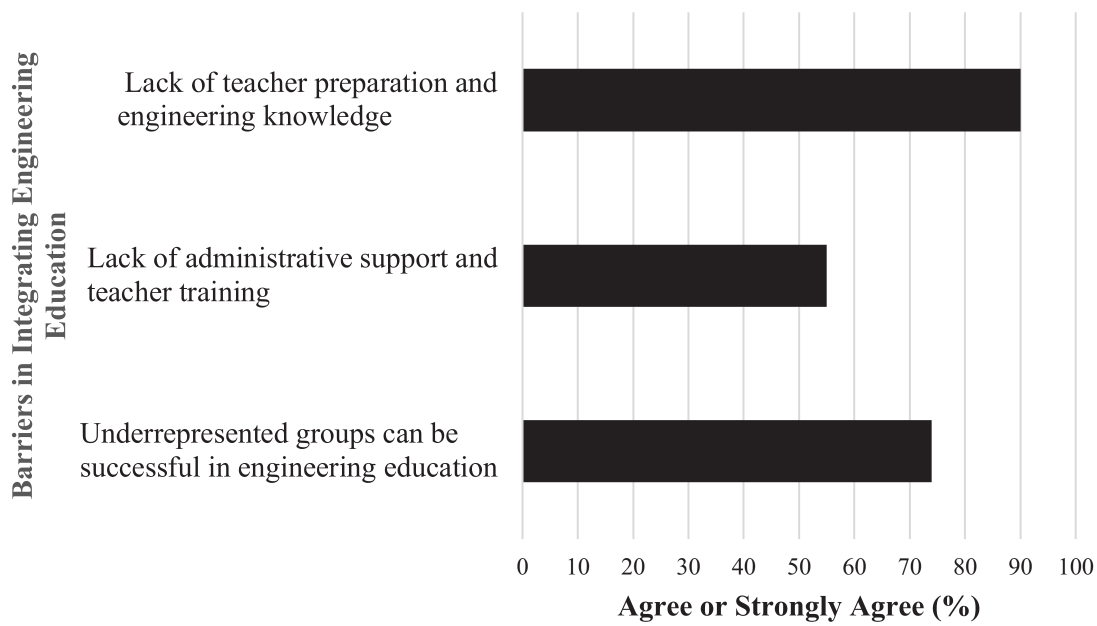


Figure 4.5 Percentage of curriculum administrators that agree or strongly agree with respective themes regarding barriers in integrating engineering education

Conclusion

There is high agreement from the curriculum administrators that the appropriate pre-service education is important for teachers teaching engineering education (84% Agree or Strongly Agree). In turn, there exists extremely low agreement among the curriculum administrators that current pre-service curricula support teachers' ability to teach, and contains aspects of, engineering education (8.2% Agree or Strongly Agree). In addition, 90% of curriculum administrators expressed agreement that the lack of teacher knowledge, training, and in-service time learning engineering education as a barrier for integrating engineering education. Despite the perceptions of a lack of pre-service curricula support and teacher familiarity barriers in engineering education, curriculum administrators agree that in-service teachers can be trained to effectively implement engineering education. Ninety-one percent (91%) of curriculum administrators expressed that professional development for in-service teachers is a means for teachers to learn more about engineering education through in-service, workshops, college courses, and/or peer-training.

Currently, 57% of curriculum administrators expressed there are engineering education activities (e.g., curriculum, programs, or courses) in their districts. Therefore, nearly half may rely on NDE and/or their district's policy makers to support the procurement of engineering education activities. However, 19% agreed that a lack of administrative support is a barrier to integrating engineering education. Those curriculum administrators represented six school districts of 500 or fewer students and two districts of between 2,501-5,000 students.

Nearly all curriculum administrators expressed that the Science curriculum is an effective means to deliver engineering education and its components (96% Agree or Strongly Agree). The study revealed that engineering education can promote: an understanding of the technical world, workforce preparation, and enjoyment of learning through the Science curriculum. Curriculum administrators also expressed that engineering education benefits students through its concepts and practices such as the use of the design process, project planning, technology development, and the application of the hard sciences and mathematics. Additionally, they expressed that engineering education may help foster students' understanding of their impact on society. Furthermore, the study revealed that historically under-represented groups such as minorities and females are believed to be able to be successful in engineering education.

