AN ASSESSMENT OF KNOWLEDGE AND SKILLS COMPETENCIES FOR WIND ENERGY TECHNICIAN I: A DELPHI METHODOLOGY

A Record of Study

by

RICHARD HOWARD COPPEDGE

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

Chair of Committee,	Robert Strong
Co-Chair of Committee,	Rudy Ritz
Committee Members	Theresa Murphrey
	Johnathan Ulmer
Head of Department,	John Elliot

December 2015

Major Subject: Agricultural Education

ABSTRACT

Harvesting power for mankind is not a new concept, but the ideology of wind energy is considered an emerging field. The United States alone has grown from producing 3,000 megawatts in 2000 to 39,000 megawatts today (Liming & Hamilton, 2011). With the growth in the wind energy industry new jobs are being added daily. With this growth comes a need to better understand what knowledge and skills are expected for a person to have to enter the field.

The goal of Career and Technology Education (CTE) is to prepare individuals for the world after high school. As new occupations form there is a need for CTE programs to take a deeper look at what courses are offered and how the curriculum for those courses are developed.

This Delphi study sought to identify the knowledge and skills a person should possess to successfully be employed as a wind energy technician. The theory of content-centered education was utilized to drive this study. The theory emphasizes the use of industry experts to develop curriculum to better prepare students for the industry itself.

To develop the instrument, the researcher identified six colleges in the state of Texas which offered a wind energy technician certificate I. The curricula from the six different programs were combined to create the instrument. The instrument consisted of one hundred twenty-two knowledge and skill competencies which were divided into 11 categories. The instrument was sent to three different instructors, each of whom taught

wind energy at a college in the state of Texas, for validation.

The study consisted of 17 individuals, with the title of wind energy technician, to form the panel of experts. The Delphi process relied on three rounds to form a consensus on the specific knowledge and skill competencies the panel of experts believed were important for a person to know or possess to be successfully employed as a wind energy technician. The panel of experts where given the opportunity to add to the list of knowledge and skill competencies during the first round, but no further competencies were added.

The study identified 86 knowledge and skill competencies which achieved a level of agreement to meet consensus. The consensus was based on a 75% level of agreement. There were thirty-two knowledge competencies and fifty-four skill competencies which the panel of experts achieved a sufficient level of agreement on. These competencies could potentially be utilized to begin a new Career and Technology Education program which prepares secondary students for a successful career in the wind energy industry.

DEDICATION

This record of study is dedicated to my family, without them I would never had the courage to start school again.

To my mother Patti Coppedge, my biggest fan. You never missed an opportunity to say you were proud of me. You have driven countless miles just so you would never miss a game, a concert, or any event in my life, no matter how small.

To my father Richard Coppedge, the smartest man I know. You are the example of the man I hope to become one day. You have always taught me to just do what is right.

To Dallas, the biggest hero in my life. Ever since I can remember I have followed you around, because I look up to you. There is nothing you cannot fix, and nothing you wouldn't do for family.

To Rick your dedication to me during this time has been unswerving. You've kept me inspired and sane.

ACKNOWLEDGEMENTS

I would like to thank my committee chairs, Dr. Robert Strong and Dr. Rudy Ritz, and my committee members, Dr. Theresa Murphrey and Dr. Jon Ulmer. Their support and guidance has been unwavering, and truly appreciated.

I thank my chair, Dr. Robert Strong. Dr. Strong is the example of the researcher I hope to become one day. His dedication to our profession and its advancement is a testament for any graduate student.

I thank my chair, Dr. Rudy Ritz. Dr. Ritz sets the bar for the type of professor I hope to be. His style of teaching inspires students and creates an atmosphere which cultivates learning.

I thank Dr. Theresa Murphrey. Dr. Murphrey heard my ideas for research and was able to form them into what this study has become.

I thank Dr. Jon Ulmer. Dr. Ulmer set me on the correct path to identify my competencies and challenged me to expand the research into a study which would be meaningful.

I would like to thank my high school agriculture science teachers Sue Witt and Russell Thomas. They inspired my love for agricultural education and are examples of the selfless dedication teachers provide to their students.

I would like to thank the members of the Tower Climbing Grease Monkeys, whom without this study would not be possible. I have truly met some hardworking and knowledgeable guys whom care greatly about their profession and sharing it with others.

Finally I would like to thank Leigha Pate and Ashley Ivins, my partners from the beginning. We started this journey together and along the way formed a bond which has kept me going. Your friendship has made the trip worthwhile.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

CHAPTER I

INTRODUCTION

According to Jennings (2009) the renewable energy sector is growing amidst rising concerns about oil depletion and climate change. The renewable energy sector is expected to add half of a million jobs between 2009 and 2020, both directly and indirectly (Wei, Patadia, & Kammen, 2009). The United States has sought to ensure 20% of the nation's electricity production comes from wind power by 2030 (Baring-Gould, Flowers, Kelly, Barnett, and Miles, 2009). The task of meeting the 20% goal would have challenges which need to be met, including an increase in the trained workforce, the development of a national educational infrastructure, and raised awareness in American schools of the benefits of wind energy.

National Outlook for Wind Energy

Gray and Herr (2006) indicated there is an "unprecedented shortage of skilled workers" in the nation, which is predicted to incur a 5% decrease in the gross domestic product (p. 17). The U.S. House of Representatives passed the American Clean Energy and Security Act in 2009, which provided provisions which would aid in developing programs to train individuals for occupations in the green industry (Robertson, 2010). Two of these provisions were to provide grants for clean energy curriculum development and to develop energy-training programs, which would train the workforce in the renewable energy sector.

State of Texas Outlook for Wind Energy

According to the American Wind Energy Association (AWEA) the states which produce the most electricity from wind energy are Texas, Iowa, California, and Oklahoma (2014). Texas is the overall leading state for energy production and consumption, containing 22% of the nation's installed wind capacity and still continues to grow (Office of the Governor, 2012). Texas employees more than 55,000 renewable energy workers ranging from wind turbine manufacturing to wind turbine maintenance (Pew Charitable Trusts, 2009).

Robertson (2010) indicated the American Recovery and Reinvestment Act was signed into law in 2009 by President Barack Obama and provides $787 billion in loans, tax cuts, grants, and contracts to stimulate the economy. The state of Texas received more than $590 million dollars from this Act; $90 million of this money was allocated for the Skills Development Fund, which can be used for skills training in green jobs.

The Texas Renewable Energy Education Consortium (TREEC) is a group of twelve colleges in Texas whom are devoted to educating Texas's renewable energy workforce (Office of The Governor, 2012). The mission of TREEC is to investigate, develop, and teach curricula dedicated to post-secondary education in emerging energy technologies to meet the demand of the Texas Workforce (Texas Renewable Energy Education Consortium, 2010). The primary goals for the TREEC include certificates of training, workforce training, and technician training.

Need for the Study

Twiddy (2008) indicated the green industry draws workers from military and agricultural fields, and there are a growing number of training courses emerging at community colleges to equip workers for this field. As the discipline of agricultural education and Career and Technology Education moves forward and incorporates new courses, wind energy education is a field which deserves attention. There are six factors (2014) make wind energy and the skills needed for the industry an important candidate for an agricultural education program.

Growth

Obtaining the energy wind can provide is an old concept, but the idea of harnessing the wind power to create electricity is relatively new. During the 1970's an oil crisis began bringing about grants, research initiatives, and demonstration projects for a variety of energy generation, which focused on using wind, solar, and geothermal (Deal, 2010).

Today the renewable energy sector has been growing at a rapid rate. Between 2004 and 2009 the wind-generating capacity grew 39 percent per year (Liming & Hamilton, 2011). They further indicated in 2000 the United States produced 3,000 Megawatts (MW) of electricity through wind generation and in 2010 the country had grown to producing 35,000 MW of electricity through wind generation, which is enough to power 9.7 million homes. In 2013 there were more wind turbines being constructed than ever in history, with more than 12,000 MW under construction (American Wind

Energy Association, 2014). The report further indicated at the end of 2013 there were 61,108 MW being produced in the U.S. 12,355 MW are being produced in Texas alone.

The drive behind this growth has stemmed from government subsidies, tax incentives, improved technology, higher fossil fuel prices and investor concerns about possible federal action to reduce carbon emissions (The State of Texas, 2008). The interest in wind energy policy comes from the supply and demand of energy (Deal, 2010). For the first time, in 2012, wind energy became the number one provider for new electricity generation (The United States Department of Energy, 2013). Advances in technology, lowered maintenance, and lowered hardware costs are adding to the increase in wind energy, because it lowers the cost of electric prices. In 2011 and 2012 the price per kilowatt-hour was 4 cents for wind energy (The United States Department of Energy, 2013).

Economic

In 2012 private investors invested $25 billion in wind energy, which provided for 42 percent of all new American electricity generation (Salerno, 2013). Salerno (2013) further indicated wind farms create positive economic impacts in the communities in which they are erected. These impacts are threefold; first wind farms create jobs in rural areas, secondly new careers for local residents may boost the local economy, and finally they create a new tax base for these communities. Wind farms are typically located in rural areas where jobs may otherwise be isolated to agriculture only. States are impacted positively if local labor is utilized to install wind equipment and to operate it (Tegen, 2006). Goossens (2012) indicated a 250 MW project generates 522 construction jobs, 432 positions in manufacturing, and 27 jobs for operations. They further suggest the wind energy industry in the U.S. employees 75,000 individuals. A case study showed Sherman County, Oregon 10 years ago was reliant on wheat alone to provide for jobs and a tax base (Druckenmiller, 2012). Druckenmiller (2012) further indicated throughout the past decade 12 wind farms have come into existence in this rural farming community, and have built a larger tax base as well as new careers for local residents. The average household income in 2001 was $18,254 compared to the state average of $29,250; today the average household income for this county is $52,530 compared to the state average of $36,317. The U.S. Department of Energy (2013) indicated the Wind Powering America program would provide $1.2 Billion in new income in rural areas of the United States. They further indicated wind energy projects generate more new jobs than fossil fuel projects. Increased work opportunities and higher salaries generate new customers for local businesses (Tegen, 2006). Another economic impact comes from landowner leases, on average leases are worth $2,700-$2,900 per MW. Druckenmiller (2012) indicated in Livingston County, Illinois after the Streator Cayuga Ridge South project was established $6 million was set-aside in a fund to spur economic growth in the county. Property tax on these wind farms average $8,000-$9,000 per MW, which in turn increases local tax bases and provides for more revenue for local public services (Lantz & Tegen, 2008). Wind farms add $10,000 per MW in property tax payments; in Pecos County, Texas $4.6 million was added to property tax revenue in 2002 alone (United States Department of Energy, 2008).

Education

"For most positions the wind companies hire people with experience in other industries and give them wind specific training. The primary exception to this trend is the wind turbine service technician. Currently large portions of these technicians learn on the job or through apprenticeship programs. However, as more vocational training programs are developed and training is standardized, technicians would be expected to have formal training and a certificate or a degree" (Hamilton & Liming, 2010, p. 8). CTE programs provide students with opportunities to acquire the competencies required in today's workplace (American Institutes for Research, 2013). Though CTE prepares students for life after high school, the need to complete this task does not completely rest on CTE programs. The entire education system needs to fully prepare students to be able to participate in postsecondary education and/or the high-skilled workplace (Hyslop, 2006). Jennings (2009) indicated education is vital to the development of a sustainable society by raising awareness, providing training, and acting as an agent of social change.

Bangser (2008) indicated high schools fail to prepare students for postsecondary education or for work. To aid in this preparation the author referred to the Carl D. Perkins Career and Technical Education Act of 2006, which provides for an increased focus on academic achievement from students enrolled in CTE programs and strengthens the connections between secondary and postsecondary education. A great deal of effort is being spent on CTE programs and not only how they increase student's core academic knowledge, but also how they better prepare students for the workforce. Bangser (2008) referred to the American Diploma Project, which outlined four goals:

- Align high school standards with postsecondary and workforce expectations.
- Upgrade high school course requirements so students take a college and work ready curriculum.
- Streamline assessment systems so the tests high school students take serve as readiness tests for college and the workforce.
- Hold both high schools and postsecondary institutions accountable for student success.

Bangsor (2008) indicated these goals align to provide a solution for the experiences of high school students whom are disconnected from what employers and postsecondary educational institutions expect.

STEM

All students need a strong understanding of reading, comprehension, reasoning, problem solving, and personal skills to be ready for postsecondary education and/or the high-skilled workplace (Hyslop, 2006). Breiner, Johnson, Harkness, and Koehler (2012) suggest STEM, which stands for Science, Technology, Engineering, and Math, is a result of the need to create better prepared high school and college graduates to compete globally. They further indicate STEM has become a top priority in funding from the federal government. According to the Committee on STEM Education (2013), "Advances in science, technology, engineering, and mathematics (STEM) have long been central to our nation's ability to manufacture better and smarter products, improve health care, develop cleaner and more efficient domestic energy sources, preserve the environment, safeguard national security, and grow the economy" (vi).

According to the National Governors Association (2007), there are three obstacles to having a world class STEM education system. The second of these obstacles is the misalignment of STEM coursework with work expectations. The authors further make recommendations to correct this problem by aligning standards of the education system with post-secondary courses and the workplace. Part of this recommendation is to reinvigorate Career Technical Education (CTE) so students in CTE and non-CTE would have the same postsecondary pathway readiness. This need to reinvigorate CTE comes from the need to close the skills gap which exists in the labor force. The American Institutes for Research (2013) indicated CTE programs are replacing low-level courses with academically rigorous, integrated and sequenced programs of study which align with and lead to postsecondary education. They offer key advantages in providing STEM centered courses and offering students a deeper understanding of STEM career pathways allowing for facilitation of student transition into these career paths, they build interest in STEM and STEM related careers, and integrate math and science content into more tangible experiences. These facts, principles, and techniques obtained through STEM courses are easily transferable skills which would aid in a person's success in school and beyond (Thomasian, 2011). Thomasian (2011) identified these transferable skills as:

- Using critical thinking to recognize a problem

- Utilizing math, science, technology, and Engineering concepts to evaluate a problem
- Being able to identify the steps required to solve a problem

The United States' future workforce lacks the technical skills needed to enter new jobs or take the place of today's workforce (Dickman, Schwabe, Schmidt, & Henken, 2009). Students who participate in project based instruction by investigating and solving problems develop a larger complete picture of the concepts associated with the project and build connections between the classroom instruction and real life experiences (Blumenfeld et al., 1991).

Jobs

According to the Bureau of Labor Statistics (2014), there will be 800 new wind energy technicians positions added over a 10 year period from 2012- 2022; it is further projected there will be a 24 percent growth during this time period; which is faster than the average for all occupations. The Bureau of Labor Statistics (2014) further indicated there is currently a shortage of qualified individuals for this profession. Twiddy (2008) reiterated this statement suggesting the potential labor force is not enough to keep up with the future demand, and attributed this to the newness of the industry and any possible training programs are not more than five years old. Wei et al. (2009) indicated the renewable energy sector is expected to create more jobs than the fossil fuel energy sector per unit of energy. The Renewable Energy Policy Project estimates for every 1000 MW of wind power developed there is a potential for 600 jobs in operations and maintenance (Feldbaum, 2009).

Jennings (2009) suggested the demand for renewable energy specialists continue to grow, and there is an urgent need to develop and implement new courses which would train engineers, scientists, and energy planners to work in this field. In 2000 installed wind capacity was less than 3,000 megawatts, by 2011 this had grown to more than 35,000 megawatts; in 2009 alone more than 10,000 megawatts of energy was installed (Liming & Hamilton, 2011). They further indicated as of 2011 there were 85,000 Americans who were employed in the wind power industry or a field which was related to wind power. As a whole renewable energy generate more jobs than those of industries which rely on fossil fuels per unit of energy (Wei et al., 2010). They further indicated wind energy is a reliable job for both skilled and unskilled labor.

Liming and Hamilton (2011) described three phases involved in the process of getting energy from the wind to the consumer, and the different occupations associated with these phases. The first phase is the manufacturing, which consists of manufacturing the wind turbines. The second phase is project development, which consists of site selection and construction of the wind farm. The last phase is operation and maintenance, which consists of the wind turbine producing electricity and any maintenance required for the turbine. During the operation and maintenance phase wind turbine service technicians, known as wind techs, are utilized to ensure the turbine is generating power efficiently and perform routine checks on the turbine.

Policy

President Bush emphasized a need for energy efficiency and a diverse energy portfolio which led to a modeled scenario where wind energy provides 20% of the nation's energy needs by 2030 (United States Department of Energy, 2008). O'Connell et al. (2007) indicated the 20% scenario is ambitious and challenging, but is still feasible. O'Connell et al. (2007) identified several factors support the feasibility of the 20% plan:

- The potential wind resources in the US exceed the requirements of the entire electricity sector.
- The wind industry continues to grow at a fast rate which should reach the 20% goal.
- States are actively integrating wind into their energy planning efforts.

O'Connell et al. (2007) further explored what policy developments need to be implemented to support the 20% goal.

- Long-term policy which supports wind and increases manufacturing and technology improvement.
- Policy combined with investment in R&D to aid in reducing the cost assumed in the 20% plan.
- Transmission policies which support the transmission needed for high wind penetration.

There is a continued growth and development in the renewable energy sector, which creates a need for more programs which focus on training individuals whom meet the demand. Renewable wind energy education previously formed only a small part of traditional engineering courses (Wei et al., 2009). Wei et al. (2009) further indicated renewable energy is becoming a field of its own with certain topics which are not normally encountered in other disciplines. Xie, Feng, and Qiu (2013) suggested education and training lags behind the growth in the wind energy industry. With this lag in education there is a need to increase the availability of wind energy programs at the pre-collegiate and collegiate level of education. Osborne (2007) indicated there is a need to identify and develop instructional based systems to meet industry needs. Acker (2008) further suggested there is a need to develop renewable energy curriculum for secondary, middle, and primary schools.

Problem Statement

There is an increase in wind energy jobs and a lack of skilled workforce to fill those positions, there is a need to train more wind energy technicians in the state of Texas.

Purpose and Objectives

The purpose of this study is to identify knowledge and skills needed for individuals to become successfully employed as a wind energy technician. The researcher sought to poll industry professionals on these items, with two main objectives:

- Identification of knowledge needed to become successfully employed as a wind energy technician.
- Identification of skills needed to become successfully employed as a wind energy technician.

National Research Agenda for Agricultural Education

Priority three of the National Research Agenda "Sufficient Scientific and Professional Workforce That Addresses the Challenges of the 21st Century;" indicated there is a need for a highly educated, skilled workforce which would meet challenges of the 21st Century (Doerfert, 2011). This priority further indicated without a focus on the development of skilled workers agricultural education would fail to address these challenges. Agricultural education as a discipline has a unique advantage to incorporate new programs and educational opportunities which address the needs of the workforce, and provide skills and knowledge which would make it more sustainable.

Significance of the Study

Findings from this study were meant to provide educators in both secondary and post-secondary education institutions with occupational knowledge and skills specific to the wind energy industry. These skills are the standards a wind turbine technician would be expected to possess or understand. The Identification of these skills enable educators, students, and the industry as a whole to better understand what skills are needed to successfully work in this field.

Educators would benefit from this study, because it reveals knowledge and skills, which industry professionals have identified as important to their industry. Educators are able to utilize this data when determining the curriculum they could potentially provide in their classrooms.

Students would benefit from this study, because it provides a glimpse into what is expected of them if they wish to enter this field. They are able to gain industry relevant knowledge which comes straight from a group of professionals in the industry.

The wind industry as a whole may benefit from this study; because it creates a uniformed standard which they may align their own expectations with. The study gives the industry a voice in the educational setting which allows them to identify what they are looking for in their employees or potential employees.

Aligning education with the industry provides for a mutually beneficial relationship. It allows the industry to express their needs, and education to hear those needs and respond with adequate training programs. These programs would provide qualified individuals, which meet the skill needs of the industry.

Definitions

- **Behaviorism:** The study of observable actions, and the consequences of behavior (Tomic, 1993).
- **Career and Technical Education (CTE):** Educational programs designed to prepare students for postsecondary education and the workforce.
- **Competency**: "A set of observable performance dimensions, including individual knowledge, skills, attitudes, as well as collective team, process, and organizational capabilities, which are linked to high performance, and provide the organization with sustainable competitive advantage" (Athey & Orth, 1999, p. 216).
- **Content-Centered Education:** Viewing agriculture as the content and context for teaching agriculture, may be applied to other industries (Roberts & Ball, 2009).
- **Competency-Based Education:** Curriculum which is structure on the perspective needs and standards of an industry (Finch & Crunkilton, 1999).

- **Experiential Learning:** “Learning is the process whereby knowledge is created through the transformation of experience” (Kolb, p. 38, 1984).
- **Industry standard:** Set of practices which are required and expected for a person to be successful in a set industry.
- **Skill standards:** Performance specifications which identify the knowledge, skills, and abilities an individual needs to succeed in the workplace; they are critical to improving the workforce, raising living standards, and improving the competiveness of the U.S. economy (“Developing Skill Standards”, 2013).

CHAPTER II

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Roberts and Ball (2009) indicated successful learning in agricultural education produces observable skills performed by the student which can be transferred to successful employment. Bush (2006) postulated the only behaviors worthy of scientific inquiry are those which are observable, measurable, and outward. Roberts and Ball (2009) suggested education with the goal of obtaining knowledge and skills for a job aligns with the theory of behaviorism.

Weegar and Pacis (2012) indicated the two major theories which lead education and learning are those of behaviorism and constructivism. Bush (2006) suggests behaviorism seeks to question only those changes which are observable and measurable. Constructivism seeks to understand students' knowledge at different stages of development (Rummel, 2008).

The theoretical framework which guided this study was the theory of behaviorism, and was based on Roberts and Ball (2009) framework for content-centered education. Schunk (2000) suggested education with a purpose of obtaining knowledge and skills in the preparation for a job aligns with the theory of behaviorism, because learning leads to an observable change in behavior. Roberts and Ball (2009) postulated the content-centered education examines skill acquisition. Roberts and Ball (2009) synthesized the ideology of viewing agriculture as the content and context for teaching agriculture, yielding a comprehensive model which can serve to explain the benefits of conceptualizing agricultural as both the content and the context.

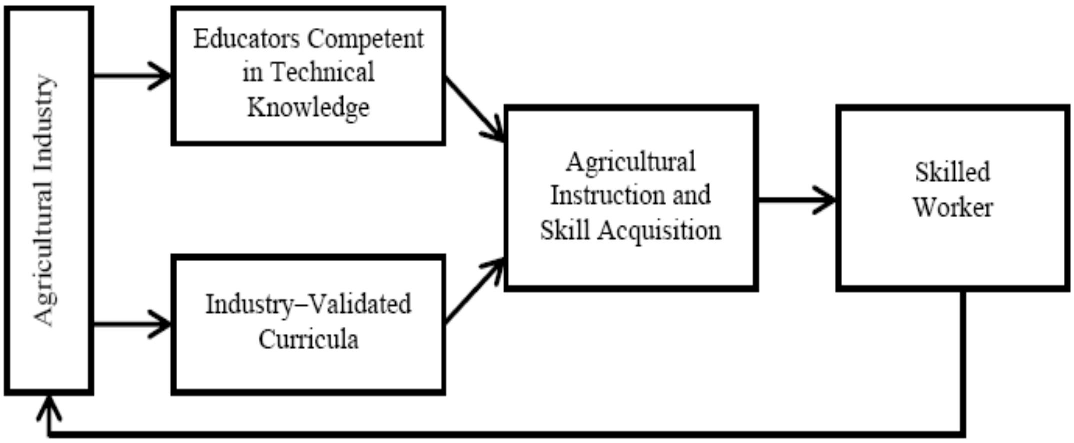

Figure 1. A content-based model for teaching agriculture (Used with permission from Roberts & Ball, 2009)

The framework begins with industry; Roberts and Ball (2009) suggested industry provides a basis for curricula taught. Teachers provide industry relevant instruction, based on industry relevant curriculum, resulting in observable skill acquisition (Roberts & Ball, 2009). The end product is skilled workers whom are ready for successful employment in the industry (Roberts & Ball, 2009).

Behaviorism

The theory of behaviorism has influenced curriculum development for many years (Weegar & Pacis, 2012). Tomic (1993) indicated the primary concern of behaviorism is the ability of humans to learn. Behaviors can be learned, unlearned, and changed by immediate consequences including: positive and negative reinforcement, modeling, shaping, and cueing (Shaffer, 2000). Shaffer further defined modeling as the act of demonstrating a skill while the learner observes; shaping as a process which results in gradual change in behavior; and cueing as the act of providing a learner with either or both verbal and non-verbal prompts which promote or deter a behavior.

CTE is founded on the learning principles of behaviorism (Doolittle & Camp, 1999). CTE curricula tend to be heavily weighted with psychomotor tasks and must be mastered in a sequential manner (Dobbins, 1999). The two major developers of the behaviorist school of thought were B.F. Skinner and John Watson (Weegar & Pacis, 2012). Both (Skinner and Watson) construed knowledge as being aware of ones behavior (Goldberg & Pessin, 1997). Skinner (1976) suggested knowledge does not guide ones' action, but instead knowledge is action, and is a set of responses to stimuli.

Gredler (1997) indicated the goal of behaviorism is to discover the lawful relationship between environmental events and behaviors. Good and Brophy (1990) suggest the theory of behaviorism concentrates on behaviors can be observed and measured. Skinner (1976, p. 23) "The quickest way to observe physical causes is to consider only those facts which can be objectively observed in the behavior of one person in its relation to his [or her] environment." Behaviorism deals with precisely defined objectives (Combs, Popham, & Hosford, 1977). The flow of the objectives are sufficiently defined and placed in a proper sequence to aid in learning (Kramlinger & Huberty, 1990). Kramlinger and Huberty (1990) further proposed an advantage of behaviorism is the objectives are highly specific, ensures behavioral practice (not just theory), and works best for helping learners to acquire new behavioral skills. Learning has an outcome of observable changes in behavior (Roberts & Ball, 2009).

Dobbins (1999) indicated behaviorist principles often use linear step-by-step approaches in instruction. Entwistle (1981) suggested one of the major components of behaviorism, theorized by B. F. Skinner, was a job should be broken down into tasks and students learn best in a linear step-by-step format. Grobecker (1999) reiterated this statement by suggesting one strategy of utilizing behaviorism in the classroom involves breaking tasks down into small manageable segments for teaching. Students learn by memorizing chunks of information before moving on to higher-level, problem- based information (Shield, 2000).

Behaviorists believe the goal of educational activities is to produce desirable behaviors in students (Simonson & Thompson, 1997). "Learning, if authentic, provides relevance to the learner, and is a primary catalyst of knowledge construction," (Doolittle & Camp, 1999, p. 1). Combs et al. (1977) suggest behaviorism is a useful system for dealing with events which can be clearly defined. Human beings go beyond just responding to the environment, but also react to the environment based on prior experiences (Skinner, 1976). Boone, Gartin, Wright, Lawrence, and Odell (2002) stated, "behaviorist concepts include mastery learning and standards-based education" (p. 39). In education behaviorism has been proven as a useful approach to teaching skills (Combs et al., 1977). Bush (2006) suggests behaviorists look at the content to be learned and the influence of the environment upon learning. In the theory of behaviorism experience is an important cause of learning (Eggen & Kaucak, 2007). Skinner (1968) stated, "The learner does not passively absorb knowledge from the world around him but must play an active role" (p. 5). Skinner further indicated learners learn by doing, experiencing, and engaging in trial and error.

Behaviorism has been the most promoted and recognized theory when discussing content or competency based approaches to education (Jones & Moore, 1995). The theory of behaviorism focuses mainly on objectively observable behaviors and discounts mental activities, which emphasizes the acquisition of new behavior (Bednar, Cunningham, Duffy, & Perry, 1992). "Learning is a persisting change in performance or performance potential, which results from experience and interaction with the world" (Driscoll, 2000, p. 3). The idea performance should be observable and measurable, and the impact of the environment on the performance are the quintessential principles of the behaviorist approach to learning ("From Theory to Practice", 2002).

Experiential Learning

"Learning is the process whereby knowledge is created through the transformation of experience" (Kolb, p. 38, 1984). Baker, Robinson, and Kolb (2012) indicated creating knowledge comes from the learning process. Kolb (1984) suggested experiential learning is strengthening the critical linkages among education, work, and personal development. An experiential learning activity is one where a real life work-based experience is followed up with the opportunity for a structured reflection of the experience (Joplin, 1981). Baker, Robinson, and Kolb (2012) suggested learning skills creates knowledge; the authors suggested divergent knowledge is represented by interpersonal skills, assimilative knowledge is represented by information skills, convergent knowledge is represented by analytical skills, and accommodative knowledge is represented by action skills.

The structure for experiential learning involves four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). Dewey (1933) suggested the context students learn in would need to be as authentic as the real world. Kolb (1984 indicated there are three characteristics of experiential learning: concepts come from experiences, learning is a continuous process, and learning requires the resolution of conflicts between opposing modes of adaption of the world. Knobloch (2003) suggested experiential learning can be defined as learning through real-life contexts which involves learners participating in tasks, solving problems, or conducting projects.

Dewey suggested experiential learning involves: observation of surroundings, knowledge of similar situations in the past, and judgment, which connects the observed experiences with the experiences, or knowledge which has been recalled. He further indicated each experience builds on past experiences.

Content-Centered and Competency-Based Education

Finch and Crunkilton (1999) indicated a competency-based curriculum is structured on the perspective needs and standards of an industry, based on predetermined performance objectives. Effective use of a curriculum content is based on a linkage to industry-relevant outcomes gives the student an opportunity to learn industry-relevant knowledge and industry-relevant skills; this in turn contributes to the industry having access to a more skilled workforce (Lualhati, 2007). Roberts and Ball (2009) examined two different types of skills: specific and general. Roberts and Ball determined specific skills are those which apply to a certain discipline, while general skills are those which can be used across different disciplines. Robinson (2000) suggested discussions about today's workforce focus on employable skills. Employable skills are "transferable core skill groups represent essential functional and enabling knowledge, skills, and attitudes required by the 21^{st} century" (Overtoom, 2000, p. 1).

The basis for the content in curriculum which identifies these skills begins with the industry, which is turned into industry-relevant instruction which results in observable skill acquisition (Roberts & Ball, 2009). The approach to identify those skills is to first identify and prioritize the competencies needed on the job using community input and job task analysis (Finch & Crunckilton, 1999). Roberts and Ball (2009) determined "the end result is skilled workers are ready for successful employment in the agricultural industry (p. 84)." Relevancy of the content is likely to lead to an increase in motivation, as the learner comes to understand the need for certain knowledge (Pintrich & Schunk, 1996). Elias and Merriam (1995) stated, "Developing a curriculum or course for competency based occupational technical instruction begins with a detailed job description. These descriptions include location and general working conditions, job functions, general duties, contingent responsibilities, and so on" (p. 95). Slusher, Robinson, and Edwards (2011) indicated curriculum should be based on the needs of the industry regarding the skills needed of workers.

Content Based on Industry Standards and Competencies

The Carl D. Perkins Act of 2006 stresses the need for greater alignment between CTE programs and industry (Lualhati, 2007). Lualhati further suggests CTE programs need to provide students with an opportunity to learn industry-relevant knowledge and skills. Content-based education imparts knowledge of the subject matter to students so they may quickly become proficient in the workforce (Tan, 2004). Lynch (2000) indicated various goals of a CTE program, three of these goals dealt with aligning instructional content to industry based standards. The three goals outlined by Lynch were; Prepare students with the education and technical skills needed for successful employment in various careers; Teach students about all aspects of an industry; Enhance academics by bringing real-world content and application.

In January of 2014, Vice President Joseph Biden lead a review of federal programs in the workforce and training system to ensure they are designed to equip the nation's workforce with skills match the needs of employers (What Works in Job Training: A synthesis of the evidence, 2014). By matching competencies to critical work functions and key activities, employers are able to improve efficiencies and productivity ("Developing Skill Standards", 2013). Lualhati (2007) indicated content should be based on standards derived from the documentation of knowledge and skill requirements for an industry. Educators can identify core competencies and create assessments based on the skill standards ("Developing Skill Standards", 2013). Lualhati (2007) further indicated aligning curriculum with industry ensures industry standards are driving the content of the curriculum and as a result influences the choice of instructional methods and assessments. Belcber and McCaslin (1997) indicated skill standards aid teachers in defining the knowledge and skills expected of students from an industry.

Skills outlined by an industry allow for employers to indicate the level of competence a worker needs (Belcber & McCaslin, 1997). Bragg, Bartlett, Marvelspill, and Osman (2002) postulated skill standards benefit employers by communicating knowledge and skill requirements to new and incumbent employees; Bragg et al. further suggest skill standards aid in determining proficiency levels of an employee while reducing the costs and risks when hiring new workers or promoting existing employees. These standards may be used to establish personnel qualification requirements, and their productivity can be evaluated with a higher degree of accuracy (“Developing Skill Standards”, 2013).

Skill standards enable workers to be recognized as being certified or accomplished as a craftsperson (Hudelson, 1993). Hoachlander and Rahn (1994) identified potential benefits of having a standard skill set for an industry including clearer goals and educational pathways for students, consistent instruction and curriculum, greater mobility and transfer of credentials, and more efficient recruitment and placement of employees. These standards may be utilized to assist students in making career choices by providing industry expectations for success in the workplace (“Developing Skill Standards”, 013). These standards provide students, as well as journeymen, with the credentials which prove their work-readiness (“Developing Skill Standards”, 2013).

Identifying Skill Standards

Askov (1997), analyzed the National Workplace Literacy Program (NWLP), which entailed reviewing job-specific and job-related curriculum. The purpose of the study was to determine a common set of basic skills for the workplace which took into account the great variability exists between workplaces. The goal of the study was to provide guidance to service providers in designing instruction for workplace literacy and preparation programs.

Askov (1997) found as a result of the NWLP 208 entries had been made, which identified skills required for different occupations. From these entries identifying required skills for the occupations there was an overarching theme of seven skills needed to be literate in the workplace. The themes which arose, in order of number of occurrences, are listed and explained below:

The first theme was reading comprehension with 41 entries found. The purpose of reading comprehension is to be able to decode, interpret, and comprehend information drawn from written documents. This skill would include being able to recognize technical vocabulary used at the workplace, which includes abbreviations. This theme would also include locating information, reading for details, and scanning material for specific facts. Askov (1997) found it was vital along with these skills in this theme which a person would also be able to follow written instructions.

The next theme which surfaced in the review of the NWLP documents was writing with 38 entries. This theme is identified as a person being able to communicate thoughts, ideas, information, and messages in writing, planning, and revising text. The skills associated with this theme would entail writing notes and memos, enter or transfer information, and creating a flowchart to convey information.

The next theme Askov (1997) identified was quantitative with 38 entries. The theme of quantitative entails a person being able to understand basic mathematical computations and problem solving procedures and how these procedures could be used to answer various problems. The skills which were identified were converting decimals, fractions, and percentages; interpret ratio and proportions; convert numbers to and from the metric system; interpret data from graphs and charts; and utilizing a ruler to solve problems or finding an area.

The next theme Askov (1997) found was oral communication with 35 entries. Askov (1997) identified this theme as the ability to communicate thoughts, ideas, and information orally. The person would be able to attend to the comprehension of listeners and the demands of the setting. The skills which relate to the curriculum development are being able to listen, asking and responding to questions, and the utilization of proper grammar.

The next theme which was identified by Askov (1997) was problem solving, with 23 occurrences. This theme is defined as being able to understand procedures for basic problem solving and how those procedures may be used to address problems. The skills which were associated with this theme were differentiating and classifying information; evaluating and choosing options to solve problems; trouble shooting problems; predicting outcomes based on provided information; and prioritizing job tasks.

The next theme discovered by Askov (1997) was critical thinking with 15 occurrences. Askov (1997) identified critical thinking as recognizing and analyzing strengths and weaknesses of arguments using logic to determine the validity of the proposition. The skills which would be entailed in this theme are brainstorming; being able to judge the credibility of information; differentiate between major and minor problems; comparing and contrasting information determining relevancy.

The last theme which arose was “knowing how to learn”, with only 5 occurrences. Knowing how to learn is defined as being able to identify and use alternative strategies for working on learning tasks, searching for examples, taking notes, and identifying strategies for working with material (Askov, 1997). The skills which were found associated with this theme were applying appropriate learning style, techniques, and resources; managing time effectively; and maintaining a high level of concentration.

Askov (1997) found identifying these skill standards defined not only what a worker needs to be able to do, but also what they needed to know. The knowledge base is essential for the worker to be able to apply their learned skills into practice. The intent of the study was to inform educators on the skill descriptions would benefit them in work-related programs. Wills (1993) indicated educators should work with businesses and industry to define skills which are needed for career clusters. Askov (1997) indicated skill standards would enable a worker to be successful in the workplace, which begins with their training.

Developing Skill Standards

There are two components involved with skill standards: a description of the responsibilities required for competent performance and a description of knowledge and skills which are necessary to fulfill those responsibilities (National Skill Standards Board, 2000). The process of establishing standards, assessing them, and certifying outcomes are all components of developing an effective workforce (Naquin & Wilson, 2002).

Skill standards provide measurable benchmarks of skill and performance which answer two critical questions: What do workers need to know? and How do we know when workers are performing well ("Developing Skill Standards", 2013). Merritt (1996) identified two models of Developing Skill Standards, the Professional model and the Skill-Components Model. The two models differ in two ways, the conceptualization of skill and the role workers play in the development and governance of the skill-standards system (Merritt, 1996).

The Professional Model

Wolfson, Trebilcock, and Tuohy (1980) suggest the concept of professionalism assumes a worker would have the ability to apply their general knowledge to a myriad of circumstances or situations. Professionals are expected to be able to make autonomous non-routine decisions (Merritt, 1996). Merritt (1996) indicated in the professional model, technical and academic skills are the foundation for more complex functions including problem solving, reasoning, and judgment. Souders (2009) indicated technical skills are basic abilities which are necessary for a worker to perform a task. Souders (2009) further indicated there are critical work functions which are general areas of responsibility which are required of a person working in a specialty area.

The Skill-Components Model

The skill-components model is based on the limited roles workers are expected to assume (Merritt, 1996). Merritt (1996) suggested workers are expected to have basic academic skills such as literacy and numeracy, but academic skills are learned prior to occupational skills, and are only useful to the extent which they may help the worker to perform the required list of tasks. Tasks are observable and measurable activities which technicians need to perform to accomplish their work function (Souders, 2009).

Souders (2009) outlined the process for “Developing Skill Standards”, the process is outlined as follows:

- Formation of a development group
    - Development group should be made up of industry representatives and educational representatives
    - A moderator with both educational and industry background should be appointed
- Outline processes involved in industry
    - Determine equipment, materials, instrumentation, etc. which is involved in the process.
- Identify key steps within a process
    - Translate these steps into critical work function statements
    - Use verbs which are measurable (avoid know and understand)
- Determine tasks which are required to complete the work function
    - Specify procedures, equipment, instrumentation, specifications, codes, etc. which are relevant
- Create task statements which are measurable
- Develop workplace skills list
- Review each task and determine the principles, industry standards, etc. required to accomplish the task

Bunn and Stewart (1998) referred to the potential of skill standards improving the United States workforce; providing uniform measures for the international marketplace; providing portability of employment for United States workers; an increase in accountability; and the ability to meet the needs of business and industry. Aragon, Woo, and Marvel (2005) acknowledged skill standards are seen as a way to achieve better accountability for CTE programs, improving quality as well as alignment with the needs of the workplace. To be effective, skill standards must reflect a consensus of industry professionals ("Developing Skill Standards", 2013).

Developing Curriculum from Skill Standards

In an educational setting skill standards define a protocol in which students' performance can be measured and built upon as they transition through the educational setting into the workplace (Rahn, O'Driscoll, & Hudecki, 1999). With the increasing importance of national skills standards and student certification, secondary and postsecondary institutions need to focus on building a reputation for developing students for relevant jobs (Boesel, Rahn, & Diech, 1994). Utilizing skill standards in curriculum development has become an increasingly paramount aspect of CTE programs (Aragon, Woo, & Marvel, 2004). Lualhati (2007) reported the first and most common approach to aligning industry and education together was developing curriculum which was tightly linked to industry relevant outcomes. Aragon et al. (2004) found institutions were developing curriculum aligned more to national skill standards than state-level skill standards. Skill standards form the foundation of any technical program's curriculum (Souders, 2009).

In a presentation at the 2009 National Career Pathways Conference Souders (2009) indicated the steps to developing curriculum based on skill standards follow the following steps:

- Form a development team comprised of industry representatives and educational faculty
- Review technical skills needed for the industry
    - Address knowledge components needed in the industry
- Organize knowledge components into subject groups; i.e. humanities, science, technology, etc.
- Organize courses into a pre-requisite structure forming a curriculum

Bunn and Stewart (1998) speculated the utilization of skill standards in developing curriculum would impact education in the following ways:

- Improved communication between education and industry
- Improved relevancy of curriculum content
- Improved teaching and learning processes
- Enhanced connections between school and employment for graduates
- Better prepared entry-level workers
- Improved accountability

Souders (2009) suggested the development of both skill standards and technical program curricula should be a joint industry and academic endeavor. Skills are the productive assets of the workforce which are acquired through learning activities (Toner, 2011). The utilization of skill standards in the development of curriculum is steadily increasing in both secondary and post secondary CTE programs (Aragon et al., 2004).

Career and Technical Education aligned to Industry

Career and Technical Education (CTE) provide individuals with academic, technical, and employability skills as well as knowledge to pursue postsecondary training or higher education and enter a career field (Partnership for 21st Century Skills, Association for Career and Technical Education, & National Association of State Directors of Career Technical Education Consortium, 2010). The National Center for Education Statistics (2011) indicated 90 percent of high school graduates have taken CTE courses. CTE programs prepare students not only for postsecondary education, but for the workforce as well. Schneider (2006) indicated exposure to the world of work is important because students often are not aware of what educational requirements are required for certain jobs. CTE and agricultural education can provide this exposure to students.

CTE programs are modeled closely after real careers which provide students with answers to how they could use what they learn from these programs (Meeder & Suddreth, 2012). CTE programs aim to prepare students for potential careers, and look to build on existing programs adding fields of study which meet emerging challenges our nation faces. Today's challenges integrate global food and agriculture enterprise; and include energy security, national security, human health, and climate change (The National Academy of Sciences, 2009). The field of alternative energy has emerged to combat the challenge of energy security.

Copa (1985) proposed education must change to meet the needs of society and technology. The occupation of wind energy technician or wind turbine technician is an occupation which can be cultivated by CTE programs to meet the needs of an ever changing society. According to Hyslop (2009) “CTE programs are poised and ready to ease the workforce bottlenecks could limit job growth in sustainability and meet the need for green-collar job training across career areas” (p. 23). Hyslop (2009) further indicated CTE programs are flexible and responsive to workforce needs, which place them in a prime position to serve the green industry.

The content of CTE programs are driven by the needs of the workplace; CTE instructors maintain a close connection with industry (Pearson, Young, & Richardson, 2013). Academia and industry can build a cohesive relationship through like-minded expectations of students’ abilities and work readiness (“Developing Skill Standards”, 2013). The closer training is in relation to an occupation the better the results are for the participants; this strategy of industry engagement into the educational setting may possess the potential to better meet the needs of employers (“What Works in Job Training: A synthesis of the evidence, 2014). In order to keep current with the changing workplace standards need to be continually updated with full partner participation (“Developing Skill Standards”, 2013).

STEM Integration with Career and Technology Education

STEM is an interdisciplinary approach to education where rigorous academic concepts are integrated with real-world lessons for students to apply science, technology, engineering, and mathematics in contexts which build a connection between school, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy (Tsupros, Kohler, & Hallinen, 2009). Lantz (2009) suggested STEM curriculum should be constructed around trans-disciplinary in its approach. STEM education offers students a holistic view of the world in relation to work. STEM education removes the barriers between the four disciplines of Science, Technology, Engineering, and Math and creates one cohesive teaching and learning paradigm which aids students in making connections between school and work (Lantz, 2009).

STEM integration is the process of inserting science and mathematics education into the content of technology and engineering education (Walkington, Nathan, Wolfgram, Alibali, & Srisurichan , 2013). Lantz (2009) further indicated STEM education is the creation of a discipline based on the integration of other disciplinary knowledge into a new whole. A curriculum analysis would examine the content of existing curricula and align the content to STEM competencies (Walkington et. al., 2013). Prevost (2010) suggested curriculum analyses contribute to a better understanding of the intended lessons may be provided through STEM integration. Hylsop (2010) indicated CTE courses deliver STEM content in a manner which is above the average academic courses; CTE courses demonstrate to students a very vivid sense of how the knowledge or skill is applied in real-world scenarios.

Dewey (1916) postulated the use of applied problems provided students with a genuine purpose for the scientific or mathematical practices they are learning. Lantz (2009) indicated a part of STEM is Problem-Based Learning (PBL) which is an instructional strategy which is student-centered and allow students to solve problems an answer questions collaboratively while allowing them to reflect on their experiences. Unstructured problem solving carves lessons into a young mind more effectively than reading about it, and allows for higher order learning skills (Greenes, 1996). Within the contexts of Problem-Based Learning students would engage in projects which involve the design, creation, and testing of devices and utilization of instructional objectives which provide authentic venues for mathematical and scientific ideas to arise (Walkington, 2013).