Chapter 5

Conclusions, Discussion, and Suggestions for Future Research

The Nebraska Department of Education implemented the *Nebraska's College and Career Readiness Standards for Science* (NCCRS-S) in the fall of 2018 (NDE, 2017a). NCCRS-S provides science objectives that utilize engineering concepts and practices involving technology and engineering design to reinforce crosscutting concepts across all grade levels (NDE, 2017a). The engineering-based crosscutting concepts can provide effective, authentic means to engage students throughout all academic and ability levels. The fall 2018 rollout (i.e., the dissemination, training, and evaluation of best practices) of NCCRS-S is the responsibility of school districts' curriculum administrators and will highlight their ability to ensure the engineering components of the NCCRS-S do not present pedagogical difficulties for teachers. Therefore, it is vital to understand these administrators' perceptions of engineering education, such as its importance and their familiarity with it, as it can impact how effectively the engineering components of the NCCRS-S are implemented in their respective districts.

Teachers' effective implementation of NCCRS-S, in particular its engineering components, will depend on the level and type of support they receive from administrators to teach their students. As planned, NDE will "support educators while they explore and implement the CCR-Science standards, through an implementation plan that includes; exploration, initial implementation, scale up, deep implementation, and sustainability" (p. 4). The implementation plan will consist of guidance related to systems alignment, professional development, curriculum, instruction, and resources (NDE, 2017b). Curriculum administrators will be tasked with the management and assessment of the products of NDE's guidance to ensure appropriate, effective support of their respective teachers. Some curriculum administrators will be able to employ extant engineering education products in respective districts, whereas others will have to seek products and means independently through partnerships with similarly sized districts, or through guidance from NDE.

More important than academic or material resources are the adequately prepared and equipped human resources available to deliver the content. This study identified curriculum administrators' need for support for the appropriate, effective implementation of engineering education at the start of the teacher education process (pre-service) and the teacher's professional educational experience (in-service).

Based on the findings of this study, the following questions arise: What revisions, or alternatives, can be established at Nebraska teacher preparation programs to prepare pre-service teachers to teach engineering education in their prospective districts?, What continuing education/graduate education programming can be established at Nebraska teacher education programs to equip in-service teachers to teach engineering education in their respective districts?, and How can NDE and state postsecondary education and/or engineering colleges develop and assess the implementation of NCCRS-S in support of public school districts?

Discussion

Pre-service programs

Currently, none of the 16 teacher preparation programs in the state of Nebraska offer a teacher certification/endorsement in engineering education (NDE, 2018f). This is similar to the majority of post-secondary pre-service institutions nationwide that do not provide engineering education as an integral aspect of their teacher education programs. A program such as UTeach has addressed this issue, in part, in that it has certified nearly 1,000 STEM-certified Science teachers in 22 states (UTeach, 2018). Whereas secondary Science pre-service programs require several science content courses, most Elementary Education majors only receive one Science methods course as a part of the multiple methods required including Mathematics, Social Studies, and Reading. Pre-service engineering education opportunities should be offered for teacher education majors to be prepared to teach engineering education. The opportunities should provide an emphasis on design, the design process, and/or explicit STEM pedagogy. ATOMS (Accomplished Teachers of Mathematics and Science), exclusive to North Carolina State University, does this as a 27-hour pre-admittance program (DiFrancesca, Lee, & McIntyre, 2014). Although not as extensive as ATOMS, an example within the state of Nebraska of a pre-service General Science course and laboratory (i.e., pre-admittance) is a course titled *Science Methods and Design.*

Science Methods and Design was developed by this researcher to introduce STEM concepts and their applications to undergraduate students. The course fosters 21st Century Learning through study and work in active, experiential learning environments through all phases of near-space experiments on high-altitude balloon platforms. Course work includes research question development, experiment hardware fabrication, experiment software integration, payload launch and recovery, data analysis, and formal experiment results reporting. The Scientific Method and Process of Design serve as a framework for students' work and experiences in the course, as the course models the interdisciplinary connectedness of academic fields, industry, and the community to encourage collaborative discovery to realize STEM concepts, practices, and innovation. Albeit a general science course available to all majors, this course has been strongly advised for Elementary Education majors to bolster their aptitude and efficacy in interdisciplinary knowledge and skills.