CTE is a foundation to STEM pathways in both high schools and middle schools (Drage, 2009). Hylsop (2010) indicated more careers than ever before are requiring a better and deeper understanding of STEM principles. Drage (2009) suggested the STEM pathway is comprised of two groups; the first group is the knowledge needed to prepare students for careers and the second group is the skills needed to prepare students for careers. CTE is a leader in the integration of high-level academics and technology; in recent years CTE programs have grown to encompass new cutting edge careers which are STEM intensive (Hylsop, 2010). CTE serves as a critical option to prepare individuals for the world of work; CTE offers a holistic education is responsive the ever-changing needs and advances of technology, education and the workforce (Asunda, 2011).

Summary

This study was concerned with identifying skills needed for a particular occupation. Texas industries have a need for high school graduates to possess better academic and vocational skills compared to their predecessors (De Leon & Borchers, 1998). The principles of behaviorism guided this study, because behaviorism highlights the need for observable and measurable outcomes in a students' learning. The content-centered education framework scaffolds this study, because the content which is the focus for a CTE program comes from standards which are accepted by the industry which a course is aligned to. Curriculum for CTE programs can come directly from skill standards which an industry recognizes, and should be the basis for the content to be delivered in an educational setting.

CHAPTER III

METHODOLOGY

Overview

The purpose of this study was to identify knowledge and skills needed for individuals to become successfully employed as a wind energy technician. With the increase in wind energy jobs this Delphi study sought to create a consensus from industry professionals on two main questions:

- What knowledge does a person need to possess to become successfully employed as a wind energy technician?
- What skills does a person need to possess to become successfully employed as a wind energy technician?

Research Design

For this descriptive study a Delphi method was used to determine the entry-level skills a worker should need to become successfully employed as a wind energy technician. The Delphi technique is a "group process technique for eliciting, collating, and generally directing informed judgment towards a consensus on a particular topic" (Delp, Thesen, Motiwalla & Seshadri, 1977, p. 168). "Delphi may be characterized as a method for structuring a group communication process so the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone & Turoff, 1975, p. 3). The Delphi method is a widely accepted method for achieving convergence of opinion concerning real-world knowledge solicited from experts in a certain area of concern (Hsu & Sandford, 2007). According to Stitt-Gohdes and Crews

(2004), the Delphi technique began at the Rand Corporation in the early 1950's and is used to solicit reliable responses from experts covering a particular problem. They also indicate a Delphi study allows researchers to combine expert opinions together to create a unified version.

Panel Selection

The Delphi technique is a process which utilizes a group of experts and collects their opinions about a particular topic in a series of rounds of questioning (Yousuf, 2007). Jacobs (1996) indicated the selection of an expert panel is the most important sept in the entire Delphi process because it directly relates to the quality of the results generated. The experts should be highly trained and competent within the specialized area of knowledge which pertains to the target issue (Hsu & Sandford, 2007). Hsu and Sandford (2007) proposed the selections of these experts are dependent upon the disciplinary areas of expertise required by the issue. Ludwig (1997) remarked the individuals selected for a Delphi should be knowledgeable and have experience to base their responses on. "The panel of experts should have similar characteristics in the form of their knowledge, but otherwise should be heterogeneous to preserve validity" (Linstone & Turoff, 1975, p.4). Hsu and Sandford (2007) suggested the selected expert's qualifications need to be closely examined. Experts should be a group of individuals with characteristics and qualifications which are identified as desirable to the study (Ludwig, 1997).

For this study a purposive sample was taken of twenty-two industry professionals who have the title of Wind Energy Technician, Wind Energy Manager, or Trainer. Stitt-

Gohdes and Crews (2004) remarked the keystone to a successful Delphi study is the careful selection of a panel of experts. The selection of these experts was based on an identification of companies who operate wind farms in the state of Texas. The list of these companies was obtained through the Public Utility Commission of Texas using their generation producers located in their market directories (http://www.puc.texas.gov/industry/electric/directories/Default.aspx). The directory produced 80 companies operating in Texas. The list was reduced further based on MW production of electricity, companies producing 150 MW or more were kept, reducing the list to 38 individual companies. A reliability of .90 can be achieved when a population size of 13 or more is utilized for the expert panel; a group size of 12-15 experts on the panel is recommended (Dalkey, Rourke, Lewis, & Snyder, 1972). Each company was sent a letter via email inviting them to nominate a representative with the title of wind energy technician for the expert panel. Additional members for the panel of experts were sought through electronic media.

In total 22 individuals agreed to participate in the study, making up the panel of experts. The experts held titles which included Wind Energy Technician, Manager, and Trainer; all experts were directly involved in the wind industry. Throughout this study sixteen experts replied consistently to each round. The experts continually expressed a strong interest in the study and were passionate about the competencies which made up the instrument. The experts further indicated they believed it would shine light into their industry, allow for them to have a voice in the curriculum being developed, and emphasize the knowledge and skills which they believed were important for a person to know to come into the industry.

The researcher was able to make sight visits to talk face-to-face with many of the experts and to gather their opinions on the study as well as the industry they were employed in.

Instrumentation

Linstone and Turoff (1975) suggest four issues important to the communication process which is involved in a Delphi Technique: (1) some feedback of individual contributions of information and knowledge, (2) assessment of the group judgment, (3) an opportunity for individuals to revise views, (4) anonymity. The communication process which occurs during a Delphi technique takes place between members of the expert panel and the researcher, who serves as a facilitator (Yousuf, 2007). The emphasis of the technique is on maintaining anonymity within the group and their responses, which diminishes the potential for social and political interactions which may prove to be counterproductive for identifying acceptable solutions (Frewer, et al., 2011). "The controlled interaction appears to be more conducive to independent thought on the part of the experts and to aid them in the gradual formation of a considered opinion" (Dalkey & Helmer, 1963).

Woudenberg (1991) summarized a Delphi study as having the following characteristics:

- Anonymity- Individuals from the panel do not communicate to each other.
- Iteration- The various rounds the panel move through till a consensus is reached.

- Feedback- The results of the rounds are compiled then returned to the respondents.

In a study utilizing the Delphi technique the development and administration of questionnaires are interconnected (Ludwig, 1997). "The Delphi technique uses rounds of written questionnaires and guaranteed anonymity with summarized information and controlled feedback to produce a group consensus on an issue" (Beech, 1999, p. 283). Stitt-Gohdes and Crews (2004) postulated unlike survey research the rounds associated with the Delphi technique allow for initial feedback, collation of feedback, and distribution of collated feedback to participants for further review. Gross (1980) indicated the Delphi technique utilizes several rounds to obtain a consensus.

Round 1- A panel of experts are asked to list their opinion on a specific topic.

Round 2- The panel is asked to evaluate the list of opinions against some criteria, based on the importance of each item on the list.

Round 3- The participants receive the list and a summary of responses to the items and are asked to revise their response and to provide a reason for their decision.

The Delphi method has both advantages and disadvantages. Linstone and Turoff (1975) suggest a major advantage of the method is a consensus would emerge which is a representative opinion of the experts. The method is simple to use and mathematical skills are not necessary to use it (Yousuf, 2007). Barnes (1987) suggested barriers such as reluctance to state unpopular views or to disagree with peers are minimized because of the confidentiality which a Delphi method affords. He further listed disadvantages, as the consensus of the group may not be representative of the group and the tendency to eliminate any positions which are at extremes for a middle of the road consensus.

Development of the Instrument

To prepare for this Delphi study the researcher identified six different colleges in the state of Texas which offer wind energy technician certification. Each college was contacted to secure course syllabi for each course which was a requirement for the certificate program for a person to receive the Wind Energy Technician Level I certification. The curriculum was reviewed by the researcher to identify all competencies to be learned and objectives to be met by students in order to complete the course.

The researcher broke down the curriculum to each individual class, and then further broke each class down to the competencies for each class. This process initially provided more than 600 competencies which were required to become certified as a Wind Energy Technician Level I.

The competencies were combined and condensed to eliminate any repeat competencies. The researcher further examined the courses required by the colleges and identified four courses which were only required by one college and failed to match up with wind energy technology. The courses of Algebra I, Applied Physics, Computer Applications I, and Composition I and the competencies from these courses were eliminated. The researcher sought to keep the instrument aligned solely with wind energy technology and determined these courses would be outside of the perimeter of this study.

The final list (Appendix G) consisted of one hundred twenty-two knowledge and skill competencies which were required for a person to master in order to become certified as a Wind Energy Technician Level I. The one hundred twenty-two knowledge and skill competencies were divided into 11 categories according to their subject area. The categories were (A) Personal Skills, (B) Leadership, (C) Safety, (D) Intro to Wind Energy, (E) Applied Wind Energy, (F) Electricity Principles, (G) DC/AC Circuits, (H) Distribution Systems, (I) Motor Controls, (J) Basic Fluid Power, and (K) Distributed Control and Programmable Logic.

The list (Appendix G) can be divided down into fifty-six knowledge competencies and sixty-six skill competencies. The instrument which was utilized for the first two rounds of this study (Appendix B) did not differentiate between what was knowledge and what was a skill; instead it only grouped them by category.

Validity

The list of one hundred twenty-two competencies was sent to three different individuals in Texas whom instruct college courses required to achieve the level I certification. Each individual was asked to review the competencies and indicate the validity and pertinence within the context of becoming a wind energy technician. All one hundred twenty-two competencies were determined to be valid and pertinent by the three instructors.

IRB Approval

Before the study began, the Institutional Review Board (IRB) for both Texas Tech University and Texas A&M University were sent a proposal requesting for permission to perform the research. Approval was granted from Texas Tech University's IRB with approval number 504934, and from Texas A&M University's IRB with approval number 2015-3000M. An amendment was sent for the next two rounds to both IRB's at Texas Tech University and Texas A&M University.

Process

Round I

To begin the study, the twenty-two individuals identified to be members of the panel of experts were sent, via email, an opening letter (Appendix A) to explain the study and requesting the individual to participate in the study.

After the individual agreed to participate in the study they were emailed the instrument (Appendix B) listing the one hundred twenty-two competencies. The wind technicians were asked to review each of the knowledge and skill competencies and determine if they were needed or not for a person to become a wind energy technician. The members were also asked to add any additional knowledge or skills which they believed would be pertinent for a person to possess to become a wind energy technician. Of the twenty-two experts on the panel seventeen responded during the first round, resulting in a 77% response rate.

Round II

After the first round of the study the researcher calculated the responses utilizing Microsoft Excel to determine the percentage of respondents whom agreed or disagreed with the competencies listed on the first survey. There were no replies to the open ended questions, so no additional knowledge or skill competencies were added to the instrument.

The same one hundred twenty-two skill and knowledge competencies were utilized for the second round. The respondents from the first round were sent, via email, a letter (Appendix C) to explain the second round of the study. The respondents were also sent, via email, the instrument (Appendix D) which was utilized for the second round.

For the second round the respondents were asked to rate the knowledge and skill competencies on a Likert-type scale using the descriptors: not important (1), slightly important (2), important (3), rather important (4), very important (5).

There were 16 respondents to the second round of the original 17 whom responded during the first round, resulting in a 94% response rate.

Round III

The responses from the second round were calculated utilizing Microsoft Excel. The researcher recoded the ratings from a 1-5 scale to a 0-4 scale to be able to code 1 "not needed" as a 0, to more accurately determine the mean. All the ratings were moved down one numerical rating. The responses were calculated to determine the mean and standard deviation. The researcher also determined the percentage of each rating for all knowledge and skill competencies, i.e. what percentage rated the item a 3.

In order to determine consensus the researcher utilized the percentage of individuals whom rated an item at each rating. The ratings were of "important" (3), "rather important" (4), and "very important" (5) were combined together to determine the percentage of the three ratings combined to determine a consensus. The competencies which achieved an agreement of 75% or higher from this combination were determined to have met a consensus; while competencies which achieved an agreement of less than 51% were removed from the list (51% ≥ but ≤ 75%) (Ramsey & Edwards, 2011; Hsu & Sanford, 2007; Jenkins, 2009).

Of the one hundred twenty-two knowledge and skill competencies twenty failed to meet the criteria of 51% agreement to be considered for the third round (i.e. ≥ 51%), these items were removed from the list. Of the one hundred twenty-two competencies eighty-four competencies were found to meet the criteria of an agreement of 75% or higher (75% ≤ i.e.); these items were found to have met the required consensus and were therefore not needed for the third round of the study. The third round of the survey consisted of the seventeen items which fell between 51% and 75% agreement (51% ≥ but ≤ 75%); these items comprised the third round instrument and were sent to the panel of experts.

For the third round of the study the panel of experts was sent, via email, a letter (Appendix E) explaining the process for round three and the instrument (Appendix F) for round three. The instrument included the seventeen items, the mean rating of each item and the rating which each expert had rated the item. The panel of experts were asked to review each of the seventeen items and the ratings and to determine if they still wanted to assign the item the rating which they had previously given the item or to give the item a new rating.

CHAPTER IV

FINDINGS

This study sought to identify knowledge and skills needed for an individual to become successfully employed as a wind energy technician from the consensus of individuals whom are currently directly employed in the wind energy field. The two main objectives of this study were to identify:

- The knowledge a person would need to possess to become successfully employed as a wind energy technician.
- The skills a person would need to possess to become successfully employed as a wind energy technician.

1st Round Results

The first round was sent to twenty-two individuals whom were directly involved in the wind energy field as a wind energy technician, manager, or trainer. Out of the twenty-two experts whom were to make up the panel of experts seventeen responded to the first round, resulting in a 77% response rate.

The first round of the Delphi study sought to achieve a level of agreeability for each of the one hundred twenty-two knowledge and skill competencies based on its importance in a person possessing to be able to successfully enter the wind energy field. The panel of experts was also asked for their input for additional knowledge and skill competencies to be included which they felt would benefit a person in possessing in order to successfully enter the career field as a wind energy technician. The panel of experts were asked to review the one hundred twenty-two knowledge and skill competencies and mark a response of "yes" the competency is important for a person to know to be able to successfully become a wind energy technician or "no" the competency is not important to be able to successfully become a wind energy technician. The one hundred twenty-two competencies were divided into eleven categories based on the content of the competency and the open ended question: "What additional knowledge and/ or skill do you feel a person should know in order to successfully become a wind energy technician?"

Tables 1.1-1.11 display the results of the first round by category, the competencies are listed in order of highest to lowest on agreement for the responses of "yes" the knowledge and skill competency is needed.

Table 1.1

Delphi I Results: Agreement for Personal Knowledge and Skills

Knowledge or Skill competency	Yes	No	% of Agreement
Communicate effectively, listening, writing, nonverbal communication	17	0	100%
Use technology on the job, e-mail, hardware, software, and troubleshooting	17	0	100%
Make self-assessments and knowing one's own abilities	16	1	94%
Organize a schedule	14	3	82%
Analyze data, use chart and graphs	13	4	76%
Demonstrate job search and resume preparation skills	13	2	76%
Demonstrate preparation for the interview	13	3	76%
Know the law, fair and safe labor practice	10	7	59%

Note: 100% Agreement (marked Yes)= consensus, $\geq$75% Agreement (marked Yes)= consensus, $\leq$ 75% Agreement (marked Yes) = Consensus not met.

Table 1.1 displays the results for the first category, which was "Personal Knowledge and Skills." This category consisted of competencies which dealt with simple job seeking and employability skills. Two competencies were found to be 100% needed by the panel of experts. The two competencies were "Communicate effectively, listening, writing, and nonverbal communication" and "Use technology on the job, e-mail, hardware, software, and troubleshooting". The only competency which did not have at least a 75% agreeableness was "Know the law, fair and safe labor practice," which only ten members of the Panel found to be important.

Table 1.2

Delphi I Results: Agreement for Leadership Knowledge and Skills

Knowledge or Skill competency	Yes	No	% of Agreement
Employ various methods to identify, analyze, and solve a problem	17	0	100%
Employ methods of time management	17	0	100%
Discuss the decision making process	16	1	94%
Define integrity	16	1	94%
Identify the characteristics of a desired work ethic	16	0	94%
Define leadership or essential skills	15	2	88%
Discuss goal setting	15	2	88%
Discuss the changing roles of technicians in the workforce	14	3	82%
Demonstrate the use of basic skills to collect information relating to the changing use of technology	14	3	82%
Identify sources of conflict in the workplace and the community and how to resolve them	14	3	82%
Be able to explain the application of leadership to the technical workforce	12	5	71%

Note: 100% Agreement (marked Yes)= consensus, ≥75% Agreement (marked Yes)= consensus, ≤ 75% Agreement (marked Yes) = Consensus not met.

The second category was “Leadership Knowledge and Skills,” which is displayed in Table 1.2. This category consisted of competencies which involved goal setting, problem solving, and decision-making. Two of the knowledge and skill competencies had 100% of the Panel responding “yes.” The two competencies were “Employ various methods to identify, analyze, and solve a problem” and “Employ methods of time management.” The only competency which did not receive at least 75% of the response being “yes” was “Be able to explain the application of leadership to the technical workforce.”

Table 1.3

Delphi I Results: Agreement for Safety Knowledge and Skills

Knowledge or Skill Competency	Yes	No	% of Agreement
Demonstrate safety procedures for energized electrical work	17	0	100%
Demonstrate safety procedures for working with shock and arc boundaries	17	0	100%
Explain and demonstrate lock out/ tag out procedures (simple and complex)	17	0	100%
Describe the different types and components of Fall Arrest Systems	17	0	100%
Identify Confined Space (permitted and non-permitted)	17	0	100%
Demonstrate tool safety: hand and power tools used in the wind industry	17	0	100%
Demonstrate proficient use of a job hazard analysis for all tasks on a wind farm	17	0	100%
Exhibit proficiency in basic First Aid, CPR, and AED	17	0	100%
Readily make adjustment to work strategies and methods when maintaining and repairing turbine components	17	0	100%
Define the purpose of OSHA as applied to the employer and the employee	16	1	94%
State the procedure in obtaining a permit to enter a permitted confined space	16	1	94%

Table 1.3 (continued)

Depict the importance of hazardous communication on a wind farm	16	1	94%
Explain a MSDS	16	1	94%
Demonstrate a flash hazard analysis	15	2	88%
Express safe work practices as related to cranes and rigging	14	3	82%
Identify type, application, and compatibility of different lubricants	10	7	59%
Identify types of gear boxes (hybrid, planetary versus helical/parallel shaft) and probable causes of failure	9	8	53%
Describe the impact of heat generations on various materials and heat control mechanisms	8	9	47%
Define the effects of machining and heat treating on metals as it relates to predictable failures	7	10	41%
Identify gel coats, UV characteristics, flexibility, impact resistance of various coatings and how they are applied	5	12	29%

Note: 100% Agreement (marked Yes)= consensus, ≥75% Agreement (marked Yes)= consensus, ≤ 75% Agreement (marked Yes) = Consensus not met.

Table 1.3 shows the responses for the third category, which was "Safety Knowledge and Skills." This category contained competencies which were related to safety procedures and safe job practices. Of the twenty competencies listed nine received a 100% response of "yes", and all but five received at least a 75% response rate of "yes."

Table 1.4

Delphi I Results: Agreement for Intro to Wind Energy Knowledge and Skills

Knowledge or Skill Competency	Yes	No	% of Agreement
Define general wind turbine terminology	16	1	94%
Identify safety regulations, personal protective equipment, and practices for wind farm technicians	16	1	94%
Describe anatomy of a wind farm	15	2	88%
Discuss environmental, ethical, and legal obligations of the wind farm	14	3	82%
Explain how to plan and schedule maintenance	12	5	71%
Explain air flow as related to wind turbines	9	8	53%
Examine site construction, foundations, roads, and substation development	9	8	53%
Describe evolution of wind turbine technology	7	10	41%

Note. 100% Agreement (marked Yes)= consensus, ≥75% Agreement (marked Yes)= consensus, ≤ 75% Agreement (marked Yes) = Consensus not met.

The fourth category “Intro to Wind Energy,” was made up of competencies which were meant to familiarize individuals with the wind industry. Table 1.4 shows the responses to this category. There were eight competencies, and none of the competencies received a 100% response of “yes.” The highest response rate were for two competencies, “Define general wind turbine terminology” and “Identify safety regulations, personal protective equipment, and practices for wind farm technicians” which both received sixteen out of seventeen responding “yes.”

Table 1.5

Delphi I Results: Agreement for Applied Wind Energy Knowledge and Skills

Knowledge or Skill Competency	Yes	No	% of Agreement
Use teamwork to identify, analyze, and solve safety problems in tower climbs and rescue events	17	0	100%
Perform a climb test	16	1	94%
Discuss aspects of wind turbine control	15	2	88%
Analyze operational issues, the components of an operation and maintenance team	13	4	76%
Define types of wind turbines	10	7	59%
Demonstrate a knowledge of supply chain	10	7	59%
Identify rotor blade materials	9	8	53%
Demonstrate infrared inspection (thermography)	9	8	53%
Model forms of rotor blade vibrations	7	10	41%
Analyze environmental impacts of both wind resources and blade efficiencies	6	11	35%
Analyze blade efficiencies	5	12	29%
Demonstrate how to test wind turbine rotor blades	5	12	29%
Demonstrate measuring strains	5	12	29%
Demonstrate fatigue testing and static testing of rotor blades	4	13	24%

Note. *100% Agreement (marked Yes)= consensus, $\geq$75% Agreement (marked Yes)= consensus, $\leq$ 75% Agreement (marked Yes) = Consensus not met.*

Table 1.5 displays the responses to the fifth category, “Applied Wind Energy.” This category was comprised by competencies which were based on practical skills needed for a wind energy technician. The only competency to receive a 1000%

response of “yes” was “Use teamwork to identify, analyze, and solve safety problems in tower climbs and rescue events.”

Table 1.6

Delphi I Results: Agreement for Electricity Knowledge and Skills

Knowledge or Skill Competency	Yes	No	% of Agreement
Accurately read analog and digital multi-meters and install them properly in circuits so they may be used for circuit analysis	17	0	100%
Differentiate between a good insulator and a good conductor	17	0	100%
Solve problems associated with charged bodies, current, and voltage	16	1	94%
Identify and solve problems associated with both, series and parallel circuits	16	1	94%
Explore the use of switches and safety devices in electrical circuits	16	1	94%
Troubleshoot various digital circuits using schematic diagrams	16	1	94%
Solve problems associated with conductance and resistor tolerances	15	2	88%
Define Inductance and capacitance and analyze the effects of capacitor in both AC and DC circuits	15	2	88%
Define Ohm's law and use it to solve for resistance, current, and voltage and determine and use proper prefixes associated with electronic terms	14	3	82%
Analyze the function and different types of conductors	14	3	82%
Describe the relationship between wire size (diameter) and wire gauge (AWG)	14	3	82%
Identify different types of batteries and describe their proper application	14	3	82%
Analyze the relationship between a current carrying conductor and the magnetic field surrounding the conductor	14	3	82%
Construct digital circuits such as combinational logic circuits, clocking, and timing circuits, analog-to-digital, and digital-to-analog devices	9	8	53%
Determine the proper operation of RS, master-slave, JK, and D-type flip-flop circuits	8	9	47%
Verify normal operations for synchronous and asynchronous shift registers and counters	8	9	47%

Table 1.6 *(Continued)*

Verify normal operations of 4-bit adders and subtractor circuits and 64-bit memory circuit	8	10	47%
Identify operation, truth tables, and logic symbols for an, or, not, nand, nor, and xor gates	7	10	41%
Simplify multiple logic gate circuits using Boolean algebra and Karnaugh mapping	7	10	41%
Determine the proper orientation of one-shot, monostable, astable, and bistable multivibrator circuits	7	10	41%
Convert between decimal, binary, octal, and hexadecimal number systems	6	11	35%

Note. *100% Agreement (marked Yes)= consensus, ≥75% Agreement (marked Yes)= consensus, ≤ 75% Agreement (marked Yes) = Consensus not met.*

The sixth category was "Electricity Knowledge and Skills," which consisted of competencies based on electrical knowledge and skills. Table 1.6 shows the responses of the panel of experts. Only two competencies received a 100% response rate of "yes;" the two competencies were "Accurately read analog and digital multi-meters and install them properly in circuits so they may be used for circuit analysis" and "Differentiate between a good insulator and a good conductor."

Table 1.7

Delphi I Results: Agreement for DC/AC Knowledge and Skills

Knowledge or Skill Competency	Yes	No	% of Agreement
Demonstrate proper usage of a multimeter and oscilloscope to make measurements	17	0	100%
Describe the source of electricity	16	1	94%
Understand and use Kirchoff's law, Ohm's law, and the Power formula	14	3	82%
Construct and analyze DC and AC circuits from simple to complex	14	3	82%
Perform calculations using decimal, scientific, engineering, and metric notation numbers	13	4	76%

Table 1.7 (Continued)

Perform calculations and measurements on series and parallel series DC and AC circuits and series-parallel DC circuits	13	4	76%
Perform calculations and measurements on transformer circuits	12	5	71%

Note. 100% Agreement (marked Yes)= consensus, ≥75% Agreement (marked Yes)= consensus, ≤ 75% Agreement (marked Yes) = Consensus not met.

Table 1.7 displays the responses for the seventh category, " DC/AC Knowledge and Skills." This category also dealt with competencies which pertained to electricity, these competencies were based on practical application of electrical principles. The only competency which received a 100% response of "yes" was "Demonstrate proper usage of a multimeter and oscilloscope to make measurements."

Table 1.8

Delphi I Results: Agreement for Distribution Knowledge and Skills

Knowledge or Skill Competency	Yes	No	% of Agreement
Apply and understand proper grounding procedures	17	0	100%
Apply ground fault and ground protective relays	15	2	88%
Demonstrate proper wiring techniques	15	2	88%
Install line protective devices and protective relaying	14	3	82%
Construct, troubleshoot, and repair simple electrical distribution systems	12	5	71%
Calculate and install overcurrent protection	12	5	71%
Identify electrical and stand-by distribution system	11	6	65%
Calculate circuit loads, conduit fill, and ampacity	11	6	65%
Install multiple switch circuit	11	6	65%
Demonstrate use of National Electric Code	11	6	65%

Table 1.8 (continued)

Construct service entrance	9	8	53%
Select equipment and install branch circuit	9	8	53%
Construct an electric metallic tubing conduit system	9	8	53%

Note. *100% Agreement (marked Yes)= consensus, ≥75% Agreement (marked Yes)= consensus, ≤ 75% Agreement (marked Yes) = Consensus not met.*

The eighth category was "Distribution Knowledge and Skills," which had competencies which consisted of power delivery systems. There was only one competency receiving a 100% response of "yes" which was the competency "Apply and understand proper grounding procedures."

Table 1.9

Delphi I Results: Agreement for Motor Controls Knowledge and Skills

Knowledge or Skill Competency	Yes	No	% of Agreement
Demonstrate proper and safe troubleshooting practices	17	0	100%
Analyze schematics and relay logic functions	16	1	94%
Sketch construct, operate, and troubleshoot circuit with motor, motor starter, and control devices	15	2	88%
Determine proper power source	15	2	88%
Sketch, construct, operate, and troubleshoot overload protection circuit to comply with all specifications	14	3	82%
Sketch circuit and construct pushbutton and selectors switches to operate as specified	14	3	82%
Select and size relays and conductors	14	3	82%
Select and size control circuit components	14	3	82%
Select and size line voltage components	14	3	82%
Sketch and construct magnetic solenoid circuits as specified	12	5	71%

Note. *100% Agreement (marked Yes) = consensus, ≥75% Agreement (marked Yes)= consensus, ≤ 75% Agreement (marked Yes) = Consensus not met.*

The ninth category was “Motor Controls Knowledge and Skills,” which consisted of competencies, which require demonstration of hands on circuit control. Table 1.9 displays the responses of the panel of experts. There was only one competency which had a response rate of 100% “yes;” the competency “Demonstrate proper and safe troubleshooting practices,” had all seventeen respondents indicating “yes” the competency is needed for a person to possess in order to successfully enter the wind energy technician field.

Table 1.10

Delphi I Results: Agreement for Basic Fluid Power Knowledge and Skills

Knowledge or Skill Competency	Yes	No	% of Agreement
Identify components of a fluid power system and explain their operation	13	4	76%
Report on characteristics of fluid power and vacuum and their uses in industry	10	7	59%
Design a general fluid power system	8	9	47%
Discuss building and maintaining vacuum systems	7	10	41%

Note. *100% Agreement (marked Yes)= consensus, ≥75% Agreement (marked Yes)= consensus, ≤ 75% Agreement (marked Yes) = Consensus not met.*

Table 1.10 displays the responses for the category, “Basic Fluid Power Knowledge and Skills.” This category was comprised by competencies which dealt with fluid power and vacuum systems. There were only four competencies to the category, and only one competency received a response rate of at least 75% responding “yes.” The competency “Identify components of a fluid power system and explain their operation,” received thirteen responses of “yes” from the seventeen members of the panel of experts.

Table 1.11

Delphi I Results: Agreement for Distributed Control and Programmable Logic Knowledge and Skills

Knowledge or Skill Competency	Yes	No	% of Agreement
Operate and troubleshoot digital systems	16	1	94%
Demonstrate the use of SCADA and various data communications systems	15	2	88%
Utilize programmable logic controllers (PLCs) to interpret sensor and process variable data	14	3	82%
Configure programmable logic controllers (PLCs) to perform various tasks	10	7	59%
Display the ability to configure a smart transmitter	7	10	41%

Note. *100% Agreement (marked Yes)= consensus, ≥75% Agreement (marked Yes)= consensus, ≤ 75% Agreement (marked Yes) = Consensus not met.*

The eleventh category was "Distributed Control and Programmable Logic Knowledge and Skills." This category consisted of competencies which were based on the ability to understand and work on digital control systems. No competency received a 100% response of "yes," the competency to received the most responses of "yes," was "Operate and troubleshoot digital systems." This competency received sixteen responses of "yes" from the seventeen members of the panel of experts.

1st Round Summary

The first round asked members to review the one hundred twenty-two knowledge and skill competencies. The members were asked respond "yes" or "no" if the competency was pertinent in becoming successfully employed as a wind energy technician. The knowledge and skill competencies were broke down into eleven categories according to the nature of the knowledge and skill competency. Members were also asked to add any additional knowledge and skills which they believed should be included on the instrument. Of the seventeen members of the panel of experts whom responded to the first instrument, none of them included any additional knowledge or skills to be added for the second round. The instrument for the second round mirrored the first round instrument with the exception of the rating system which was added.

2nd Round Results

The second round was sent to seventeen individuals whom were directly involved in the wind energy field as a wind energy technician, manager, or trainer. The seventeen individuals were those whom responded during the first round of surveys. Out of the seventeen experts whom made up the panel of experts sixteen responded to the second round, resulting in a 94% response rate.

The second round of this Delphi study sought to determine a consensus for the average rating of level of importance for each competency. A 5-point Likert-type scale of 1- not important, 2- slightly important, 3- important, 4-rather important, 5-very important was utilized by the panel of experts. The scale was designed to indicate the level of importance for a person to possess to successfully enter the wind energy technician field.

The one hundred twenty-two knowledge and skill competencies from round one were utilized for round two. The ratings of 1, 2, 3, 4, and 5 were recoded as 0, 1, 2, 3, and 4 after the responses were received. This was to allow for a more accurate score for 1 as not being needed.

From the one hundred twenty-two knowledge and skill competencies eighty-four were determined to have met consensus with 75% or more responses having rated the competency a 3, 4, or 5. Tables 2.1-2.11 display the results of the second round by category; the competencies are listed in order of highest to lowest on percentage of agreement for ratings of 3, 4, or 5.

Table 2.1

Delphi II Results: Ratings for Personal Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Communicate effectively, listening, writing, nonverbal communication	3.56	.81	100%
Use technology on the job, e-mail, hardware, software, and troubleshooting	3.50	.63	100%
Make self-assessments and knowing one's own abilities	3.19	1.17	94%
Demonstrate job search and resume preparation skills	2.50	1.10	81%
Demonstrate preparation for the interview	2.56	1.21	75%
Organize a schedule	2.31	1.30	69%
Know the law, fair and safe labor practice	2.19	1.05	69%
Analyze data, use chart and graphs	1.73	.88	47%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

Table 2.1 displays the responses for the category of "Personal Knowledge and Skills." This category was made up of competencies which dealt with standard application and job skills.

As illustrated in Table 2.1 the second round revealed five of the competencies met consensus (≥75%), meaning the percentage of members from the panel of experts responded with a 3 (important), 4 (rather important), or 5 (very important) was 75% or higher. Two items fell in the undecided range (51% ≤ ≥ 75%), "Organize a schedule" and "Know the law, fair and safe labor practice." These two items failed to reach a consensus and were reviewed during the round three.

One competency, "Analyze data, use chart and graphs," met an agreement level of 47%, which was below the level to be undecided ($\leq$ 51%) and was therefore rejected and removed from the list.

Table 2.2

Delphi II Results: Ratings for Leadership Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Employ various methods to identify, analyze, and solve a problem	3.38	1.15	94%
Employ methods of time management	3.06	1.18	88%
Define integrity	3.00	1.21	88%
Identify the characteristics of a desired work ethic	2.88	1.20	88%
Discuss the decision making process	2.63	1.02	88%
Discuss goal setting	2.56	1.09	88%
Define leadership or essential skills	2.44	.81	94%
Demonstrate the use of basic skills to collect information relating to the changing use of technology	2.44	1.09	88%
Be able to explain the application of leadership to the technical workforce	2.19	.98	81%
Identify sources of conflict in the workplace and the community and how to resolve them	2.19	1.17	69%
Discuss the changing roles of technicians in the workforce	1.88	1.20	69%

Note. Percentage of respondents marked 3, 4, or 5: 75% $\leq$ Agreement= consensus met, 51% $\leq \geq$ 75% Agreement= undecided, $\leq$ 51% Agreement= Reject

Table 2.2 displays the results of the responses to the second round for the category of "Leadership Knowledge and Skills." Nine competencies achieved an agreement level to meet consensus ($\geq$75%). Two competencies were found to be undecided (51% $\leq \geq$ 75%), "Identify sources of conflict in the workplace and the community and how to resolve them," (69%) and "Discuss the changing roles of technicians in the workplace" (69%). These two competencies were placed on the third instrument in an attempt to achieve consensus.

Table 2.3

Delphi II Results: Ratings for Safety Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Explain and demonstrate lock out/ tag out procedures (simple and complex)	3.69	.70	100%
Demonstrate safety procedures for energized electrical work	3.63	.72	100%
Demonstrate safety procedures for working with shock and arc boundaries	3.56	.73	100%
Demonstrate tool safety: hand and power tools used in the wind industry	3.56	.81	100%
Exhibit proficiency in basic First Aid, CPR, and AED	3.56	.63	100%
Express safe work practices as related to cranes and rigging	3.25	1.00	94%
Depict the importance of hazardous communication on a wind farm	3.25	1.13	94%
Demonstrate proficient use of a job hazard analysis for all tasks on a wind farm	3.25	1.13	94%
Demonstrate a flash hazard analysis	3.19	.98	94%
Describe the different types and components of Fall Arrest Systems	3.19	1.05	94%
Readily make adjustment to work strategies and methods when maintaining and repairing turbine components	3.19	.91	94%
Identify Confined Space (permitted and non-permitted)	3.13	1.02	94%
Explain a MSDS	3.07	.96	93%
Define the purpose of OSHA as applied to the employer and the employee	2.81	1.05	88%
State the procedure in obtaining a permit to enter a permitted confined space	2.94	1.18	81%
Identify types of gear boxes (hybrid, planetary versus helical/parallel shaft) and probable causes of failure	2.00	.82	81%
Describe the impact of heat generations on various materials and heat control mechanisms	1.75	1.00	63%
Identify type, application, and compatibility of different lubricants	2.00	1.37	56%
Identify gel coats, UV characteristics, flexibility, impact resistance of various coatings and how they are applied	1.31	.87	44%
Define the effects of machining and heat treating on metals as it relates to predictable failures	1.56	1.15	38%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

The results for the third category titled "Safety Knowledge and Skills," are reflected in Table 2.3. Sixteen competencies achieved an agreement level to meet consensus (≥75%), meaning the percentage of members responding with a 3 (important), 4 (rather important), or 5 (very important) was 75% or higher.

Two competencies were found to be undecided (51% ≤ ≥ 75%). "Describe the impact of heat generations on various materials and heat control mechanisms," (63%) and " Identify type, applications, and compatibility of different lubricants," (56%).

Two competencies were rejected because the level of agreement achieved fell below the undecided level (≤51%). The two competencies which were rejected were "Identify gel coats, UV characteristics, flexibility, impact resistance of various coatings and how they are applied" (44%) and "Define the effects of machining and heat treating on metals as it relates to predictable failures" (38%).

Table 2.4

Delphi II Results: Ratings for Intro to Wind Energy Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Identify safety regulations, personal protective equipment, and practices for wind farm technicians	3.50	.82	100%
Define general wind turbine terminology	2.69	1.01	88%
Discuss environmental, ethical, and legal obligations of the wind farm	2.38	1.31	75%
Describe anatomy of a wind farm	2.31	1.14	75%
Explain how to plan and schedule maintenance	2.13	1.20	75%
Explain air flow as related to wind turbines	1.50	.82	56%
Describe evolution of wind turbine technology	1.63	1.26	50%
Examine site construction, foundations, roads, and substation development	1.44	.96	50%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

Table 2.4 displays the results of the responses for the fourth category "Intro to Wind Energy Knowledge and Skills." Five of the eight competencies achieved a consensus of 75% or more (≥75%). Only one of the competencies was determined to be undecided (51% ≤ ≥ 75%) and was included in the survey for the third round of the study. The competency "Explain air flow as related to wind turbines" had an agreement of 56%.

Two competencies had an agreement of less than 51% and were rejected (≤51%). "Describe evolution of wind turbine technology" and "Examine site construction, foundations, roads, and substation development" both achieved a 50% level of agreement and were rejected.

Table 2.5

Delphi II Results: Ratings for Applied Wind Energy Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Perform a climb test	3.69	.60	100%
Use teamwork to identify, analyze, and solve safety problems in tower climbs and rescue events	3.50	.89	94%
Analyze operational issues, the components of an operation and maintenance team	2.19	1.22	75%
Define types of wind turbines	1.94	1.12	75%
Discuss aspects of wind turbine control	2.33	1.35	73%
Demonstrate a knowledge of supply chain	1.88	1.20	63%
Demonstrate infrared inspection (thermography)	1.50	.97	44%
Analyze environmental impacts of both wind resources and blade efficiencies	1.38	1.15	44%
Analyze blade efficiencies	1.25	.77	44%
Demonstrate how to test wind turbine rotor blades	1.19	1.11	38%
Identify rotor blade materials	1.19	.66	31%
Model forms of rotor blade vibrations	1.06	.93	31%
Demonstrate fatigue testing and static testing of rotor blades	1.06	.85	25%
Demonstrate measuring strains	0.94	.68	19%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

Table 2.5 illustrates the results for the response for the category "Applied Wind Energy Knowledge and Skills," which consisted of fourteen competencies. Four of the competencies reached an agreement level of 75% or higher and were determined to meet consensus (≥75%); further consideration was not needed.

The competency "Demonstrate a knowledge of supply chain," (63%) was determined to be undecided (51% ≤ ≥ 75%). This competency was used for round three to attempt to meet a level of consensus.

Eight competencies failed to reach a level of agreement of 51% or higher and was rejected.

Table 2.6

Delphi II Results: Ratings for Electricity Principles Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Accurately read analog and digital multi-meters and install them Properly in circuits so they may be used for circuit analysis	3.50	.73	100%
Analyze the function and different types of conductors	2.88	.81	100%
Solve problems associated with charged bodies, current, and voltage	3.38	.89	94%
Explore the use of switches and safety devices in electrical circuits	3.38	.89	94%
Define Ohm's law and use it to solve for resistance, current, and voltage and determine and use proper prefixes associated with electronic terms	3.25	.93	94%
Identify and solve problems associated with both, series and parallel circuits	3.25	.86	94%
Differentiate between a good insulator and a good conductor	3.13	.96	94%
Troubleshoot various digital circuits using schematic diagrams	3.13	1.09	88%
Solve problems associated with conductance and resistor tolerances	3.13	1.02	88%
Define Inductance and capacitance and analyze the effects of capacitor in both AC and DC circuits	3.00	1.21	88%

Table 2.*6 (Continued)*

Describe the relationship between wire size (diameter) and wire gauge (AWG)	2.81	1.22	88%
Identify different types of batteries and describe their proper application	2.63	1.26	88%
Analyze the relationship between a current carrying conductor and the magnetic field surrounding the conductor	2.75	1.24	81%
Construct digital circuits such as combinational logic circuits, clocking, and timing circuits, analog-to-digital, and digital-to-analog devices	2.56	1.31	81%
Verify normal operations for synchronous and asynchronous shift registers and counters	2.00	1.21	69%
Identify operation, truth tables, and logic symbols for an, or, not, nand, nor, and xor gates	1.81	1.22	56%
Determine the proper operation of RS, master-slave, JK, and D-type flip-flop circuits	1.81	1.38	56%
Determine the proper orientation of one-shot, monostable, astable, and bistable multivibrator circuits	1.75	1.29	50%
Convert between decimal, binary, octal, and hexadecimal number systems	1.63	1.20	50%
Verify normal operations of 4-bit adders and subtractor circuits and 64-bit memory circuit	1.56	.96	50%
Simplify multiple logic gate circuits using Boolean algebra and Karnaugh mapping	1.50	1.26	38%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

The results for the second round for the sixth category "Electricity Principles Knowledge and Skills," are found in Table 2.6. This category contained the most competencies with twenty-one different knowledge and skills competencies. Of the twenty-one competencies fourteen achieved a level of agreement to meet consensus (75% ≤) and were not included for the third round of this study.

Three competencies were determined to be undecided (51% ≤ ≥ 75%). The competencies "Verify normal operations for synchronous and asynchronous shift registers and counters" (69%), "Identify operation, truth tables, and logic symbols for an, or, not, nand, nor, and xor gates" (56%), and "Determine the proper operation of RS, master-slave, JK, and D-type flip-flop circuits" (56%) were utilized for round three to achieve a level of consensus for each.

Four competencies fell below a 51% level of agreement and were rejected (≤51%).

Table 2.7

Delphi II Results: Ratings for DC/AC Circuits Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Demonstrate proper usage of a multimeter and oscilloscope to make measurements	3.56	.73	100%
Describe the source of electricity	3.44	.81	100%
Perform calculations and measurements on series and parallel series DC and AC circuits and series-parallel DC circuits	3.06	1.06	94%
Perform calculations and measurements on transformer circuits	3.00	1.03	94%
Understand and use Kirchoff's law, Ohm's law, and the Power Formula	2.88	0.96	94%
Construct and analyze DC and AC circuits from simple to complex	2.81	1.42	81%
Perform calculations using decimal, scientific, engineering, and metric notation numbers	2.38	1.26	81%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

The seventh category was "DC/AC Circuits Knowledge and Skills;" Table 2.7 shows the results of the responses from the panel of experts. All seven competencies achieved an agreement level which met consensus (≥ 75%). No further consideration was needed for these seven competencies and they were not utilized for the third round of the study.

Table 2.8

Delphi II Results: Ratings for Distribution Systems Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Apply and understand proper grounding procedures	3.56	1.09	94%
Demonstrate proper wiring techniques	3.19	1.17	94%
Apply ground fault and ground protective relays	3.19	1.28	88%
Construct, troubleshoot, and repair simple electrical distribution systems	3.00	1.15	88%
Install line protective devices and protective relaying	2.81	1.22	88%
Install multiple switch circuit	2.44	1.26	88%
Identify electrical and stand-by distribution system	2.31	1.08	81%
Demonstrate use of National Electric Code	2.38	1.36	75%
Calculate and install overcurrent protection	2.38	1.54	75%
Calculate circuit loads, conduit fill, and ampacity	2.31	1.45	75%
Construct an electric metallic tubing conduit system	2.00	1.37	63%
Select equipment and install branch circuit	1.75	1.24	50%
Construct service entrance	1.69	1.30	50%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

Table 2.8 displays the results of the second round for the category "Distribution Systems Knowledge and Skills." Out of the thirteen competencies ten achieved a level of agreement which met consensus (≥ 75%) during round two.

The competency "Construct an electric metallic tubing conduit system" (63%) was determined to be undecided (51% ≤ ≥ 75%). This competency was utilized during the third round for further review to achieve a level of agreement to meet consensus.

Two competencies fell below the 51% level of agreement and was rejected (≥ 51%). The competencies "Select equipment and install branch circuit" and "Construct service entrance" both obtained a level of agreement of 50%.

Table 2.9

Delphi II Results: Ratings for Motor Controls Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Demonstrate proper and safe troubleshooting practices	3.75	.58	100%
Determine proper power source	3.31	.95	94%
Analyze schematics and relay logic functions	2.88	1.26	88%
Sketch construct, operate, and troubleshoot circuit with motor, motor starter, and control devices	2.63	1.36	81%
Sketch, construct, operate, and troubleshoot overload protection circuit to comply with all specifications	2.63	1.36	81%
Sketch circuit and construct pushbutton and selectors switches to operate as specified	2.56	1.31	81%
Select and size relays and conductors	2.44	1.36	75%
Select and size line voltage components	2.44	1.36	75%
Select and size control circuit components	2.31	1.30	75%
Sketch and construct magnetic solenoid circuits as specified	2.06	1.24	75%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

Table 2.9 displays the results for the second round for the category "Motor Controls Knowledge and Skills." All 10 of the competencies were found to have achieved a level of agreement to meet consensus (75% ≤) and were not included in the third round for further review.