Therefore, teacher education programs in Nebraska can better prepare pre-service teacher candidates for teaching and learning within NCCRS-S by: revising extant Science or STEM general science courses to employ engineering concepts and practices, revising extant required Science methods courses to reflect NCCRS-S requirements, and/or developing and offering general education Science courses with a foundation in engineering-related pedagogy.

In-service programs

In-service teachers should be afforded opportunities to familiarize themselves with engineering education through professional development to be effective educators guided by NCCRS-S. In an effort to do this, an eastern Nebraska school district mobilized volunteer Science teachers over the summer to draft Science unit/lesson plans based on the NCCRS-S. The unit/lesson plans would be available for Science teachers' use for the 2018-19 school year, and district "teacher content days" would be devoted to training and evaluating the use of district-developed materials and practices.

The use of summer professional development is a best practice, and can be beneficial for Nebraska curriculum administrators. This should involve professional development activities conducted during summer sessions reinforced with scheduled, intermittent year-long reviews and evaluations. These efforts have proven successful in changing participants' (i.e., district personnel) perceptions of engineering, technology, and the engineering design process in a positive and constructive way through engineering design challenges, teamwork, and lesson planning (Pelletier et al., 2009). In addition, exposure and engagement of teachers to the implementation of engineering education methodology in the classroom can increase teachers' awareness and understanding of the importance of such activities and cause a shift in teachers' classroom pedagogy to a multi-disciplinary model of inquiry-oriented problem-based learning (High et al., 2009). Classroom applications of engineering concepts and practices fosters teachers' familiarity with engineering education.

As a result, teacher education programs should support the changing Nebraska Science landscape by offering graduate courses for in-service teachers with a focus on Engineering Education. As with pre-service programs, graduate programs can better prepare in-service teacher candidates for teaching and learning within NCCRS-S by: revising extant graduate education Science courses to employ engineering concepts and practices to reflect NCCRS-S requirements and/or developing and offering Engineering Education courses. An example within the state of Nebraska of a graduate engineering education course – required for a Masters or Doctorate with a STEM Concentration – is a course titled *Invention & Innovation in Engineering Education.*

Invention & Innovation in Engineering Education was developed by this researcher to introduce engineering education pedagogy to in-service educators. The course was designed for primary, elementary, middle, or high school teachers. The course addresses emerging trends in STEM education through the use of engineering design for teaching and learning K-12 STEM content. K-12 teachers, as graduate candidates, develop applicable, interactive, classroom-ready engineering education experiences through lecture, group discussion, research, and teacher-developed projects. The systematic use of the Engineering Design Process is central to the teachers' experiences and products, as the course models engineering design as a foundational strategy for encouraging student invention and innovation within their respective learning environments. Teachers' curriculum-development work is aligned to current Nebraska science and mathematics standards as well as with the interdisciplinary context of STEM instruction through the instructional lens and context of engineering.

Preparation of in-service educators for the engineering requirements of NCCRS-S, also can be fulfilled through a partnership between NDE and public school districts to develop grant-funded engineering education certificate programs with teacher education programs. The grant-funded engineering education certificate programs can serve to equip Science in-service educators to effectively plan, teach, and assess engineering in their classrooms. Staff development programs such as the Career Ladder Programs between Omaha Public Schools and area universities including the University of Nebraska at Omaha, Midland University, and Creighton University prepare non-, or under-, qualified in-service educators in high-need areas such as Reading, Special Education, Early Childhood Education, and support staff in the area of Paraprofessional to Teacher.

Engineering education certificate programs can consist of nine hours required engineering education courses (e.g., design, the engineering design process, and teaching and learning in engineering) and six hours of elective content-related courses. These courses can be offered as hybrid semester courses requiring four face-to-face class meetings (typically once-a-month) with online or distance learning the weeks in between face-to-face class meetings. Online or distance learning weeks can constitute instruction, assigned readings, online discussions, research, group activities, presentations, and/or assessments.

Suggestions for Future Research

This study proved timely in its inquiry of curriculum administrators' perceptions of K-12 engineering education due to 2017 adoption and 2018 implementation of the Nebraska Department of Education's *Nebraska's College and Career Readiness Standards for Science* (NCCRS-S). The researcher's experience in the field of K-12 engineering education provided foresight to the findings of the study which validate collaborative initiatives to provide robust engineering education opportunities in the state of Nebraska.