Table 2.10

Delphi II Results: Basic Fluid Power Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Identify components of a fluid power system and explain their operation	2.44	1.36	69%
Report on characteristics of fluid power and vacuum and their uses in industry	2.00	1.37	69%
Design a general fluid power system	1.88	1.45	63%
Discuss building and maintaining vacuum systems	1.50	1.21	50%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

The tenth category was “Basic Fluid Power Knowledge and Skills;” the results of the responses are displayed in Table 2.10. None of the competencies had an agreement level to meet consensus (≥ 75%).

Three competencies’ level of agreement were determined to be undecided (51% ≤ ≥ 75%), and were utilized during the third round for further review to achieve a level of agreement to meet consensus.

The competency “Discuss building and maintaining vacuum systems” (50%) fell below the level to be undecided and was rejected (≤ 51%).

Table 2.11

Delphi II Results: Ratings for Distributed Control and Programmable Logic Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Demonstrate the use of SCADA and various data communications systems	3.25	.93	94%
Operate and troubleshoot digital systems	3.00	1.15	88%
Utilize programmable logic controllers (PLCs) to interpret sensor and process variable data	2.50	1.21	81%
Configure programmable logic controllers (PLCs) to perform various tasks	2.25	1.29	75%
Display the ability to configure a smart transmitter	1.94	1.12	69%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, 51% ≤ ≥ 75% Agreement= undecided, ≤ 51% Agreement= Reject

Table 2.11 displays the results for second round of the category “Distributed Control and Programmable Logic Knowledge and Skills.” Four of the five competencies achieved a level of agreement to meet consensus (≥ 75%).

The competency “Display the ability to configure a smart transmitter,” (69%) was determined to be undecided (51% ≤ ≥ 75%). The competency was utilized during the third round for further review to obtain a level of agreement to meet consensus (75% ≤).

2nd Round Summary

The second round of the study was completed by sixteen of the seventeen original members from the panel of experts. The goal of the second round was to achieve a consensus on each of the one hundred twenty-two knowledge and skill competencies across the 11 categories. Consensus was determined to have been met when a level of agreement of was 75% or more.

Round two found eighty-four knowledge and skill competencies met consensus and were not needed for the third round. Out of the one hundred twenty-two knowledge and skills competencies seventeen were determined to be undecided, because it fell in between 51% and 75% on the level of agreement. Those seventeen knowledge and skills competencies were utilized for the third round, to allow for further review by the panel of experts. Out of the one hundred twenty-two knowledge and skills competencies 20 were determined to be below the 51% agreement level and were therefore rejected. No further review was needed for those twenty knowledge and skills competencies.

3rd Round Results

The third round was sent to sixteen individuals whom were directly involved in the wind energy field as a wind energy technician, manager, or trainer. The sixteen individuals were those whom responded during the second round of surveys. Out of the sixteen experts whom made up the panel of experts, all sixteen responded to the third round, resulting in a 100% response rate for the third round.

The third round of this Delphi study sought to further determine a consensus for the average rating for the level of importance for each competency. A 5-point Likert-type scale of 1- not important, 2- slightly important, 3- important, 4-rather important, 5- very important was utilized by the panel of experts. The scale was designed to indicate the level of importance of each skill for a person to possess to successfully enter the wind energy technician field.

The third round consisted of an instrument composed of seventeen knowledge and skill competencies from round two had not achieved a level of consensus above 75%, but had achieved at least a 51% agreement level. The agreement level was based on what percent of the members of the panel of experts had rated the item a 3- important, 4, rather important, or 5- very important. Members of the panel of experts were sent an individualized instrument, which contained their responses on the 17 knowledge and skill competencies from the second round and the average rating for each item. Members were asked to review their previous responses along with the average rating which was calculated for the group and determine if they would like to keep their original response or adjust it after seeing the group average.

The ratings of 1, 2, 3, 4, and 5 were recoded as 0, 1, 2, 3, and 4 after the responses were received. This was to allow for a more accurate score for 1 as not being needed. The results displayed in the following tables are recorded as they appear after being recoded.

Table 3.1

Delphi III Results: Ratings for Personal Skills Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Organize a schedule	2.31	1.08	75%
Know the law, fair and safe labor practice	2.13	1.09	63%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, ≤ 74% Agreement= Reject

Table 3.1 displays the results for the third round of the category “Personal Skills Knowledge and Skills.” Only one of the competencies achieved a consensus with an agreement of 75% or higher. The competency “Organize a schedule,” had an agreement level of 75% and was determined to have met a consensus.

Table 3.2

Delphi III Results: Leadership Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Identify sources of conflict in the workplace and the community and how to resolve them	1.94	.85	75%
Discuss the changing roles of technicians in the workforce	1.69	1.14	63%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, ≤ 74% Agreement= Reject

Table 3.2 displays the results for the third round of the category “Leadership Knowledge and Skills.” Only one of the competencies achieved a consensus with an agreement of 75% or higher. The competency “Identify sources of conflict in the workplace and the community and how to resolve them,” had an agreement level of 75% and was determined to have met a consensus.

Table 3.3

Delphi III Results: Ratings for Safety Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Identify type, application, and compatibility of different lubricants	1.94	1.12	50%
Describe the impact of heat generations on various materials and heat control mechanisms	1.50	.89	50%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, ≤ 74% Agreement= Reject

The results for the second round for the category "Safety Knowledge and Skills," are displayed in Table 3.3. Neither of the competencies achieved a consensus of an agreement of 75% or higher. Both competencies "Identify type, application, and compatibility of different lubricants" and "Describe the impact of heat generations on various materials and heat control mechanisms," were rejected and considered to not be a needed knowledge or skill competency.

Table 3.4

Delphi III Results: Ratings for Introduction to Wind Energy Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Explain air flow as related to wind turbines	1.38	.81	44%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, ≤ 74% Agreement= Reject

Table 3.4 displays the results for the third round of the category "Introduction to Wind Energy Knowledge and Skills." The competency "Explain air flow as related to wind turbines," failed to reach an agreement of 75% or higher and was therefore rejected.

Table 3.5

Delphi III Results: Ratings for Applied Wind Energy Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Discuss aspects of wind turbine control	2.31	1.14	75%
Demonstrate a knowledge of supply chain	1.63	1.09	50%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, ≤ 74% Agreement= Reject

The results for the category "Applied Wind Energy Knowledge and Skills" are displayed in Table 3.5. Only one of the competencies achieved a consensus with an agreement of 75% or higher. The competency "Discuss aspects of wind turbine control," had an agreement level of 75% and was determined to have met a consensus.

Table 3.6

Delphi III Results: Ratings for Electricity Principles Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Verity normal operations for synchronous and asynchronous shift registers and counters	1.69	1.01	63%
Identify operation, truth tables, and logic symbols for an, or, not, nand, nor, and xor gates	1.75	1.13	56%
Determine the proper operation of RS, master-slave, JK, and D-type flip-flop circuits	1.75	1.13	56%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, ≤ 74% Agreement= Reject

Table 3.6 displays the results for the third round of the category "Electricity Principles Knowledge and Skills." None of the competencies achieved a consensus with an agreement of 75% or higher. All three competencies were rejected, and determined to not be a knowledge or skill need for a wind energy technicians.

Table 3.7

Delphi III Results: Ratings for Distribution Systems Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Construct an electric metallic tubing conduit system	1.50	1.10	50%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, ≤ 74% Agreement= Reject

Table 3.7 displays the results for the third round of the category "Distribution Systems Knowledge and Skills." The only competency for this category did not reach a level of consensus with an agreement of 75% or higher. The competency "Construct an electric metallic tubing conduit system," was only able to reach a level of agreement of 50% and was therefore rejected.

Table 3.8

Delphi III Results: Ratings for Basic Fluid Power Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Identify components of a fluid power system and explain their operation	2.50	1.15	88%
Report on characteristics of fluid power and vacuum and their uses in industry	1.88	1.20	63%
Design a general fluid power system	1.69	1.35	56%

Note. Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, ≤ 74% Agreement= Reject

The results for the third round for the category "Basic Fluid Power Knowledge and Skills," are displayed in Table 3.8. Only one of the competencies achieved a consensus with an agreement of 75% or higher. The competency "Identify components of a fluid power system and explain their operation," had an agreement level of 88% and was determined to have met a consensus (≥ 75%).

Table 3.9

Delphi III Results: Ratings for Distributed Control and Programmable Logic Knowledge and Skills

Knowledge or Skill Competency	*M*	*SD*	Agreement
Display the ability to configure a smart transmitter	1.69	.95	56%

Note. *Percentage of respondents marked 3, 4, or 5: 75% ≤ Agreement= consensus met, ≤ 74% Agreement= Reject*

Table 3.9 displays the results for the third round of the category "Distributed Control and Programmable Logic Knowledge and Skills." The only competency "Display the ability to configure a smart transmitter," did not reach a consensus of 75% or higher and was therefore rejected and determined to not be needed.

3rd Round Summary

The seventeen knowledge and skill competencies from round two, which did not meet consensus, were utilized for round three. Of the seventeen competencies four were found to have met a consensus of 75% or higher (≥ 75%). The four competencies: "Organize a schedule"; "Identify sources of conflict in the workplace and the community and how to resolve them"; "Discuss aspects of wind turbine control"; and "Identify components of a fluid power system and explain their operation" were all found to have met a consensus.

Out of the seventeen competencies five were at 50% or below (≤ 50%), The remaining eight competencies were found to be in the 51% - 74% range (51% ≤ ≥ 74%). During the second round of this study, competencies, which fell into this range, was determined to be undecided. For the third round of the study these competencies were rejected. A fourth round was not sought for these competencies; (Custer, Scarcella, & Stewart, 1999) indicated a fourth or fifth round may only achieve a slight change in the consensus, and therefore not needed. As the number of rounds increase during a Delphi process, the number of response rates tend to decrease (Alexander, 2004). The thirteen competencies which did not reach a consensus of 75% or higher (≥ 75%) were considered not needed and were rejected by the researcher.

Summary of Findings

This study sought to identify various knowledge and skills needed for an individual to become successfully employed as a wind energy technician from the consensus of individuals whom are currently directly employed in the wind energy field. The two main competencies of this study were to identify:

- The knowledge a person would need to possess to become successfully employed as a wind energy technician.
- The skills a person would need to possess to become successfully employed as a wind energy technician.

This study initially began with one hundred twenty-two knowledge and skills competencies. After three rounds of a Delphi method study eighty-eight knowledge and skills competencies reached a level of agreement among the panel of experts to meet consensus.

CHAPTER V

CONCLUSIONS, IMPLICATIONS, RECOMMENDATIONS

Purpose and Objectives

The purpose of this study is to identify knowledge and skills needed for individuals to become successfully employed as a wind energy technician. The researcher sought to poll industry professionals on these items, with two main objectives:

- Identification of knowledge needed to become successfully employed as a wind energy technician.
- Identification of skills needed to become successfully employed as a wind energy technician.

Need

Priority three of the National Research Agenda "Sufficient Scientific and Professional Workforce which Addresses the Challenges of the 21st Century;" indicates a need for a highly educated, skilled workforce which meet challenges of the 21st Century (Doerfert, 2011). Agricultural education as a discipline has a unique advantage to incorporate new programs and educational opportunities to address the needs of the workforce.

As the discipline of agricultural education moves forward and incorporates new courses, wind energy education is a field, which deserves attention. There are six factors, which make the knowledge, and skills needed for the industry of wind energy an important candidate for an agricultural education program. The factors of growth, economy, education, STEM, job growth, and public policy drive a need for curriculum development based on industry experts' view to create a knowledgeable and skilled workforce for the wind energy industry. According to Phipps and Osborne (1988) the agriculture classroom can provide unique and essential skill development opportunities.

This study sought to provide educators in both secondary and post-secondary education institutions with occupational knowledge and skills specific to the wind energy industry. Educators would be able to benefit from the knowledge and skills which are identified by industry experts, to utilize in preparing students for meaningful careers in the wind energy industry. Aligning education with the industry provides for a mutually beneficial relationship, which allows industry to express their needs, and for education to respond with curriculum, which is appropriate to the need.

Summary of Methods

For this descriptive study a Delphi method was used to determine the entry-level knowledge and skills a worker would need to become successfully employed as a wind energy technician. The instrument was developed utilizing the competencies from courses at six different colleges, in the state of Texas, these courses are designed to train and certify a person as a wind energy technician level 1. The competencies were combined and condensed to eliminate any repeat competencies. The final instrument contained one hundred and twenty-two knowledge and skills competencies which were validated by having three instructors, whom instruct in the field of wind energy, review the competencies and eliminate any they believed were not pertinent to becoming successfully employed as a wind energy technician.

For the first round of this study the instrument was electronically sent to twenty-two individuals whom comprised the panel of experts. The members were asked to review the one hundred and twenty-two knowledge and skills competencies and to agree or disagree with the need for each particular competency in its pertinence with becoming a wind energy technician. In addition members were asked to add any additional knowledge and/ or skills they believed should be included in the instrument.

For the second round of this study an instrument with the same one hundred and twenty-two knowledge and skills competencies was sent electronically to the members of the panel of experts. The second instrument asked members to rate each competency on a 5-point Likert scale ranging from 1-not important to 5- very important.

For the third round of this study an instrument was created utilizing the seventeen knowledge and skills competencies, which were identified as undecided. Each member of the panel of experts were electronically sent the instrument which contained the seventeen knowledge and skills competencies listed, the mean rating, and the individuals' personal rating for each of the competencies. This provided an opportunity for each member to review the mean rating and their own and to decide if they would still rate the knowledge and skill competency the same or if they would change their opinion for each particular competency.

Summary of Findings

For the first round of this study the instrument was electronically sent to twenty-two individuals whom comprised the panel of experts. Of the twenty-two members seventeen responded to the first round, all one hundred and twenty-two knowledge and skill competencies were kept, and no additional competencies were added.

For the second round of this study an instrument with the same one hundred and twenty-two knowledge and skills competencies was sent electronically to the seventeen members of the panel of experts. The second round received responses from sixteen members of the panel of experts. Out of the one hundred and twenty-two knowledge and skills competencies eighty-four were found to have met consensus, twenty were rejected, and seventeen were identified to be undecided and needed further review from the panel.

The third round utilized the seventeen undecided knowledge and skills competencies to send back to the panel of experts for further consideration to achieve a consensus. Of the seventeen knowledge and skill competencies only four achieved a consensus, the remaining thirteen failed to meet consensus. These thirteen knowledge and skill competencies were determined to be not needed for a person to possess to become a wind energy technician and were therefore rejected.

Conclusions

Objective 1

Education is vital to the development of a sustainable society by raising awareness, providing training, and acting as an agent of social change (Jennings, 2009). Bangser (2008) indicated high schools fail to prepare students for postsecondary education or for work. To aid in this preparation the author referred to the Carl D. Perkins Career and Technical Education Act of 2006, which provides for an increased focus on academic achievement from students enrolled in CTE programs and strengthens the connections between secondary and postsecondary education. A great deal of effort is being spent on CTE programs and not only how they increase student's core academic knowledge, but also how they better prepare students for the workforce.

Hyslop (2006) indicated students would need a strong understanding of reading, comprehension, reasoning, problem solving, and personal skills to be ready for postsecondary education and/or the high-skilled workplace. Breiner, Johnson, Harkness, and Koehler (2012) suggest STEM is the answer to this need to create better-prepared high school and college graduates. According to the Committee on STEM Education (2013), "Advances in science, technology, engineering, and mathematics (STEM) have long been central to our nation's ability to manufacture better and smarter products, improve health care, develop cleaner and more efficient domestic energy sources, preserve the environment, safeguard national security, and grow the economy (vi)."

The American Institutes for Research (2013) indicated CTE programs are replacing low-level courses with academically rigorous, integrated and sequenced programs of study which align with and lead to postsecondary education.

The first objective of this study was to identify knowledge a person should possess to successfully become a wind energy technician. It can be concluded there are thirty-two knowledge competencies needed for a person to possess to become a wind energy technician. The knowledge competencies are divided into seven categories: Personal Skills, Leadership, Safety, Intro to Wind Energy, Applied Wind Energy, Electricity Principles, and Distribution Systems.

There are two knowledge competencies, which met consensus in the category of Personal Skills, which are important. The Panel of experts achieved a level of agreement to form a consensus for the competencies "Use technology on the job, e-mail, hardware, software, and troubleshooting" and "Make self-assessments and knowing one's own abilities."

For the category of Leadership it can be concluded there are seven knowledge competencies, which met consensus. The seven competencies are "Employ various methods to identify, analyze, and solve problems," "Employ methods of time management," "Define integrity," "Identify the characteristics of a desired work ethic," "Define leadership or essential skills," "Be able to explain the application of leadership to the technical workforce," and "Identify sources of conflict in the workplace and the community and how to resolve them."

The data indicated there were eight knowledge competencies needed for the category of Safety. The panel of experts achieved a level of agreement to meet consensus on the knowledge competencies of "Identify types of gear boxes (hybrid, planetary versus helical/ parallel shaft) and probable causes of failure," "Identify confided space," "Explain a MSDS," "Define the purpose of OSHA as applied to the employer and the employee," "State the procedure in obtaining a permit to enter a permitted confined space," "Describe the different types and components of Fall Arrest Systems," "Depict the importance of hazardous communication on a wind farm," and "Express safe work practices as related to cranes and rigging."

There are five knowledge competencies for the category of Introduction to Wind Energy. The panel of experts reach a level of agreement to form a consensus on the competencies of “Identify safety regulations, personal protective equipment, and practices for wind farm technicians,” “Define general wind turbine terminology,” “Discuss environmental, ethical and legal obligations of the wind farm,” “Describe anatomy of a wind farm,” and “Explain how to plan and schedule maintenance.”

The data provided insight into the category of Applied Wind Energy, which included two knowledge competencies. The panel of experts achieved a level of agreement to meet consensus on the two knowledge competencies of “Define types of wind turbines” and “Discuss aspects of wind turbine control.” To create a deeper understanding of the knowledge needed for this category, more competencies should be sought and offered for experts to review, which align closely with the two competencies meeting consensus.

The category of Electricity Principles included seven knowledge competencies needed for a person to possess to become a wind energy technician. The panel of experts achieved a level of agreement to meet consensus on the knowledge competencies of “Analyze the relationship between a current carrying conductor and the magnetic field surrounding the conductor,” “Solve problems associated with conductance and resistor tolerances,” “Explore the use of switches and safety devices in electrical circuits,” “Define Ohm’s law and use it to solve for resistance, current, and voltage and determine and use proper prefixes associated with electronic terms,” “Identify and solve problems associated with both series and parallel circuits,” “Differentiate between a good insulator and a good conductor," and "Define inductance and capacitance and analyze the effects of capacitor in both AC and DC circuits."

This category returned a larger number of competencies, which met consensus. This larger number of competencies may be an indication of the importance of the category. Future research should explore this category more in-depth to gain a better understanding of potential knowledge competencies.

Three knowledge competencies for the category of Distribution Systems achieved consensus. The panel of experts achieved a level of agreement to meet consensus on the knowledge competencies of "Identify electrical and stand-by distribution system," "Calculate and install overcurrent protection," and "Calculate loads, conduit fill, and ampacity."

Objective 2

Hamilton and Liming (2010) suggested for many of the positions in the wind energy industry, companies hire people with experience in other industries and give them wind specific training. The authors further suggested a primary exception to this trend is the wind turbine service technician, this position typically acquires skills through on the job learning, and do not need outside industry experience.

CTE programs provide students with opportunities to acquire the competencies required in today's workplace (American Institutes for Research, 2013). Though CTE prepares students for life after high school, the need to complete this task does not completely rest on CTE programs. Students who participate in project based instruction by investigating and solving problems develop a larger complete picture of the concepts associated with the project and build connections between the classroom instruction and real life experiences (Blumenfeld et al., 1991).

The National Governors Association (2007) suggested three obstacles to having a world class STEM education system. The second of these obstacles is the misalignment of STEM coursework with work expectations. The authors further make recommendations to correct this problem by aligning standards of the education system with post-secondary courses and the workplace.

The American Institutes for Research (2013) suggested key advantages of providing STEM centered courses would be they allow for the facilitation of student's transition into career paths, they build interest in STEM and STEM related careers, and integrate math and science content into more tangible experiences. These facts, principles, and techniques obtained through STEM courses are easily transferable skills, which would aid in a person's success in school and beyond (Thomasian, 2011).

The second objective of this study was to identify skills, which a person should possess to successfully become a wind energy technician. It can be concluded there are fifty-four skill competencies, which are important for a person to possess to become a wind energy technician. The skill competencies are divided into nine categories: Personal Skills, Leadership, Safety, Applied Wind Energy, Electricity Principles, DC/AC Circuits, Distribution Systems, Motor Controls, and Distributed Control and Programmable Logic.

There are four skill competencies needed for the category of Personal Skills. The panel of experts achieved a level of agreement to meet consensus on the skill competencies of “Communicate effectively, listening, writing, nonverbal communication,” “Demonstrate job search and resume’ preparation skills,” “Demonstrate preparation for the interview,” and “Organize a schedule.”

The category of Leadership consists of four skill competencies needed for a person to possess in order to become a wind energy technician. The panel of experts achieved a level of agreement to meet consensus on the skill competencies of “Discuss the decision making process,” “Discuss goal setting,” “Demonstrate the use of basic skills to collect information relating to the changing use of technology.”

Eight skill competencies were identified for the category of Safety as needed. The panel of experts achieved a level of agreement to meet consensus on the skill competencies of “Explain and demonstrate lock out/ tag out procedures (simple and complex),” “Demonstrate safety procedures for energized electrical work,” “Demonstrate safety procedures for working with shock and arc boundaries,” “Demonstrate tool safety: hand and power tools used in the wind industry,” “Exhibit proficiency in basic first aid, CPR, and AED,” “Demonstrate proficient use of a job hazard analysis for all tasks on a wind farm,” “Demonstrate a flash hazard analysis,” and “Readily make adjustment to work strategies and methods when maintaining and repairing turbine components.”

Consensus was met on three of the skill competencies needed for the category of Applied Wind Energy. The panel of experts achieved a level of agreement to meet consensus on the skill competencies of “Performa a climb test,” “Use teamwork to identify, analyze, and solve safety problems in tower climbs and rescue events," and "Analyze operational issues, components of an operation and maintenance team."

For the category of Electricity Principles it can be concluded there are six skill competencies needed to become a wind energy technician. The panel of experts achieved a level of agreement to meet consensus on the skill competencies of "Accurately read analog and digital mutli-meters and install them properly in circuits so they may be used by circuit analysis," "Analyze the function and different types of conductors," "Solve problems associated with charged bodies, current, and voltage," "Troubleshoot various digital circuits using schematic diagrams," "Describe the relationship between wire size (diameter) and wire gauge (AWG)," "Identify different types of batteries and describe their proper application," and "Construct digital circuits such as combinational logic circuits, clocking, and timing circuits, analog-to-digital, and digital-to-analog devices."

Consensus was reached on seven skill competencies needed for the category of DC/AC Circuits. The panel of experts achieved a level of agreement to meet consensus on the skill competencies of "Demonstrate proper usage of a multimeter and oscilloscope to make measurements," "Describe the source of electricity," "Perform calculations and measurements on series and parallel series DC and AC circuits and series-parallel DC circuits," "Perform calculations and measurements on transformer circuits," "Understand and use Kirchoff's law, Ohm's law, and the Power Formula," "Construct and analyze DC and AC circuits from simple to complex," and "Perform calculations using decimal, scientific engineering, and metric notation numbers."

There are seven skill competencies needed for the category of Distribution Systems. The panel of experts achieved a level of agreement to meet consensus on the skill competencies of “Apply and understand proper grounding procedures,” “Demonstrate proper wiring techniques,” “Apply ground fault and ground protective relays,” “Construct, troubleshoot, and repair simple electrical distribution systems,” “Install line protective devices and protective relaying,” “Install multiple switch circuit,” and “Demonstrate use of National Electric Code.”

The category of Motor Controls included nine skill competencies meeting consensus. The panel of experts achieved a level of agreement to meet consensus on the skill competencies of “Demonstrate proper and safe troubleshooting practices;,” “Determine proper power source; analyze schematics and relay logic functions,” “Sketch, construct, operate, and troubleshoot circuit with motor, motor starter, and control devices,” “Sketch, construct, operate, and troubleshoot overload protection circuit to comply with all specifications,” “Sketch circuit and construct pushbutton and selectors switches to operate as specified,” “Select and size relays and conductors,” “Select and size line voltage components,” “Select and size circuit components,” and “Sketch and construct magnetic solenoid circuits as specified.”

Only one skill competency achieved a level of agreement to meet consensus for the category of Basic Fluid Power. The skill competency “Identify components of a fluid power system and explain their operation,” was the only competency which members of the panel of experts agreed as needed.

For the category of Distributed Control and Programmable Logic it can be concluded there are five skill competencies needed. The panel of experts achieved a level of agreement to meet consensus on the skill competencies of “Demonstrate the use of SCADA and various data communications systems,” “Operate and troubleshoot digital systems,” “Utilize programmable logic controllers (PLC’s) to interpret sensor and process variable data,” “Configure programmable logic controllers (PLC’s) to perform various tasks,” and “Identify components of a fluid power system and explain their operation.”

There were one hundred twenty-two knowledge and skill competencies at the beginning of the study which were identified through the collection and analysis of current curriculum at community colleges in the state of Texas. At conclusion of the study, eighty-eight knowledge and skill competencies achieved a level of agreement to meet consensus. This consensus identified those eighty-six knowledge and skill competencies as important for a person to possess to successfully become a wind energy technician.

Implications

This focus of this study was to identify knowledge and skills needed for a person to become a wind energy technician. The Kansas Board of Regents (2013) indicated both business and industry continue to report a need for individuals whom are able to learn and master the skills needed to adapt to a rapidly changing work environment.

This study was built from the principles of the theory of behaviorism; which indicates there is a need to display observable and measurable outcomes in a students’ learning. Weegar and Pacis (2012) suggest behaviorism is one of the leading theories utilized in educational research. Behaviors which are observable, measurable, and outward are the changes in a student's performance and are considered desirable for scientific inquiry (Bush, 2006). Schunk (2000) suggested education with a purpose of obtaining knowledge and skills in the preparation for a job aligns with the theory of behaviorism, because learning leads to an observable change in behavior.

The framework this study was built on, was Roberts and Ball (2009) content-centered education. CTE programs' content and curricula are based on standards, which are accepted and recognized by the industry that each program falls into. Roberts and Ball (2009) suggested education with the goal of obtaining knowledge and skills for a job aligns with the theory of behaviorism. When discussing the approaches of content or competency based education, behaviorism is the most widely promoted theory, which includes these two approaches (Jones & Moore, 1995).

Objective 1

Behaviorism

Doolittle and Camp (1999) indicated CTE is founded on the learning principles of behaviorism. The curriculum for CTE tends to be mostly psychomotor task and must be mastered in a sequential manner (Dobbins, 1999). Skinner (1976) postulated knowledge is action and responses to stimuli. Knowledge is being aware of ones behavior (Goldberg & Pessin, 1997).

Driscoll (2000) proposed learning is a change in performance, which results from experience. Performance should be observable and measurable and are the quintessential principles of the behaviorist approach to learning ("From Theory to Practice, 2002). Dolittle and Camp (1999) iterated if learning is to be authentic it must provide relevance to the learner and is the primary catalyst of knowledge construction.

The results from this study provide knowledge competencies which if mastered may provide for an authentic career-oriented knowledge base which would prepare students for the workforce. There were thirty-two knowledge competencies identified at the conclusion of this study. These knowledge competencies provide for knowledge sets which when mastered should provide for an observable outcome for individuals to be better equipped to meet the demand of the wind energy industry.

Content-Centered Education

Souders (2009) suggested knowledge components needed in the industry need to be addressed. He further suggests knowledge should be compiled into subject groups forming curriculum.

Effective use of curriculum content based on industry relevant outcomes provides students the opportunity to learn industry-relevant knowledge (Lualhati, 2007). Developing a curriculum based on occupational instruction begins with detailing job functions and responsibilities (Elias & Merriam, 1995).

The instrument employed during this study was developed utilizing current curriculum for wind energy technician certification programs in the state of Texas. The curricula were grouped into categories based on the subject matter and competencies. Members of the panel of experts were given the opportunity to review the competencies from the curricula and evaluate it for need as well as add to it. Allowing experts to consistently review current curriculum for needed changes provide for more industry relevant instruction. This study utilized one set panel of experts; the utilization from a different panel of experts may yield different results which could enrich the competencies should be included in the curricula for this particular industry. This process delves into the knowledge of those who are directly employed in the industry and better aligns the knowledge being taught to the knowledge needed for the industry.

Experiential Learning

Students having the option to engage in hands-on activities lead to a richer understanding of science concepts, because it provides them with meaningful, concrete experiences (Meichtry, 1992).

Competency-Based Education

Competency-based curriculum is structured curriculum, which should be based on the needs of the industry (Slusher, Robinson, & Edwards, 2011). The relevancy of the content to the industry is more likely to increase motivation, resulting in learners understanding the need for the learned knowledge (Pintrich & Schunk, 1996).

Lynch (2000) suggests one of the goals of CTE programs is to bring real-world content and application to the classroom. Skill standards aid teacher in defining the knowledge and skills expected of students from an industry (Belcber & McCaslin, 1997).

This study was designed to bring real world knowledge to individuals seeking to enter the career field in this industry. The knowledge competencies identified from this study is intended to provide individuals with relevant concepts of what is needed to understand and master in order to successfully enter the field.

Objective 2

Behaviorism

Merritt (1996) indicated the Skill-Components Model is based on the limited roles which workers are expected to assume. Suggesting workers are expected to have basic academic skills (i.e. literacy and mathematics). These basic academic skills are learned prior to occupational skills and may only be helpful to the extent in which they assist the worker in their tasks on the job. Combs et. al (1977) postulated behaviorism has been proven as a useful approach to teaching skills.

The results from this study provide skill competencies which if mastered may provide for authentic career-oriented skills, which prepare students for the workforce. There were fifty-four skill competencies identified at the conclusion of this study. These skill competencies provide for skill sets which when mastered should provide for an observable outcome for individuals to be better equipped to meet the demand of the wind energy industry.

Content-Centered Education

Roberts and Ball (2009) postulated the content for curriculum begins with the identification of skills needed for the industry, which leads to industry-relevant instruction. The acquisition of these industry related skills result in observable behaviors and a more skilled workforce for the industry.

The skill competencies developed from this study derived from industry professionals. Souders (2009) indicated in the process of developing skill standards the first step is to form a development group made of industry representation. He further suggested to develop the formalization of the skills the tasks, which are required to complete the work should be determined.

Skill competencies based on industry standards and task accomplishment is a key to providing better and more sustainable training to the potential workforce. Skill standards provide a uniform measure for the United States workforce and the international marketplace, while meeting the needs of business and industry (Bunn & Stewart, 1998).

The instrument employed during this study was developed utilizing current curriculum for wind energy technician certification programs in the state of Texas. The researcher reviewed the curriculum and themes emerged which provided for grouping of skill competencies. Members of the panel of experts were given the opportunity to review the competencies from the curricula and evaluate it for need. The experts were also given the opportunity to add additional skill competencies to the instrument which they believed to be needed. The process of allowing experts from an industry to review current curriculum provides for a more up-to-date skill base, which offers learners a chance to obtain a real-world feel for the industry they are seeking to enter.

Competency-Based Education

Belcber and McCaslin (1997) suggest skills outlined by an industry may allow for employers to indicate the level of competence a worker needs. Skill standard sets provide for clearer goals and educational pathways for students and for greater placement into employment (Hoachlander & Rahn, 1994). These skill standards provide individuals with the credentials, which prove their work-readiness ("Developing Skill Standards". 2013).

Aragon, Woo, and Marvel (2004) suggest utilizing skill standards in curriculum development has become an increasingly paramount part of CTE programs. Souders (2009) referred to skill standards as the foundation of any technical program's curriculum.

Data collected from this study provides skills in the form of competencies a person should master to successfully enter the field of wind energy technician. The competencies, which were determined during this study, provide instructors in the wind energy field more of an insight into industry requirements. There is a need for education to align to industry standards through the process of developing competencies, which are based on the need of the industry developed from those currently employed in the industry.

Recommendations for Practice

The framework, which guided this study, was based on Roberts and Ball's Content- Based Model to teach agricultural education curriculum. The model suggests the industry guides the content which instruction should be based in. Roberts and Ball (2009) postulate the end product would be skilled workers ready for successful employment in the industry.

Practitioners should align secondary and postsecondary curriculum with workforce knowledge and skill competencies. Aligning these competencies may allow for a smoother transition from secondary education to postsecondary education and into the workforce. Hyslop (2006) postulated acquiring these professional skill-sets would be required for the workplace. Thomasian (2011) indicated STEM courses are easily transferable skills to aid in a person's success in school and beyond. These competencies and those competencies found in STEM should be utilized in the creation of a CTE program, which is aligned with industry to prepare students to enter the wind energy industry.

Bangser (2008) inferred there is a need to align high school standards with postsecondary and workforce expectations, upgrade high school course requirements so students take a college and work ready curriculum, streamline assessment systems so the tests which high school students take serve as readiness tests for college and the workforce, and hold both high schools and postsecondary institutions accountable for student success.

Acker (2008) suggested a need to develop renewable energy curriculum for secondary schools. It is recommended secondary and post-secondary educators utilize industry experts' knowledge to design curriculums, which meet the demand of the industry. The curricula should meet any STEM needs for the student. It is suggested that the inclusion of industry experts provide students that opportunity to be better prepared for workforce success (Bangser, 2008) after graduation.

There is a need to close the skills gap, which exists in the labor force (National Governors Association, 2007). The Authors further suggest there is a need to align workforce expectations with the standards of education. There is a continued need to develop curriculum and instruction to meet the needs of industries.

Aligning education with the industry provides for a mutually beneficial relationship. It allows the industry to express their needs, and education to hear those needs and respond with adequate training programs. These programs would provide qualified individuals, which meet the skill needs of the industry.

In regards to leadership, there is a need for students, both secondary and post-secondary, to learn adequate knowledge and skills that promote their leadership abilities. Courses that address problem solving, time management, and conflict resolution need to be designed around industry needs. Courses that develop students' leadership potential would address industry needs for more confident and knowledgeable workers with the right skill sets that could potentially move an employee up into management positions.

Further there is a need for the Texas Education Agency (TEA) to explore programs through CTE, which would enable students to go straight from school into the workforce. Programs of this caliber may serve beneficially to students who lack interest in postsecondary educational programs and would prefer to go directly into the workforce without advanced educational requirements. Providing students at the secondary level with the appropriate knowledge and skill sets to be work-ready may also aid students whom find postsecondary education to be cost prohibitive.

Recommendations for Future Research

Objective 1

CTE programs are replacing low-level courses with more academically rigorous programs are STEM centered and may lead to postsecondary educational opportunities (The American Institutes for Research, 2013). Future research should work to identify curricula needed for wind energy technicians and to analyze the coursework to identify components that may qualify as STEM components.

There is a need to take a broader approach in research which is inclusive to individuals whom have varying education levels. Research should focus on isolating individuals with different background education levels, to ensure a richer sample of knowledge is taken. The varying educational backgrounds allow for a more in-depth look into individuals perspectives' based on their knowledge base. Hamilton and Liming (2010) suggested as training programs are developed, technicians would be expected to have more formal training and a certificate or degree. Texas State Technical College alone offers an Associate of Applied Science in Wind Energy Technology, Wind Energy Technician Certificate 1 and Wind Energy Technician Certificate 2. This study solely focused on the Wind Energy Technician Certificate 1 and did not distinguish educational levels of the panel of experts. It may be of benefit to incorporate larger panels of experts whom are divided according to certificate or degree they hold and allow each group conclude on their own knowledge and skill competencies. This may decipher any varying responses, which may form.

There is a need for future research to identify secondary education programs, which instruct in wind energy technologies in the state of Texas. Through the course of this study the researcher attempted to identify the number of secondary schools whom currently instruct courses in wind energy or related curriculum. The researcher was unable to achieve finding programs offering these types of courses. It is further suggested the curriculum for these courses be reviewed to decipher the correlation between what is being taught and the knowledge competencies, which industry experts have agreed, are pertinent for a person to know and possess.

Further there is a need for research that builds upon this study and the leadership competencies that were identified in it. Research should focus on those specific leadership competencies and identify CTE course curricula that include the various competencies that arose during this study. Knowledge gained from such a study would provide insight into any gaps in the leadership competencies being taught and those that are needed by industries.

Objective 2

Hamilton and Liming (2010) suggest as vocational training programs are standardized technicians would be expected to have formal training and a certificate or a degree. The Bureau of Labor Statistics (2014) indicated there is currently a shortage of qualified individuals for the wind energy profession. There is a need for future research to identify secondary education programs, in the state of Texas, which instruct in wind energy. The skills taught in these programs should be analyzed to determine the relevancy of them in regards to industry expectations and the needs of the wind energy industry.

The potential labor force is not enough to keep up with the future demand of the wind energy industry, which can be attributed to the newness of the industry and the training programs utilized to prepare individuals for the industry (Twiddy, 2008). Further research is needed to sequester the knowledge and skills postsecondary educators believe are relevant and needed for a secondary school student to know and possess to be successful in a postsecondary education program directly related to wind energy.

Further research should focus on identifying potential SAE projects which could offer skills in the wind energy field. The opportunity for students to participate in a program of this caliber may better prepare them for a career in the wind energy industry. Blumenfeld et. al. (1991) suggests students who participate in project based instruction by investigating and solving problems develop a larger complete picture of the concepts associated with the project and build connections between the classroom instruction and real life experiences.

Further research is needed to establish a rubric which identifies needed skills for the wind energy industry and the different actions which display the level of achievement the student possess when accomplishing each of the identified skills. There is a misalignment of STEM coursework and work expectations (National Governors Association, 2007). The Authors recommended aligning standards of the education system with the workplace to better prepare students for post-secondary education and the workplace.

.

REFERENCES

Acker, D. (2008). Research and education priorities in agriculture, forestry, and energy to achieve the 25x25 renewable energy visions. *North American College Teachers Association. 52*(1), 55-59.

Alexander, D. C. (2004). A Delphi study of trends or events that will influence the future of California charter schools. *Digital Abstracts International*, *65* (10), 3629. (UMI No. 3150304).

American Institutes for Research. (2013, March). How Career and Technical Education Can Help Students Be College and Career Ready: A Primer (Issue Brief No. 1463_03/13). Washington, DC: American Institutes for Research.

American Wind Energy Association (2014). AWEA U.S. Wind Industry Fourth Quarter 2013 Market Report. AWEA. Retrieved from http://www.awea.org/4q2013

Aragon, S. R., Woo, H., & Marvel, M. R. (2004). *Analysis of the integration of skill standards into community college curriculum*. Minneapolis, MN: National Research Center for Career and Technical Education, University of Minnesota.

Aragon, S. R., Woo, H., & Marvel, M. R. (2005). The role of national industry-based skill standards in the development, implementation, and assessment of community college curriculum. *Journal of Career and Technical Education*, *21*(2), 35-50.

Askov, E. N. (1997). Skill standards: Establishing a framework for basic skills, In K. Camperell, B. L. Hayes, & R. Telfer (Eds.), *Promises, Progress, and Possibilities: Perspectives of Literacy Education*, Yearbook of the American Reading Association, *17*, 37-45.

Asunda, P. A. (2011). Open courseware and STEM initiatives in career and technical education. *Journal of STEM Teacher Education*, 48(2). Retrieved from http://scholar.lib.vt.edu/ejournals/JSTE/v48n2/asunda.html

Athey, T. R. & Orth, M. S. (1999). Emerging competency methods for the future. *Human Resource Management*, *38*(3), 215-226. doi: 10.1002/(SICI)1099-050X(199923)38

Baker, M. A., Robinson, S. J., and Kold, D. A. (2012). Aligning Kolb's experiential learning theory with a comprehensive agricultural education model. *Journal of Agricultural Education*, *53*(4), p. 1-16. doi:10.5032/jae.2012.04001

Bangser, M. (2008). Preparing high school students for successful transitions to postsecondary education and employment. New York, NY: MDRC. Retrieved from http://www.betterhighschools.org/docs/PreparingHSStudentsforTransition_073108.pdf

Baring-Gould, I., Flowers, L., Kelly, M., Barnett, L., & Miles, J. (2009, August). Wind for Schools: Developing Education Programs to Train the Next Generation of the Wind Energy Workforce. Paper presented at WINDPOWER 2009 Conference and Exhibition, Chicago, IL. Retrieved from http://www.nrel.gov/docs/fy09osti/45473.pdf

Barnes, J. L. (1987). *An international study of curricular organizers for the study of technology*. Unplublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Bednar, A. K., Cunningham, D., Duffy, T. M., & Perry, J. D. (1992). Theory into practice: How do we link? In G. Anglin (Eds.), *Instructional technology: Past, present, and future* (2nd ed., p. 100-112). Englewood, CO: Libraries Unlimited.

Beech, B. (1999). Go the extra mile- use the Delphi technique. *Journal of Nursing Management*, *7*, 281-288. doi: 10.1046/j.1365-2834.1999.00125.x

Belcber, G. & McCaslin, N. L. (1997). Ohio Agricultural Education Teachers' Attitudes Toward National Skill Standards. *Journal of Agricultural Education*, *38*(1), 29-37. doi: 10.5032/jae.1997.01029

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krjcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project based learning: Sustaining the doing, supporting the learning. *Educational Psychologies*, *26*(2&4), 369-398.

Boesel, D., Rahn, M., & Diech, S. (1994). National Assessment of Vocational Education. *Final Report to Congress 3. Program improvement: Education reform* (Report No. OR-94-3502-111). Washington, D.C. (Eric Document Reproduction Service No. ED371193).

Boone, H. N., Gartin, S. A., Wright, C. B., Lawrence, L. D., & Odell K. S. (2002). Adult education philosophies practiced by agricultural education teachers in Pennsylvania, Virginia, and West Virginia. *Journal of Agricultural Education*, *43*(3). 37-48.

Bragg, D. D., Bartlett, J., & Marvel, M. R. (2002). *The goals, use, and potential impact of occupational skill standards in Illinois*. Retrieved from University of Illinois at Urbana-Champaign, Office of Community College Research and Leadership website: http://occrl.illinois.edu/files/Other/Report/SkillStandardsReport_final.pdf

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics*, *112*(1), 3-11. doi: 10.1111/j.1949-8594.2011.00109.x

Bunn, P. & Stewart, D. (1998). Perception of technical committee members regarding the adoption of skill standards in vocational education programs. *Journal of Career and Technical Education*, *14*, 7-17.

Bush, G. (2006). Learning about learning: from theories to trends. *Teacher Librarian*, *34*(2), 14- 19.

Combs, A. W., Popham, W. J., & Hosford, P. L. (1977). Behaviorism and Humanism: A synthesis?. *Association for Supervision and Curriculum Development*, *35*(1), 52-63.

Copa, G. (1985). *An Untold Story- Purposes of vocational education in secondary schools*. St. Paul, MN: Minnesota Research and Development Center for Vocational Education.

Custer, R. L., Scarcella, J. A., & Stewart, B. R. (1999). The modified Delphi technique: A rotational modification. *Journal of Vocational and Technical Education*, *15*(2). 1-10.

Dalkey, N., Rourke, D. L., Lewis, R., & Snyder, D. (1972). *Studies in the quality of life: Delphi and decision-making*. Lexington, MA: Lexington Books.

Dalkey, N. C. & Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Management Science*, *9*(3), 458-467.

Deal, W. F. (2010). Wind Power: An Emerging Energy Resource. *Technology and Engineering Teacher*, *70*(1), 9-15.

De Leon, J. E. & Borchers, R. E. (1998). High school graduate employment trends and the skills graduates need to enter Texas manufacturing industries. *Journal of Vocational and Technical Education*, *15*(1), 1-19.

Delp, P., Thesen, A., Motivalla, J., & Seshadri, N. (1977). *Delphi: System tools for project planning*. Columbus, OH: National Center for Research in Vocational Education, The Ohio State University.

Dewey, J. (1916). Play and Work in the Curriculum. In Democracy and Education: Free Press. Disessa, A. A. (2004). Metarepresentation: Native competence and targets for instruction. *Cognition and Instruction*, *22*(3), 293-331.

Dewey, J. (1933). *How we think*. Boston, MA: Heath.

Dewey, J. (1938). *Experience and Education*. New York, NY: Simon and Schuster.

Dickman, A., Schwabe, A., Schmidt, J., & Henken, R. (2009). Preparing the future workforce: Science, technology, engineering, and math (STEM) policy in K-12 education in Wisconsin. Retrieved from http://eric.ed .gov/PDFS/ED510327.pdf

Dobbins, T. R. (1999). *Clinical experiences for agricultural teacher education programs in North Carolina, South Carolina, and Virginia*. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Virginia.

Doerfert, D. L. (Ed.) (2011). *National research agenda: American Association for Agricultural Education's research priority areas for 2011–2015.* Lubbock, TX: Texas Tech University, Department of Agricultural Education and Communications.