This study suggests future research in Nebraska pre-service teacher education programs' preparation of their candidates to teach in 21st-century classrooms as required by NCCRS-S. Such a study can identify what currently exists, what factors determine what is required for an endorsement, and what opportunities exist for continuing education specific to engineering education.

Also, a programmatic research study regarding NDE's (2017) effort to provide implementation and educator support through "guidance related to systems alignment, professional learning, curriculum, instruction, resources, and assessment" (p. 4) is warranted. The study can analyze the method(s) of engineering education integration supported by NDE (e.g., state-supported curriculum, district-developed curriculum, or vendor-provided curriculum). In addition, the *NDE STEM Approach* can be explored to determine the pervasiveness, and effectiveness, of engineering education integration (i.e., selected products, interdisciplinary units/themes, electives, programs, or academies/magnets).

Future research pertaining to Nebraska Science teachers' engineering education efficacy (i.e., preparedness and familiarity) utilizing the refined DET Survey (Hong et al, 2011) would complement this current study. Furthermore, a psychometric evaluation of this study's instrument, Engineering Education Survey, can be conducted to provide an improved study of district administration, in addition to curriculum administrators, perceptions of engineering education.

Lastly, based on the positive trends in engineering-related career fields and enrollment in state universities' engineering programs, another area for future research can address industry efforts to recruit and train new employees, and investigations of the K-12 preparation/opportunities experienced by incoming freshmen, respectively.

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Appendix A

University of Nebraska IRB Approval Letter

NEBRASKA'S HEALTH SCIENCE CENTER

Office of Regulatory Affairs (ORA)
Institutional Review Board (IRB)

August 3, 2018

Derrick Nero, MA/MS
Teacher Education
UNO - VIA COURIER

IRB # 544-18-EX

TITLE OF PROPOSAL: Perceptions of School District Curriculum Administrators Regarding K-12 Engineering Education

The Office of Regulatory Affairs (ORA) has reviewed your application for *Exempt Educational, Behavioral, and Social Science Research* on the above-titled research project. According to the information provided, this project is exempt under 45 CFR 46:101b, category 2. You are therefore authorized to begin the research.

It is understood this project will be conducted in full accordance with all applicable HRPP Policies. It is also understood that the ORA will be immediately notified of any proposed changes for your research project.

Please be advised that this research has a maximum **approval period of 5 years** from the original date of approval and release.

If the research is completed prior to 5 years, please notify the Office of Regulatory Affairs at irbora@unmc.edu. If this study continues beyond the five year approval period, the project must be resubmitted in order to maintain an active approval status.

Sincerely,

Signed on: 2018-08-03 12:06:00.000

Gail Kotulak, BS, CIP
IRB Administrator III
Office of Regulatory Affairs

Appendix B

Permission to Use DET Survey by Purzer

Subject: RE: Interest in revised DET Survey
Date: Friday, May 25, 2018 at 10:48:46 AM Central Daylight Time
From: Purzer, Senay
To: Derrick Nero
Attachments: image001.png, DET_April2016_INSPIRE_short_updated.pdf

Derrick,

Thanks for following up. I included the DET survey with a cover page that includes instructions on citations.

Şenay Purzer (Shan-eye)
Associate Professor
School of Engineering Education
Purdue University
purzer@purdue.edu
Phone: 765.496.1684
Fax: 765. 496.0004

From: Derrick Nero <dnero@unomaha.edu>
Sent: Friday, May 25, 2018 10:40 AM
To: Purzer, Senay <purzer@purdue.edu>
Subject: Re: Interest in revised DET Survey

Dr. Purzer,

Thank you for considering your support of my dissertation study's use of the DET Survey. Upon receipt of the survey, are there any guidelines you require before its use in my study?

Thanks again. Have a great weekend!