Doolittle, P. E. & Camp, W. G. (1999). Constructivism: The career and technical education perspective. *Journal of Vocational and Technical Education*, *16*(1). 23-46.

Drage, K. (2009). Modernizing career and technical education programs. *Techniques: Connecting Education and Careers*, *85*(5), 32-34.

Driscoll, M. P. (2000). *Psychology of learning for instruction* (2nd ed.). Boston, MA: Allyn and Bacon.

Druckenmiller, H. (2012). *At Wind Speed: How the U.S. Wind Industry is Rapidly Growing Our Local Economies*. (Research Report No. 12-09-A). Retrieved from Natural Resources Defense Council website: http://www.nrdc.org/energy/wind-powered-communities/files/wind-communities-ib.pdf

Eggen, P. D. & Kaucak, D. P. (2007). *Educational Psychology*. New Jersey: Merrill Prentice Hall.

Elias, J. & Merriam, S. (1995). Philosophical foundations of adult education, (2nd ed.) Malabar, Florida: Krieger Publishing Company.

Entwistle, N. (1981). *Styles of learning and teaching*. New York, NY: John Wiley & Sons.

Feldbaum, M. (2009). Going green: The vital role of community colleges in building a sustainable future and green workforce. *National Council for Workforce Education and Academy for Educational Development:* Washington, D.C.

Finch, C. R. & Crunkilton, J. R. (1989). Curriculum development in vocational and technical education, (2nd ed.) Needham, MA: Allyn and Bacon.

Finch, C. R. & Crunkilton, J. R. (1999). *Curriculum development in vocational and technical education: Planning, content, and implementation* (5th ed.). Boston, MA: Allyn and Bacon.

Frewer, L. J., Fischer, A. R. H., Wentholt, M. T. A., Marvin, H. J. P., Ooms, B. W., Coles, D., & Rowe, G. (2011). The use of Delphi methodology in agrifood policy development: Some lessons learned. *Technological Forecasting and Social Change*. *78*(9), 1514-1525.

From Theory to Practice: Behaviorist Principles of Learning and Instruction. (2002, December). *The Office for Teaching and Learning Newsletter*. Retrieved from http//:www.otl.wayne.edu/pdf/newsltr/dec02.pdf

Goldberg, S. & Pessin, A. (1995). *Gray Matters: An Introduction to the Philosophy of Mind*. Armonk, NY: M.E. Sharpe, Inc.

Good, T. L. & Brophy, J. E. (1990). *Educational psychology: a realistic approach*. (4th ed.). White Plains, NY: Longman.

Goossens, E. (2012, September 11). Average U. S. Wind Farm Creates 1,079 Jobs, Report Finds. Bloomberg. Retrieved from http://www.bloomberg.com

Gray, K. C. & Herr, E. L. (1998). *Workforce education: The basics*. Needham Heights, MA: Allyn & Bacon.

Gredler, M. E. (1997). *Learning and instruction: Theory into practice*. Upper Saddle River: Prentice-Hall.

Greenes, C. (1996). Investigations: Vehicles for learning and doing mathematics. *Journal of Education*, *178*(2), 35-42.

Grobecker, B. (1999). Mathematics reform and learning disabilities. *Learning Disability Quarterly*, *22*, 43-58.

Gross, J. G. (1981). Delphi: a program planning technique. *Journal of Extension*, *19*(2), 23-28.

Hamilton, J. & Liming D. (2010). *Careers in Wind Energy*. Retrieved from US Bureau of Labor Statistics website: http://www.bls.gov/green/wind_energy/

Hoachlander, G. & Rahn, M. L. (1994). National skill standards: Everyone agrees on the destination. Getting there is another story. *Vocational Education Journal*. *69*(1), 23-25.

Hsu, C. C. & Sandford, B. A. (2007). Minimizing non-response in the Delphi process: How to respond to non-response. *Practical Assessment Research & Evaluation*, *12*(17), Retrieved from http://pareonline.net/getvn.asp?v=12&n=17

Hudelson, D. (1993). The standard approach: Skill certification on the way; is vocational education ready? *Vocational Education Journal*, *68*(2), 32-34.

Hyslop, A. (2006). Establishing a clear system goal of career and college readiness for all students. *Techniques: Connecting Education and Careers*, *81*(6), 37-39.

Hyslop, A. (2009). CTE's role in energy and environmental sustainability. *Techniques: Connecting Education and Careers*, *84*(3), 22-25.

Hylsop, A (2010). CTE's role in Science, Technology, Engineering, and Mathematics. *Techniques: Connecting Education and Careers*, *85*(3), 16-20.

Jacobs, J. M. (1996). *Essential assessment criteria for physical education teacher education programs: A Delphi study*. (Unpublished doctoral dissertation). West Virginia University, Morgantown.

Jenkins, C. C. (2009). *A quality agricultural education program: A national Delphi study* (unpublished doctoral dissertation). University of Kentucky, Lexington KY.

Jennings, P. (2009). New Directions in renewable energy education. Renewable Energy *34*(2), 435-439.

Jones, L. & Moore, R. (1995). Appropriating competence. *British Journal of Education and Work*. *8*(2), 78-92.

Joplin, L. (1981). On defining experiential education. *Journal of Experiential Education*. *4*(1), 17-20.

Knobloch, N. A. (2003). Is experiential learning authentic?. *Journal of Agricultural Education*, *44*(4). P 22-34. doi: 10.5032/jae.2003.04022.

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Upper Saddle River, NY: Prentice Hall.

Kramlinger, T. & Hubert, T. (1990). Behaviorism versus humanism. *Training and Development Journal*. *44*(12), 41.

Lantz, E. & Tegen, S. (2008). *Variables Affecting Economic Development of Wind Energy.* Golden CO: National Renewable Energy Laboratory, Conference Paper, NREL/CP-500-43506.

Liming, D. & Hamilton, J. (2011). Careers in Wind Energy. *Occupational Outlook Quarterly*, *54*(4), 12-19.

Linstone, H. A. & Turoff, M. (1975). *The Delphi method: Techniques and applications*. Reading, Massachusetts: Addison-Wesley Publishing Company.

Lualhati, J. (2007). Approaches to industry alignment. *American Chemical Society*. (Issue Brief). Retrieved from www.acs.org/aligning -skills-with-industry.

Ludwig, B. (1997). Predicting the Future: Have you considered using the Delphi Methodology? *Journal of Extension*. *35*(5), 1-3.

Lynch, R. L. (2000). *New Directions for High School Career and Technical Education in the 21st Century*. Columbus, OH: ERIC Clearinghouse on Adult, Career, and Vocational Education, Center on Education and Training for Employment, The Ohio State University, 2000. (ED 444 037) http://ericacve.org/majorpubs.asp

Meeder, H. & Suddreth, T. (2012). Common Core State Standards & Career and Technical Education: Bridging the Divide between College and Career Readiness. Retrieved from Achieve website:http://www.achieve.org/files/CCSS-CTE-BridgingtheDivide.pdf

Meichtry, Y. J. (1992). Using laboratory experiences to develop the scientific literacy of middle school students. *School Science and Mathematics*, *92*(8), 437-441.

Merritt, D. (1996). A conceptual framework for industry-based skill standards. *Centerfocus*, *11*, 1-5.

National Center for Education Statistics. (2011). Postsecondary and labor force transitions among public high school career and technical education participants. Retrieved from http://nces.ed.gov/pubs2011/2011234.pdf

National Governors Association. (2007). *Innovation America: Building a science, technology, engineering, and math agenda*. Washington, D.C.: National Governors Association Center for Best Practices. Retrieved from http://www.nga.org/files/pdf/0702INNOVATIONSTEM.pdf

National Skill Standards Board (2000). *Build to work: A common framework for skill standards*. Washington, DC: Author.

Naquin, S. S. & Wilson, J. (2002). Creating competency standards, assessments, and certification. *Advances in Developing Human Resources*, *4*(2), 180-187.

O'Connell, R., Pletka, R., Block, S., Jacobson, R., Smith, P., Tilley, S., & York, A. (2007). 20 Percent Wind Energy Penetration in the United States: A Technical Analysis of the Energy Resource. Overland, KS: Black & Veatch.

Office of the Governor, Economic Development & Tourism (2012). *Texas Renewable Energy: Industry Report*. Retrieved from http://governor.state.tx.us/files/encode/renewable_energy.pdf

Osborne, E. W. (Ed.)(2007). *National research agenda for agricultural education and communication: 2007-2010*. Gainesville, FL: Department of Agricultural Education and Communication.

Overtoom, C. (2000). *Employability skills: An update*. (Report No. EDO-CE-00-220). Columbus, OH: Center on Education and Training for Employment. (ERIC Document Reproduction Service No. 220).

Partnership for 21st Century Skills, Association for Career and Technical Education, & National Association of State Directors of Career Technical Education Consortium. (2010). Up to the challenge: The role of career and technical education and 21st century skills in college and career readiness. Retrieved from http://www.p21.org/storage/documents/CTE_Oct2010.pdf

Pearson, D., Young, R. B., & Richardson, G. B. (2013). Exploring the technical expression of academic knowledge: The science-in-CTE pilot study. *Journal of Agricultural Education*, *54*(4), 162-179.

Pew Charitable Trusts, The Clean Energy Economy. (2009). Executive Summary. Retrieved from http://www.pewenironment.org/uploadfiles/PEG/Publications/Report/Clean%20Economy%20Economy%20Exec%20Summary.pdf

Phipps, L. J. & Osborne, E. W. (1988). *Handbook on agricultural education in public schools*. Danville, IL: Interstate Printers & Publishers.

Pintrich, P. R. & Schunk, D. H. (1996). *Motivation in education: Theory, research, and applications*. Englewood Cliffs, NJ: Prentice Hall.

Prevost, A., Nathan, M. J., Stein, B., & Phelps, L. A. (2010). The enacted curriculum: A video based analysis of instruction and learning in high school engineering classrooms. *In Proceedings of the American Society of Engineering Education Annual conference*, paper no. AC 2010-1121: 1-24.

Rahn, M. L., O'Driscoll, P., & Hudecki, P. (1999). *Taking off!: Sharing state level accountability strategies*. Berkley, CA: National Center for Research in Vocational Education.

Ramsey, J. W. & Edwards, M. C. (2011). Entry-level technical skills that agricultural industry experts expected students to learn through their supervised agricultural experiences: A modified Delphi study. Journal of Agricultural Education, *52*(2), 82-94. doi: 10.5032/jae.2011.02082

Robinson, J. P. (2000). What are employability skills [Electronic version]. Alabama Cooperative Extension System – *The Workplace*, *1*(3), 1–3.

Roberts, T. G., & Ball, A. L. (2009). Secondary agricultural science as content and context for teaching. *Journal of Agricultural Education*, *50*(1), 81–91.

Robertson, K. (2010). Texas Green Jobs Guidebook. Retrieved from Environmental Defense Fund National Energy Committee website: http://www.geotechcenter.org/uploads/2/4/8/8/24886299/texas-green-jobs-guidebook.pdf

Rummel, E. (2008). Constructing cognition. *American Scientist*, *96*(1), 80-82.

Salerno, E. (2013, June 28). Wind power development powers economic growth. *The Washington Times*. Retrieved from http://communities.washingtontimes.com

Schneider, B. (2006). *Forming a college-going community in U.S. public high schools*. East Lansing, MI: Michigan State University. Retrieved March 24, 2014, from http://www.gatesfoundation.org/nr/downloads/ed/researchevaluation/CollegeGoing.pdf

Schunk, D. H. (2000). *Learning theories: An educational perspective* (3rd ed.). Upper Saddle River, NJ: Merrill Prentice Hall.

Shaffer, D. (2000). *Social and Personality Development* (4th ed.) Belmont, CA: Wadsworth/ Thompson Learning.

Shield, G. (2000). A critical appraisal of learning technology using information and communication technologies. *Journal of Technology Studies*. *26*(1), 71-79.

Simonson, M. R. & Thompson, A. (1997). *Educational Computing Foundations*. Columbus, OH: Merrill/ Prince Hall

Skinner, B. F. (1968). *The technology of teaching*. Englewood Cliffs, NJ: Prentice-Hall.

Skinner, B. F. (1976). *About Behaviorism*. New York, NY: Vintage Books.

Slusher, W. L., Robinson, J. S., & Edwards, M. C. (2011). Assessing the animal science technical skills needed by secondary agricultural education graduates for employment in the animal industries: A modified Delhi study. *Journal of Agricultural Education*, *52*(2), 95-106.

Souders, J. (2009, October). Developing Industry Specific Curriculum Through Skill Standards. Paper presented at the National Career Pathways Conference Atlanta, Georgia.

Stitt-Gohdes, W. L. & Crews, T. B. (2004). The Delphi technique: A research strategy for career and technical education. *Journal of Career and Technical Education*, *20*(2), 1-10. Retrieved from http://scholar.lib.vt.edu/ejournals/jcte/v20n2/stitt.html

Tan, B. C . Y. (2004). Balancing content-based education and process-based education. *Centre for Development of Teaching and Learning*. *7*(8), 1-2.

Tegen, S. (2006). Comparing Statewide Economic Impacts of New Generation from Wind, Coal, and Natural Gas in Arizona, Colorado, and Michigan (Research Report No. NREL/TP-500-37720). Retrieved from http://www.nrel.gov/docs/fy06osti/37720.pdf

Texas Renewable Energy Consortium (2010). *About*. Retrieved from http://www.treec.org

The National Academy of Sciences. (2009). *Transforming Agricultural Education for a Changing World* (Report in Brief). Washington, D.C.: Committee on a Leadership Summit to Effect Change in Teaching and Learning.

The State of Texas, Texas comptroller of Public Accounts. (2008). *The Energy Report 2008*. Retrieved from http://www.window.state.tx.us/specialrpt/energy/

Thomasian, J. (2011). *Building a science, technology, engineering, and math education agenda: An update of state actions* (Research Report). Retrieved from NGA Center for Best Practices website: http://www.nga.org/files/live/sites/NGA/files/pdf/1112STEMGUIDE.pdf

Tomic, W. (1993). Behaviorism and cognitivism in education. *Psychology, A Journal of Human Behavior*. *30*(3/4), 38-46.

Toner, P. (2011). *Workforce Skills and Innovation: An Overview of Major Themes in the Literature*. (Working papers, No. 55). Retrieved from OECD Education website: http://dx.doi.org/10.1787/5kgk6hpnhxzq-en

Tsupros, N., Kohler, R., & Hallinen, J. (2009). STEM education: A project to identify the missing components. *Intermediate Unit 1: Center for Education and Leonard Gelfand Center for Service Learning and Outreach*, Carnegie Mellon University, Pennsylvania.

Twiddy, D. (2008, February 24). Wind energy hasn't blown in enough workers. The Seattle Times. Retrieved from http://seattletimes.com/html/businesstechnology/2004197483_jobswind24.html

United States Department of Labor, United States Department of Commerce, United States Department of Education, and United States Department of Health and Human Services. (2014). *What Works in Job Training: A synthesis of the evidence*. Retrieved from http://wwwdol.gov/asp/evaluation/jdt/jdt.pdf

United States Department of Energy. (2013). America's Wind Industry Reaches Record High. Retrieved from http://energy.gov/articles/americas-wind-industry-reaches-record-high

United States Department of Energy. (2008). 20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply. Retrieved from http://www.20percentwind.org/20percent_wind_energy_report_revOct08.pdf

United States Department of Energy. (2013). *Energy Dept. Reports: U.S. Wind Energy Production and Manufacturing Reaches Record High*. Retrieved from http://energy.gov/articles/energy-dept-reports-us-wind-energy-production-and-manufacturing-reaches-record-high

Walkington, C. A., Nathan, M. J., Wolfgram, N., Alibali, M. W., & Srisurichan, R. (2013). Building cohesion across represntations: A mechanism for STEM integration. Journal of Engineering Education, *102*(1), 77-116. doi: 10.1002/jee.20000.

Weegar, M. & Pacis, D. (2012). *A comparison of two theories of learning- Behaviorism and Constructivism as applied to face-to-face and online learning*. Paper presented at the E-Leader Conference, Manila, Philippines. Retrieved from http://www.g-casa.com/conferences/manila/papers/Weegar.pdf

Wei, M., Patadia, S., & Kammen, D. M. (2009). Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US? *Energy Policy*, *38*(2010), 919-931.

Wills, J. L. (1993). *A study of business and education skill standards*. Washington, DC: U.S. Department of Education.

Wolfson, A. D., Trebilcock, M. J., & Tuohy, C. J. (1980). Regulating the professions: A theoretical framework. In Simon Rottenberg (Ed.), *Occupational licensure and regulation*. Washington, DC: American Enterprise Institute for Public Policy Research.

Woudenberg, F. (1991). An Evaluation of Delphi. *Technological Forecasting and Social Change. 40*(2), 131-150.

Xie, Y., Feng, Y., & Qui, Y. (2013). The present status and challenges of wind energy education and training in China. *Renewable Energy*, *60*, 34-41.

Yousuf, M. I. (2007). Using Experts' Opinions through Delphi Technique. *Practical Assessment, Research & Evaluation*, 12(4). Retrieved from: http://parconline.net/getvn.asp?v=12&n=4

APPENDIX A

ROUND 1 LETTER TO PARTICIPANTS

Dear (insert name),

My name is Ricky Coppedge, and I am a doctoral student studying agricultural education at Texas Tech University under Dr. Rudy Ritz and Texas A&M University under Dr. Robert Strong. As part of my dissertation research I am examining what is needed for individuals to enter into the field of wind energy as a wind energy technician.

The intended purpose of this research is to identify the skills, education, and certifications needed for those individuals whom wish to become a wind energy technician.

Your position in the wind energy field is of great interest in this study, as we feel that you will be able to provide us with valuable insight into the qualifications it will take to become a wind energy technician.

To enable us to identify these needs we are asking to be allowed to send you a series of three surveys. If at any time you wish to withdraw from the study, you may do so. The surveys are short and will not require more than ten minutes of your time for each one.

Your confidentiality will be ensured at all times, no person beyond Dr. Ritz, Dr. Strong, and myself will have access to your individual responses. For more information about this study, please feel free to contact me by phone at 512-739-1564 or via email at ricky.coppedge@me.com.

The Institutional Review Board at Texas Tech University has approved this study; you may contact them with any questions via phone at 806-742-2064 or by mail at Institutional Review Board for the Protection of Human Subjects, Office of the Vice President for Research, Texas Tech University, Lubbock, TX 79409.

This study has been approved by the Institutional Review Board at Texas A&M University; for questions about your rights as a research participant; or if you have questions, complaints, or concerns about the research, you may call the Texas A&M University Human Subjects Protection Program office at 1-855-795-8636 or irb@tamu.edu.

Thank you in advance for your participation in this study. It is our hope that the insights you provide for this study will help us to better understand the training and certification needs of wind energy technicians.

Sincerely,

Dr. Rudy Ritz
Texas Tech University
Department of Agricultural Education & Communications

Dr. Robert Strong
Texas A&M University
Department of Agricultural Leadership, Education, and Communications

Ricky Coppedge
Doctoral Candidate

APPENDIX B

ROUND 1 INSTRUMENT

A	Personal Skills	yes	no
1	Organize a schedule		
2	Know the law, fair and safe labor practice		
3	Communicate effectively, listening, writing, nonverbal communication		
4	Analyze data, use chart and graphs		
5	Use technology on the job, e-mail, hardware, software, and troubleshooting		
6	Make self assessments and knowing ones own abilities		
7	Demonstrate job search and resume preparation skills		
8	Demonstrate preparation for the interview		
B	Leadership		
1	Define leadership or essential skills		
2	Be able to explain the application of leadership to the technical workforce		
3	Discuss the changing roles of technicians in the workforce		
4	Demonstrate the use of basic skills to collect information relating to the changing use of technology		
5	Employ various methods to identify, analyze, and solve a problem		
6	Discuss the decision making process		
7	Identify sources of conflict in the workplace and the community and how to resolve them		
8	Define integrity		
9	Discuss goal setting		
10	Employ methods of time management		
11	Identify the characteristics of a desired work ethic		
C	Safety		
1	Demonstrate safety procedures for energized electrical work		
3	Demonstrate safety procedures for working with shock and arc boundaries		
4	Demonstrate a flash hazard analysis		
5	Identify types of gear boxes (hybrid, planetary versus helical/parallel shaft) and probable causes of failure		
6	Describe the impact of heat generations on various materials and heat control mechanisms		
7	Define the effects of machining and heat treating on metals as it relates to predictable failures		
8	Identify type, application, and compatibility of different lubricants		
9	Identify gel coats, UV characteristics, flexibility, impact resistance of various coatings and how they are applied		
10	Define the purpose of OSHA as applied to the employer and the employee		

11	Explain and demonstrate lock out/ tag out procedures (simple and complex)		
12	Describe the different types and components of Fall Arrest Systems		
13	Express safe work practices as related to cranes and rigging		
14	Identify Confined Space (permitted and non-permitted)		
15	State the procedure in obtaining a permit to enter a permitted confined space		
16	Demonstrate tool safety: hand and power tools used in the wind industry		
17	Depict the importance of hazardous communication on a wind farm		
18	Explain a MSDS		
19	Demonstrate proficient use of a job hazard analysis for all tasks on a wind farm		
20	Exhibit proficiency in basic First Aid, CPR, and AED		
21	Readily make adjustment to work strategies and methods when maintaining and repairing turbine components		
D	Intro To Wind energy		
1	Define general wind turbine terminology		
2	Describe evolution of wind turbine technology		
3	explain air flow as related to wind turbines		
4	Describe anatomy of a wind farm		
5	Identify safety regulations, personal protective equipment, and practices for wind farm technicians		
6	Examine site construction, foundations, roads, and substation development		
7	Discuss environmental, ethical, and legal obligations of the wind farm		
8	Explain how to plan and schedule maintenance		
E	Applied Wind Energy		
1	Define types of wind turbines		
2	Analyze blade efficiencies		
3	Analyze environmental impacts of both wind resources and blade efficiencies		
4	Analyze operational issues, the components of an operation and maintenance team		
5	discuss aspects of wind turbine control		
6	Demonstrate a knowledge of supply chain		
7	Use teamwork to identify, analyze, and solve safety problems in tower climbs and rescue events		
8	Demonstrate how to test wind turbine rotor blades		
9	Demonstrate fatigue testing and static testing of rotor blades		
10	Identify rotor blade materials		
11	Demonstrate measuring strains		
12	Demonstrate infrared inspection (thermography)		
13	Model forms of rotor blade vibrations		

14	Perform a climb test		
F	Electricity Principles		
1	Solve problems associated with charged bodies, current, and voltage		
2	Solve problems associated with conductance and resistor tolerances		
3	Define Ohm's law and use it to solve for resistance, current, and voltage and determine and use proper prefixes associated with electronic terms		
4	Identify and solve problems associated with both, series and parallel circuits		
5	Accurately read analog and digital multi-meters and install them properly in circuits so they may be used for circuit analysis		
6	Analyze the function and different types of conductors		
7	Describe the relationship between wire size (diameter) and wire gauge (AWG)		
8	Differentiate between a good insulator and a good conductor		
9	Explore the use of switches and safety devices in electrical circuits		
10	Identify different types of batteries and describe their proper application		
11	Analyze the relationship between a current carrying conductor and the magnetic field surrounding the conductor		
12	Define Inductance and capacitance and analyze the effects of capacitor in both AC and DC circuits		
13	Construct digital circuits such as combinational logic circuits, clocking, and timing circuits, analog-to-digital, and digital-to-analog devices		
14	Troubleshoot various digital circuits using schematic diagrams		
15	Convert between decimal, binary, octal, and hexadecimal number systems		
16	Identify operation, truth tables, and logic symbols for an, or, not, nand, nor, and xor gates		
17	Simplify multiple logic gate circuits using Boolean algebra and Karnaugh mapping		
18	Determine the proper operation of RS, master-slave, JK, and D-type flip-flop circuits		
19	Determine the proper orientation of one-shot, monostable, astable, and bistable multivibrator circuits		
20	Verify normal operations for synchronous and asynchronous shift registers and counters		
21	Verify normal operations of 4-bit adders and subtractor circuits and 64-bit memory circuit		
G	DC/AC Circuits		
1	Describe the source of electricity		
2	Perform calculations using decimal, scientific, engineering, and metric notation numbers		
3	Understand and use Kirchoff's law, Ohm's law, and the Power Formula		
4	Demonstrate proper usage of a multimeter and oscilloscope to make measurements		

5	Perform calculations and measurements on series and parallel series DC and AC circuits and series-parallel DC circuits		
6	Perform calculations and measurements on transformer circuits		
7	Construct and analyze DC and AC circuits from simple to complex		
H	Distribution Systems		
1	Construct service entrance		
2	Select equipment and install branch circuit		
3	Identify electrical and stand-by distribution system		
4	Construct, troubleshoot, and repair simple electrical distribution systems		
5	Apply and understand proper grounding procedures		
6	Apply ground fault and ground protective relays		
7	Install line protective devices and protective relaying		
8	Construct an electric metallic tubing conduit system		
9	Calculate circuit loads, conduit fill, and ampacity		
10	Install multiple switch circuit		
11	Demonstrate use of National Electric Code		
12	Demonstrate proper wiring techniques		
13	Calculate and install overcurrent protection		
I	Motor Controls		
1	Analyze schematics and relay logic functions		
2	Sketch and construct magnetic solenoid circuits as specified		
3	Sketch construct, operate, and troubleshoot circuit with motor, motor starter, and control devices		
4	Sketch, construct, operate, and troubleshoot overload protection circuit to comply with all specifications		
5	Demonstrate proper and safe troubleshooting practices		
6	Sketch circuit and construct pushbutton and selectors switches to operate as specified		
7	Select and size relays and conductors		
8	Select and size control circuit components		
9	Select and size line voltage components		
10	Determine proper power source		
J	Basic Fluid Power		
1	Report on characteristics of fluid power and vacuum and their uses in industry		
2	Design a general fluid power system		
3	Identify components of a fluid power system and explain their operation		
4	Discuss building and maintaining vacuum systems		
K	Distributed Control and Programmable Logic		
1	Configure programmable logic controllers (PLCs) to perform various tasks		
2	Utilize programmable logic controllers (PLCs) to interpret sensor and process variable data		

3	Operate and troubleshoot digital systems		
4	Demonstrate the use of SCADA and various data communications systems		
5	Display the ability to configure a smart transmitter		

APPENDIX C

ROUND 2 LETTERS TO PARTICIPANTS

Dear <Name>,

I would like to thank you for taking part in this study "Perceived Skills Needed for Wind Energy Technician." By having completed the first round of this study you are part of the panel of experts of Wind Energy Technicians whom opinion are the cornerstone of this study.

Based on your responses and the responses of your fellow Wind Energy Technicians a second survey round has been developed.

For this second survey there are 121 scale level skill competencies listed into 11 categories. You are asked to review these items and rate them on their importance to be able to enter the career field as a Wind Technician.

The scales for each item are as follows:

1- **Not important at all**
2- **Slightly important**
3- **Important**
4- **Fairly important**
5- **Very important**

At the end of the survey you will find an open ended question asking for any additional skills or knowledge you believe would be important for a person to know or possess to enter this career field.

Your contribution is extremely important to the success of this research, and we greatly appreciate your time and attention to this survey. All responses are held confidentially, and are only reported as a group average.

Thank you again for your assistance in this study.

Sincerely,

Dr. Rudy Ritz
Assistant Professor

Dr. Robert Strong
Assistant Professor

Ricky Coppedge
Doctoral Candidate

APPENDIX D

ROUND 2 INSTRUMENT

Please rate each of the following items on level of importance; please use the following ratings for each skill

1-not important at all/ 2- slightly important/ 3-important/ 4-fairly important/ 5- very important

A	Personal Skills	Ranking
1	Organize a schedule	
2	Know the law, fair and safe labor practice	
3	Communicate effectively, listening, writing, nonverbal communication	
4	Analyze data, use chart and graphs	
5	Use technology on the job, e-mail, hardware, software, and troubleshooting	
6	Make self assessments and knowing ones own abilities	
7	Demonstrate job search and resume preparation skills	
8	Demonstrate preparation for the interview	
B	Leadership	
1	Define leadership or essential skills	
2	Be able to explain the application of leadership to the technical workforce	
3	Discuss the changing roles of technicians in the workforce	
4	Demonstrate the use of basic skills to collect information relating to the changing use of technology	
5	Employ various methods to identify, analyze, and solve a problem	
6	Discuss the decision making process	
7	Identify sources of conflict in the workplace and the community and how to resolve them	
8	Define integrity	
9	Discuss goal setting	
10	Employ methods of time management	
11	Identify the characterisitics of a desired work ethic	
C	Safety	
1	Demonstrate safety procedures for energized electrical work	
2	Demonstrate safety procedures for working with shock and arc boundaries	
3	Demonstrate a flash hazard analysis	

4	Identify types of gear boxes (hybrid, planetary versus helical/parallel shaft) and probable causes of failure	
5	Describe the impact of heat generations on various materials and heat control mechanisms	
6	Define the effects of machining and heat treating on metals as it relates to predictable failures	
7	Identify type, application, and compatibility of different lubricants	
8	Identify gel coats, UV characteristics, flexibility, impact resistance of various coatings and how they are applied	
9	Define the purpose of OSHA as applied to the employer and the employee	
10	Explain and demonstrate lock out/ tag out procedures (simple and complex)	
11	Describe the different types and components of Fall Arrest Systems	
12	Express safe work practices as related to cranes and rigging	
13	Identify Confined Space (permitted and non-permitted)	
14	State the procedure in obtaining a permit to enter a permitted confined space	
15	Demonstrate tool safety: hand and power tools used in the wind industry	
16	Depict the importance of hazardous communication on a wind farm	
17	Explain a MSDS	
18	Demonstrate proficient use of a job hazard analysis for all tasks on a wind farm	
19	Exhibit proficiency in basic First Aid, CPR, and AED	
20	Readily make adjustment to work strategies and methods when maintaining and repairing turbine components	
D	Intro To Wind energy	
1	Define general wind turbine terminology	
2	Describe evolution of wind turbine technology	
3	explain air flow as related to wind turbines	
4	Describe anatomy of a wind farm	
5	Identify safety regulations, personal protective equipment, and practices for wind farm technicians	
6	Examine site construction, foundations, roads, and substation development	
7	Discuss environmental, ethical, and legal obligations of the wind farm	
8	Explain how to plan and schedule maintenance	
E	Applied Wind Energy	

1	Define types of wind turbines	
2	Analyze blade efficiencies	
3	Analyze environmental impacts of both wind resources and blade efficiencies	
4	Analyze operational issues, the components of an operation and maintenance team	
5	Discuss aspects of wind turbine control	
6	Demonstrate a knowledge of supply chain	
7	Use teamwork to identify, analyze, and solve safety problems in tower climbs and rescue events	
8	Demonstrate how to test wind turbine rotor blades	
9	Demonstrate fatigue testing and static testing of rotor blades	
10	Identify rotor blade materials	
11	Demonstrate measuring strains	
12	Demonstrate infrared inspection (thermography)	
13	Model forms of rotor blade vibrations	
14	Perform a climb test	
F	Electricity Principles	
1	Solve problems associated with charged bodies, current, and voltage	
2	Solve problems associated with conductance and resistor tolerances	
3	Define Ohm's law and use it to solve for resistance, current, and voltage and determine and use proper prefixes associated with electronic terms	
4	Identify and solve problems associated with both, series and parallel circuits	
5	Accurately read analog and digital multi-meters and install them properly in circuits so they may be used for circuit analysis	
6	Analyze the function and different types of conductors	
7	Describe the relationship between wire size (diameter) and wire gauge (AWG)	
8	Differentiate between a good insulator and a good conductor	
9	Explore the use of switches and safety devices in electrical circuits	
10	Identify different types of batteries and describe their proper application	
11	Analyze the relationship between a current carrying conductor and the magnetic field surrounding the conductor	
12	Define Inductance and capacitance and analyze the effectsof capacitor in both AC and DC circuits	

13	Construct digital circuits such as combinational logic circuits, clocking, and timing circuits, analog-to-digital, and digital-to-analog devices	
14	Troubleshoot various digital circuits using schematic diagrams	
15	Convert between decimal, binary, octal, and hexadecimal number systems	
16	Identify operation, truth tables, and logic symbols for an, or, not, nand, nor, and xor gates	
17	Simplify multiple logic gate circuits using Boolean algebra and Karnaugh mapping	
18	Determine the proper operation of RS, master-slave, JK, and D-type flip-flop circuits	
19	Determine the proper orientation of one-shot, monostable, astable, and bistable multivibrator circuits	
20	Veify normal operations for synchronous and asynchronous shift registers and counters	
21	Verify normal operations of 4-bit adders and subtractor circuits and 64-bit memory circuit	
G	DC/AC Circuits	
1	Describe the source of electricity	
2	Perform calculations using decimal, scientific, engineering, and metric notation numbers	
3	Understand and use Kirchoff's law, Ohm's law, and the Power Formula	
4	Demonstrate proper usage of a multimeter and oscilloscope to make measurements	
5	Perform calculations and measurements on series and parallel series DC and AC circuits and series-parallel DC circuits	
6	Perform calculations and measurements on transformer circuits	
7	Construct and analyze DC and AC circuits from simple to complex	
H	Distribution Systems	
1	Construct service entrance	
2	Select equipment and install branch circuit	
3	Identify electrical and stand-by distribution system	
4	Construct, troubleshoot, and repair simple electrical distribution systems	
5	Apply and understand proper grounding procedures	
6	Apply ground fault and ground protective relays	
7	Install line protective devices and protective relaying	
8	Construct an electric metallic tubing conduit system	

9	Calculate circuit loads, conduit fill, and ampacity	
10	Install multiple switch circuit	
11	Demonstrate use of National Electric Code	
12	Demonstrate proper wiring techniques	
13	Calculate and install overcurrent protection	
I	Motor Controls	
1	Analyze schematics and relay logic functions	
2	Sketch and construct magnetic solenoid circuits as specified	
3	Sketch construct, operate, and troubleshoot circuit with motor, motor starter, and control devices	
4	Sketch, construct, operate, and troubleshoot overload protection circuit to comply with all specifications	
5	Demonstrate proper and safe troubleshooting practices	
6	Sketch circuit and construct pushbutton and selectors switches to operate as specified	
7	Select and size relays and conductors	
8	Select and size control circuit components	
9	Select and size line voltage components	
10	Determine proper power source	
J	Basic Fluid Power	
1	Report on characteristics of fluid power and vacuum and their uses in industry	
2	Design a general fluid power system	
3	Identify components of a fluid power system and explain their operation	
4	Discuss building and maintaining vacuum systems	
K	Distributed Control and Programmable Logic	
1	Configure programmable logic controllers (PLCs) to perform various tasks	
2	Utilize programmable logic controllers (PLCs) to interpret sensor and process variable data	
3	Operate and troubleshoot digital systems	
4	Demonstrate the use of SCADA and various data communications systems	
5	Display the ability to configure a smart transmitter	

Please list any additional skills or knowledge that you believe a person should know in order to enter the field of becoming a wind technician.

APPENDIX E

ROUND 3 LETTER TO PARTICIPANTS

Dear <Name>,

I would like to thank you for taking part in this study "Perceived Skills Needed for Wind Energy Technician." By having completed the first round of this study you are part of the panel of experts of Wind Energy Technicians whom opinion are the cornerstone of this study.

The results from the second round of this study were combined to create an average rating for each of the 121 items listed. From the 121 items there were only 17 items that were not completely agreed upon. This third and final survey is to determine a consensus on the remaining items.

For this third and final survey there are 17 scale level knowledge and skill competencies listed. Beside each item you will find the average rating that was calculated from all the responses, beside this you will find the rating that you had given the item. To complete this survey you are asked to review the 17 items and the ratings. If you still agree with your original rating then please mark it in the new rating box, but if you believe the rating should be different, please mark your new rating in the box.

The scales for each item are as follows:

1. **Not important at all**
2. **Slightly important**
3. **Important**
4. **Fairly important**
5. **Very important**

Your contribution is extremely important to the success of this research, and we greatly appreciate your time and attention to this survey. All responses are held confidentially, and are only reported as a group average.

Thank you again for your assistance in this study.

Sincerely,

Dr. Rudy Ritz
Assistant Professor

Dr. Robert Strong
Assistant Professor

Ricky Coppedge
Doctoral Candidate

APPENDIX F

ROUND 3 INSTRUMENT

Example
Use the Rating Scale of:
1- Not Important 2- Slightly Important 3- Important 4- rather Important 5- Very Important

		Average Rating	Your Rating	Your New Rating
A	Personal Skills			
1	Organize a schedule	2.31		
2	Know the law, fair and safe labor practice	2.19		
B	Leadership			
7	Identify sources of conflict in the workplace and the community and how to resolve them	2.19		
3	Discuss the changing roles of technicians in the workforce	1.88		
C	Safety			
8	Identify type, application, and compatibility of different lubricants	2.00		
6	Describe the impact of heat generations on various materials and heat control mechanisms	1.75		
D	Intro To Wind energy			
3	Explain air flow as related to wind turbines	1.50		
E	Applied Wind Energy			
5	Discuss aspects of wind turbine control	2.33		
6	Demonstrate a knowledge of supply chain	1.88		
F	Electricity Principles			
20	Verify normal operations for synchronous and asynchronous shift registers and counters	2.00		
16	Identify operation, truth tables, and logic symbols for an, or, not, nand, nor, and xor gates	1.81		
18	Determine the proper operation of RS, master-slave, JK, and D-type flip-flop circuits	1.81		
H	Distribution Systems			
8	Construct an electric metallic tubing conduit system	2.00		
J	Basic Fluid Power			
3	Identify components of a fluid power system and explain their operation	2.44		
1	Report on characteristics of fluid power and vacuum and their uses in industry	2.00		
2	Design a general fluid power system	1.88		
K	Distributed Control and Programmable Logic			
5	Display the ability to configure a smart transmitter	1.94		

APPENDIX G

KNOWLEDGE AND SKILLS COMPETENCIES

Knowledge Competencies

A. Personal Skills

1. Know the law, fair and safe labor practice
2. Use technology on the job, e-mail, hardware, software, and troubleshooting
3. Make self-assessments and knowing one's own abilities.

B. Leadership

1. Discuss the changing roles of technicians in the workforce
2. Employ various methods to identify, analyze, and solve problems,
3. Define integrity
4. Identify the characteristics of a desired work ethic.
5. Define leadership or essential skills
6. Be able to explain the application of leadership to the technical workforce
7. Identify sources of conflict in the workplace and the community and how to resolve them

C. Safety

1. Describe the impact of heat generations on various materials and heat control mechanisms

2. Define the effects of machining and heat treating on metals as it relates to predictable failures
3. Identify type, application, and compatibility of different lubricants
4. Identify gel coats, UV characteristics, flexibility, impact resistance of various coatings and how they are applied
5. Identify types of gear boxes (hybrid, planetary versus helical/ parallel shaft) and probable causes of failure
6. Identify confided space (permitted and non-permitted)
7. Explain a MSDS
8. Define the purpose of OSHA as applied to the employer and the employee
9. State the procedure in obtaining a permit to enter a permitted confined space
10. Describe the different types and components of Fall Arrest Systems
11. Depict the importance of hazardous communication on a wind farm
12. Express safe work practices as related to cranes and rigging

D. Introduction to Wind Energy

1. Describe evolution of wind turbine technology
2. Explain air flow as related to wind turbines
3. Examine site construction, foundations, roads, and substation development

4. Identify safety regulations, personal protective equipment, and practices for wind farm technicians
5. Define general wind turbine terminology
6. Discuss environmental, ethical and legal obligations of the wind farm
7. Describe anatomy of a wind farm
8. Explain how to plan and schedule maintenance

E. Applied Wind Energy

1. Analyze blade efficiencies
2. Analyze environmental impacts of both wind resources and blade efficiencies
3. Identify rotor blade materials
4. Model forms of rotor blade vibrations
5. Define types of wind turbines
6. Discuss aspects of wind turbine control

F. Electricity Principles

1. Identify operation, truth tables, and logic symbols for an, or, not, nand, nor, and xor gates
2. Simplify multiple logic gate circuits using Boolean algebra and Karnaugh mapping
3. Determine the proper operation of RS, master-slave, JK, and D-type flip-flop circuits

4. Determine the proper orientation of one-shot, monostable, astable, and bistable multivibrator circuits
5. Verify normal operations for synchronous and asynchronous shift registers and counters
6. Verify normal operations of 4-bit adders and subrtactor circuits and 64-bit memory circuit
7. Analyze the relationship between a current carrying conductor and the magnetic field surrounding the conductor
8. Solve problems associated with conductance and resistor tolerances
9. Explore the use of switches and safety devices in electrical circuits
10. Define Ohm's law and use it to solve for resistance, current, and voltage and determine and use proper prefixes associated with electronic terms
11. Identify and solve problems associated with both series and parallel circuits
12. Differentiate between a good insulator and a good conductor
13. Define inductance and capacitance and analyze the effects of capacitor in both AC and DC circuits

G. Distribution Systems

1. Identify electrical and stand-by distribution system
2. Calculate and install overcurrent protection
3. Calculate loads, conduit fill, and ampacity

H. Basic Fluid Power

1. Report on characteristics of fluid power and vacuum power and their uses in industry
2. Discuss building and maintaining vacuum systems

Skill Competencies

A. Personal Skills

1. Analyze data, use charts and graphs
2. Communicate effectively, listening, writing, nonverbal communication
3. Demonstrate job search and resume' preparation skills
4. Demonstrate preparation for the interview
5. Organize a schedule

B. Leadership.

1. Discuss the decision making process
2. Discuss goal setting
3. Demonstrate the use of basic skills to collect information relating to the changing use of technology
4. Employ methods of time management

C. Safety

1. Readily make adjustments to work strategies and methods when maintaining and repairing turbine
2. Explain and demonstrate lock out/ tag out procedures (simple and complex)

3. Demonstrate safety procedures for energized electrical work
4. Demonstrate safety procedures for working with shock and arc boundaries
5. Demonstrate tool safety: hand and power tools used in the wind industry
6. Exhibit proficiency in basic first aid, CPR, and AED
7. Demonstrate proficient use of a job hazard analysis for all tasks on a wind farm
8. Demonstrate a flash hazard analysis
9. Readily make adjustment to work strategies and methods when maintaining and repairing turbine components

D. Applied Wind Energy

1. Demonstrate a knowledge of supply chain
2. Demonstrate how to test wind turbine rotor blades
3. Demonstrate fatigue testing and static testing of rotor blades
4. Demonstrate measuring strains
5. Demonstrate infrared inspection (thermography)
6. Performa a climb test
7. Use teamwork to identify, analyze, and solve safety problems in tower climbs and rescue events

8. Analyze operational issues, components of an operation and maintenance team

E. Electricity Principles

1. Convert between decimal, binary, octal, and hexadecimal number systems
2. Accurately read analog and digital mutli-meters and install them properly in circuits so they may be used by circuit analysis
3. Analyze the function and different types of conductors
4. Solve problems associated with charged bodies, current, and voltage
5. Troubleshoot various digital circuits using schematic diagrams
6. Describe the relationship between wire size (diameter) and wire gauge (AWG)
7. Identify different types of batteries and describe their proper application
8. Construct digital circuits such as combinational logic circuits, clocking, and timing circuits, analog-to-digital, and digital-to-analog devices

F. DC/AC Circuits

1. Perform calculations using decimal, scientific, engineering, and metric notation numbers
2. Demonstrate proper usage of a multimeter and oscilloscope to make measurements

3. Describe the source of electricity
4. Perform calculations and measurements on series and parallel series DC and AC cirucits and series-parallel DC circuits
5. Perform calculations and measurements on transformer circuits
6. Understand and use Kirchoff's law, Ohm's law, and the Power Formula
7. Construct and analyze DC and AC circuits from simple to complex

G. Distribution Systems

1. Construct service entrance
2. Select equipment and install branch circuit
3. Construct an electric metallic tubing conduit system
4. Apply and understand proper grounding procedures
5. Demonstrate proper wiring techniques
6. Apply ground fault and ground protective relays
7. Construct, troubleshoot, and repair simple electrical distribution systems
8. Install line protective devices and protective relaying
9. Install multiple switch circuit
10. Demonstrate use of National Electric Code

H. Motor Controls

1. Analyze schematics and relay logic functions
2. Demonstrate proper and safe troubleshooting practices

3. Determine proper power source; analyze schematics and relay logic functions
4. Sketch, construct, operate, and troubleshoot circuit with motor, motor starter, and control devices
5. Sketch, construct, operate, and troubleshoot overload protection circuit to comply with all specifications
6. Sketch circuit and construct pushbutton and selectors switches to operate as specified
7. Select and size relays and conductors,
8. Select and size line voltage components
9. Select and size control circuit components
10. Sketch and construct magnetic solenoid circuits as specified

I. Basic Fluid Power

1. Identify components of a fluid power system and explain their operation
2. Design a general fluid power system

J. Distributed Control and Programmable Logic

1. Display the ability to configure a smart transmitter
2. Demonstrate the use of SCADA and various data communications systems
3. Operate and troubleshoot digital systems

4. Utilize programmable logic controllers (PLC's) to interpret sensor and process variable data
5. Configure programmable logic controllers (PLC's) to perform various tasks