Derrick A. Nero, M.S.
Engineering Education Instructor
Teacher Education | Roskens 406J
University of Nebraska Omaha | unomaha.edu

402.554.3343
dnero@unomaha.edu

Strive for perfection in everything you do. Take the best that exists and make it better. When it does not exist, design it. - Sir Henry Royce

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From: "Purzer, Senay" <purzer@purdue.edu>
Date: Wednesday, May 9, 2018 at 4:28 PM
To: "Derrick A. Nero" <dnero@unomaha.edu>
Subject: RE: Interest in revised DET Survey

Derrick,

Thanks for your interest. I can send you a copy tomorrow.

Şenay Purzer (Shan-eye)
Associate Professor
School of Engineering Education, Purdue University

Fulbright Specialist since 02/2018.
Associate Editor, Journal of Pre-college Engineering Education Research (JPEER). https://docs.lib.purdue.edu/jpeer/
Board Member, NARST: A worldwide organization for improving science teaching and learning through research. http://www.narst.org

Email: purzer@purdue.edu Phone: (765) 496-1684 Fax: (765) 496-0004

From: Derrick Nero <dnero@unomaha.edu>
Sent: Wednesday, May 09, 2018 10:34 AM
To: Purzer, Senay <purzer@purdue.edu>; cardella@purdue.edu
Subject: Interest in revised DET Survey

Good morning,

I am interested in the use of the revised DET Survey (Using Factor Analysis To Re-Visit The Teaching Design, Engineering, And Technology (DET) Survey) as the basis for a survey I would like to use for my dissertation "A Mixed-Method Study of School District Curriculum Administrators' Perceptions of K-12 Engineering Education". Your feedback is truly appreciated.t

Thank you for your consideration.

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Nebraska UNIVERSITY OF Omaha

Appendix C

Why This Questionnaire?
The results from this questionnaire will be used to develop more effective pre-service and in-service engineering programs for districts. Your responses are extremely valuable to this development, but your responses will be held in strict confidence—only aggregated results will be disseminated in any fashion.

Definition of Engineering Education
Engineering education, as defined by the National Academy of Engineering (2009), is curriculum that teaches and assesses concepts and practices of engineering, design, the engineering design process, technology, and optimization. This entails an iterative process of knowledge acquisition, application by means of attained skills, and evaluation against given criteria. Please note that it is separate from the use of computers and educational technology in the classroom. It is also distinctly different from job training or vocational education.

This questionnaire has been modified for its particular population from The Design, Engineering, and Technology (DET) Survey (Hong, Purzer, & Cardella, 2011). The DET Survey was initially developed by researchers at Arizona State University (Yaşar, Baker, Robinson-Kurpius, Krause, & Roberts, 2006). The instrument was then further analyzed and refined by researchers at Purdue University (Hong et al., 2011). The term "Design/Engineering/Technology" or DET, is synonymous with engineering education. The two encompass a number of concepts and skills, including the ability to:

- identify a problem or a need to improve on current technology,
- propose a problem solution - solutions may be conceptual or physical objects,
- identify the costs and benefits of solutions,
- select the best solution from among several proposed choices by comparing a given solution to criteria it was designed to meet,
- implement solutions by building a model or a simulation, and
- communicate the problem, the process and the solution in various ways.

Examples of different functions respective of both, engineering education and DET, include:

- Designing activities for a school outing,
- Building a paper bridge that will support a weight,
- Designing the layout of a new playground,
- Inventing a new device or process,
- Designing and piloting a new device that enables paraplegics to experience a better quality of life,
- Analyzing the economics of two different types of paper towels in absorbing water, and
- Building working models of devices or processes.

Engineering Education Survey

Section I

Please answer the following questions by marking the most appropriate answer.

Position/Role (Check all that apply):

- ○ Curriculum Administrator
- ○ Instructional Facilitator
- ○ Lead Teacher
- ○ Superintendent
- ○ Assistant Superintendent

Experience as Curriculum Administrator:

- ○ 0-5 years
- ○ 6-10 years
- ○ 11-15 years
- ○ 16-20 years
- ○ 21+ years

District enrollment:

- ○ 1-250 students
- ○ 251-500 students
- ○ 501-1,000 students
- ○ 1,001-1,500 students
- ○ 1,501-2,500 students
- ○ 2,501-5,000 students
- ○ 5,001-10,000 students
- ○ 10,001+ students

District geographical location in state:

- ○ Central (includes: Buffalo, Custer, Dawson, Greeley, Hall, Howard, Sherman, and Valley counties)
- ○ East Central (includes: Butler, Cass, Colfax, Dodge, Douglas, Hamilton, Lancaster, Merrick, Nance, Platte, Polk, Sarpy, Saunders, Seward, Washington, and York counties)

○ North Central (includes: Arthur, Blaine, Boyd, Brown, Cherry, Garfield, Grant, Holt, Hooker, Keya Paha, Logan, Loup, McPherson, Rock, Thomas, and Wheeler counties)

○ Northeast (includes: Antelope, Boone, Burt, Cedar, Cuming, Dakota, Dixon, Knox, Madison, Pierce, Stanton, Thurston, and Wayne counties)

○ Panhandle (includes: Banner, Box Butte, Cheyenne, Dawes, Deuel, Garden, Kimball, Morrill, Scottsbluff, Sheridan, and Sioux counties)

○ South Central (includes: Adams, Franklin, Furnas, Gosper, Harlan, Kearney, Phelps, and Webster counties)

○ Southeast (includes: Clay, Fillmore, Gage, Jefferson, Johnson, Nemaha, Nuckolls, Otoe, Pawnee, Richardson, Saline, and Thayer counties)

○ Southwest (includes: Chase, Dundy, Frontier, Hayes, Hitchcock, Keith, Lincoln, Perkins, and Red Willow counties)

Please consider the definition and examples given on the previous page while answering the following questions regarding engineering education.

Section II

Please answer the following questions by marking the most appropriate answer.	**1 – Not at all**	**2 – Not Really**	**3 – Neutral**	**4 – Somewhat**	**5 – Very Much**
1. How familiar are you with engineering education?	1	2	3	4	5
2. Have you had any specific engineering education courses outside of your pre-service/in-service curriculum?	1	2	3	4	5
3. Current pre-service curriculum includes aspects of engineering education?	1	2	3	4	5
4. Current pre-service curricula is effective in supporting teachers' ability to teach engineering education at the beginning of their career?	1	2	3	4	5
5. How confident do you feel about integrating more engineering education into your district's curriculum?	1	2	3	4	5
6. Pre-service education is important for teaching engineering education?	1	2	3	4	5
7. Engineering education activities are in the district's curriculum?	1	2	3	4	5
8. The district supports engineering education activities?	1	2	3	4	5
9. Engineering education should be integrated into the K-12 curriculum?	1	2	3	4	5

To what extent do you agree that engineering...	**1 – Strongly Disagree**	**2 – Disagree**	**3 – Neutral**	**4 – Agree**	**5 – Strongly Agree**
10. Requires an ability to work well with people?	1	2	3	4	5
11. Requires good verbal skills?	1	2	3	4	5
12. Requires good math skills?	1	2	3	4	5
13. Requires good writing skills?	1	2	3	4	5
14. Provides a means to earn good money?	1	2	3	4	5
15. Requires an ability to fix things?	1	2	3	4	5
16. Requires doing well in science?	1	2	3	4	5

To what extent do you agree with the following statements...	**1 – Strongly Disagree**	**2 – Disagree**	**3 – Neutral**	**4 – Agree**	**5 – Strongly Agree**
17. Most people feel that female students can do well in engineering education?	1	2	3	4	5
18. Most people feel that minority students can do well in engineering education?	1	2	3	4	5

Through the Science curriculum, it is important to include...	**1 – Strongly Disagree**	**2 – Disagree**	**3 – Neutral**	**4 – Agree**	**5 – Strongly Agree**
19. Planning of a project?	1	2	3	4	5
20. Using engineering in developing new technologies?	1	2	3	4	5

The district can learn more about engineering education through...	1 – Strongly Disagree	2 – Disagree	3 – Neutral	4 – Agree	5 – Strongly Agree
21. In-service?	1	2	3	4	5
22. Workshops?	1	2	3	4	5
23. Peer training?	1	2	3	4	5
24. College courses?	1	2	3	4	5

To what extent do you agree that...	1 – Strongly Disagree	2 – Disagree	3 – Neutral	4 – Agree	5 – Strongly Agree
25. Students should understand the design process?	1	2	3	4	5
26. Students should understand the use and impact of engineering education?	1	2	3	4	5
27. Students should understand the science underlying engineering education?	1	2	3	4	5
28. Students should understand the types of problems to which engineering education can be applied?	1	2	3	4	5
29. Students should understand the process of communicating technical information?	1	2	3	4	5

To what extent do you agree that...	1 – Strongly Disagree	2 – Disagree	3 – Neutral	4 – Agree	5 – Strongly Agree
30. The science curriculum should prepare young people for the world of work?	1	2	3	4	5
31. The science curriculum should promote an enjoyment of learning?	1	2	3	4	5
32. The science curriculum should help students develop an understanding of the technical world?	1	2	3	4	5
33. The science curriculum should educate scientists, engineers and technologists for industry?	1	2	3	4	5
34. The science curriculum should promote an understanding of how engineering education affects society?	1	2	3	4	5

How strongly do you agree that in your district...

1 – Strongly Disagree	2 – Disagree	3 – Neutral	4 – Agree	5 – Strongly Agree

35. A barrier in integrating engineering education is a lack of time for teachers to learn about Engineering Education?
36. A barrier in integrating engineering education is a lack of teacher knowledge?
37. A barrier in integrating engineering education is a lack of training?
38. A barrier in integrating engineering education is a lack of administration support?

How strongly do you agree that...

1 – Strongly Disagree	2 – Disagree	3 – Neutral	4 – Agree	5 – Strongly Agree

39. Engineering education has positive consequences for society?

How much do you know about...

1 – Very little	2 – Little	3 – Neutral	4 – Much	5 – Very Much

40. The state science standards related to engineering education?

Section III
Please answer the following questions by marking the most appropriate answer.

1 – Not at all	2 – Not Really	3 – Neutral	4 – Somewhat	5 – Very Much

41. How enthusiastic do you feel about including engineering education in your district?
42. How prepared do you feel about including engineering education in your district?
43. How important is it for you that engineering education activities are aligned to state science standards?

Appendix D

Engineering Education Survey (by Factors)

Factor 1: Importance of Engineering Education

1. Students should understand the use and impact of engineering education?
2. Students should understand the science underlying engineering education?
3. Students should understand the design process?
4. Students should understand the types of problems to which engineering education can be applied?
5. The science curriculum should promote an understanding of how engineering education affects society?
6. Teachers can learn more about engineering education through in-service?
7. Students should understand the process of communicating technical information?
8. The science curriculum should prepare young people for the world of work?
9. The science curriculum should promote an enjoyment of learning?
10. Engineering education should be integrated into the K-12 curriculum?
11. Teachers can learn more about engineering education through workshops?
12. Teachers can learn more about engineering education through college courses?
13. In a science curriculum, it is important to include the use of engineering in developing new technologies?
14. Teachers can learn more about engineering education through peer training?
15. The science curriculum should help students develop an understanding of the technical world?
16. The science curriculum should educate scientists, engineers and technologists for industry?
17. In a science curriculum, it is important to include planning of a project??
18. Pre-service education is important for teaching engineering education?
19. Engineering education has positive consequences for society?

Factor 2: Familiarity with Engineering Education

20. How familiar are you with engineering education?
21. Have you had any specific engineering education courses outside of your pre-service/in-service curriculum?
22. How confident do you feel about integrating more engineering education into your district's curriculum?
23. Pre-service curriculum is effective in supporting teachers' ability to teach engineering education at the beginning of their careers?
24. Pre-service curriculum includes aspects of engineering education?
25. Engineering Education activities are in the district's curriculum?
26. I know the state science standards related to engineering education?
27. The district supports engineering education activities?

Factor 3: Characteristics of Engineering
28. Engineering requires good verbal skills?
29. Engineering requires an ability to work well with people?
30. Engineering requires good writing skills?
31. Engineering requires doing well in science?
32. Engineering requires good math skills?
33. Engineering provides a means to earn good money?
34. Engineering requires an ability to fix things?

Factor 4: Barriers in Integrating Engineering Education
35. A barrier in integrating engineering education is a lack of teacher knowledge?
36. A barrier in integrating engineering education is a lack of training?
37. A barrier in integrating engineering education is a lack of time for teachers to learn about engineering education?
38. A barrier in integrating engineering education is a lack of administration support?
39. Most people feel that minority students can do well in engineering education?
40. Most people feel that female students can do well in engineering education?